

ISSN (Print) : 2277-7261
ISSN (on-line) : 2278-3857

PRATIBHA

INTERNATIONAL JOURNAL OF SCIENCE,
SPIRITUALITY, BUSINESS & TECHNOLOGY
(IJSSBT)

Vol.1, No.2, February 2013

www.ijssbt.org



SHRAM SADHANA BOMBAY TRUST'S
COLLEGE OF ENGINEERING & TECHNOLOGY, BAMBHORI, JALGAON (INDIA)



Smt Pratibha Devisingh Patil
Former President of India

**Our inspiration
to impart Quality Education for
societal development.**

PRATIBHA

INTERNATIONAL JOURNAL OF SCIENCE, SPIRITUALITY, BUSINESS & TECHNOLOGY

Vol.1, No.2, February 2013 | ISSN (Print) : 2277-7261 | ISSN (On-line) : 2278-3857

***PRATIBHA*: INTERNATIONAL JOURNAL OF SCIENCE, SPIRITUALITY, BUSINESS AND TECHNOLOGY (IJSSBT)**

Vol.1, No.2, February 2013

ISSN (Print) : 2277-7261

ISSN (on-line) : 2278-3857

EDITOR(s)-IN-CHIEF:

Prof. Dr. Kishor S. Wani

Prof. Dr. Dheeraj Sheshrao Deshmukh



IJSSBT

PRATIBHA: INTERNATIONAL JOURNAL OF SCIENCE, SPIRITUALITY, BUSINESS AND TECHNOLOGY (IJSSBT)

Pratibha: International Journal of Science, Spirituality, Business And Technology (IJSSBT) is a research journal published by Shram Sadhana Bombay Trust's, COLLEGE Of ENGINEERING & TECHNOLOGY, Bambhori, Jalgaon, MAHARASHTRA STATE, INDIA. College was founded by FORMER PRESIDENT, GOVT. OF INDIA, Honorable Excellency Sau. PRATIBHA DEVI SINGH PATIL.

College is awarded as **Best Engineering College of Maharashtra State** by Engineering Education Foundation, Pune in year 2008-09.

The College has ten full-fledged departments. The Under Graduate programs in 7 courses are accredited by National Board of Accreditation, All India Council for Technical Education, New Delhi for 5 years with effect from 19/07/2008 vide letter number NBA/ACCR-414/2004. QMS of the College conforms to ISO 9001:2008 and is certified by JAAZ under the certificate number: 1017-QMS-0117. The college has been included in the list of colleges prepared under Section 2(f) of the UGC Act, 1956 vide letter number F 8-40/2008 (CPP-I) dated May, 2008 and 12(B) vide letter number F. No. 8-40/2008(CPP-I/C) dated September 2010. UG courses permanently affiliated to North Maharashtra University are: Civil Engineering, Chemical Engineering, Computer Engineering, Electronics and Telecommunication Engineering, Electrical Engineering, Mechanical Engineering, Information Technology. Two years Post Graduate courses are Mechanical Engineering (Machine Design), Civil Engineering (Environmental Engineering), Computer Engineering (Computer Science and Engineering), Electronics and Telecommunication (Digital Electronics). Civil Engineering Department, Mechanical, Biotechnology and Chemical Engineering Department laboratories are registered for Ph.D. Programs. Spread over 25 Acres, the campus of the college is beautifully located on the bank of River Girna.

The International Journal of Science, Spirituality, Business and Technology (IJSSBT) is an excellent, intellectual, peer reviewed journal that takes scholarly approach in creating, developing, integrating, sharing and applying knowledge about all the fields of study in Engineering, Spirituality, Management and Science for the benefit of humanity and the profession.

The audience includes researchers, managers, engineers, curriculum designers administrators as well as developers.

AIM AND SCOPE

Our philosophy is to map new frontiers in emerging and developing technology areas in research, industry and governance, and to link with centers of excellence worldwide to provide authoritative coverage and references in focused and specialised fields. The journal presents its readers with broad coverage across all branches of Engineering, Management, Spirituality and Science of the latest development and their applications.

All technical, research papers and research results submitted to IJSSBT should be original in nature. Contributions should be written for one of the following categories:

1. Original research
2. Research Review / Systematic Literature Review
3. Short Articles on ongoing research
4. Preliminary Findings
5. Technical Reports / Notes

IJSSBT publishes on the following topics but NOT LIMITED TO:

SCIENCES

- | | |
|---|--|
| ✚ Computational and industrial mathematics and statistics, and other related areas of mathematical sciences | ✚ Artificial intelligence |
| ✚ Approximation theory | ✚ Neural processing |
| ✚ Computation | ✚ Nuclear and particle physics |
| ✚ Systems control | ✚ Geophysics |
| ✚ Differential equations and dynamical systems | ✚ Physics in medicine and biology |
| ✚ Financial math | ✚ Plasma physics |
| ✚ Fluid mechanics and solid mechanics | ✚ Semiconductor science and technology |
| ✚ Functional calculus and applications | ✚ Wireless and optical communications |
| ✚ Linear and nonlinear waves | ✚ Materials science |
| ✚ Numerical algorithms | ✚ Energy and fuels |
| ✚ Numerical analysis | ✚ Environmental science and technology |
| ✚ Operations research | ✚ Combinatorial chemistry |
| ✚ Optimization | ✚ Natural products |
| ✚ Probability and stochastic processes | ✚ Molecular therapeutics |
| ✚ Simulation | ✚ Geochemistry |
| ✚ Statistics | ✚ Cement and concrete research, |
| ✚ Wavelets and wavelet transforms | ✚ Metallurgy |
| ✚ Inverse problems | ✚ Crystallography and |
| | ✚ Computer-aided materials design |

COMPUTER ENGINEERING AND INFORMATION TECHNOLOGY

- | | |
|-------------------------------------|-----------------------------------|
| ✚ Information Systems | ✚ Distributed Computing |
| ✚ e-Commerce | ✚ Telecommunication Systems |
| ✚ Intelligent Systems | ✚ Artificial Intelligence |
| ✚ Information Technology | ✚ Virtual Business and Enterprise |
| ✚ e-Government | ✚ Computer Systems |
| ✚ Language and Search Engine Design | ✚ Computer Networks |
| ✚ Data Mining and Web Mining | ✚ Database Systems and Theory |
| ✚ Cloud Computing | ✚ Knowledge Management |

- ✚ Computational Intelligence
- ✚ Simulation and Modeling
- ✚ Scientific Computing and HPC

- ✚ Embedded Systems
- ✚ Control Systems

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

- | | |
|---|--|
| ✚ 3D Vision | ✚ Nonlinear Signals and Systems |
| ✚ 3D TV | ✚ Signal Reconstruction |
| ✚ Biometrics | ✚ Time-Frequency Signal Analysis |
| ✚ Graph-based Methods | ✚ Filter Design and Structures |
| ✚ Image and video indexing and database retrieval | ✚ Spectral Analysis |
| ✚ Image and video processing | ✚ Adaptive and Clustering Algorithms |
| ✚ Image-based modeling | ✚ Fast Fourier Transforms |
| ✚ Kernel methods | ✚ Virtual, Augmented and Mixed Reality |
| ✚ Model-based vision approaches | ✚ Geometric Computing and Solid Modeling |
| ✚ Motion Analysis | ✚ Game Design and Engine Development |
| ✚ Non-photorealistic animation and modeling | ✚ 3D Reconstruction |
| ✚ Object recognition | ✚ GPU Programming |
| ✚ Performance evaluation | ✚ Graphics and Multimedia |
| ✚ Segmentation and grouping | ✚ Image Processing |
| ✚ Shape representation and analysis | ✚ Interactive Environments |
| ✚ Structural pattern recognition | ✚ Software and Web accessibility |
| ✚ Computer Graphics Systems and Hardware | ✚ Graphics & Perception |
| ✚ Rendering Techniques and Global Illumination | ✚ Computational Photography |
| ✚ Real-Time Rendering | ✚ Pattern recognition and analysis |
| ✚ Fast Algorithms | ✚ Medical image processing |
| ✚ Fast Fourier Transforms | ✚ Visualization |
| ✚ Digital Signal Processing | ✚ Image coding and compression |
| ✚ Wavelet Transforms | ✚ Face Recognition |
| ✚ Mobile Signal Processing | ✚ Image segmentation |
| ✚ Statistical Signal Processing | ✚ Radar Image Processing |
| ✚ Optical Signal Processing | ✚ Sonar Image Processing |
| ✚ Data Mining Techniques | ✚ Signal Identification |
| ✚ Motion Detection | ✚ Super-resolution imaging |
| ✚ Content-based Image retrieval | ✚ Signal Reconstruction |
| ✚ Video Signal Processing | ✚ Filter Design |
| ✚ Watermarking | ✚ Adaptive Filters |
| ✚ Signal Identification | ✚ Multi-channel Filtering |
| ✚ Detection and Estimation of Signal Parameters | ✚ Noise Control |
| | ✚ Control theory and practice |

CIVIL ENGINEERING

- | | |
|--------------------------------------|---|
| ✚ Geotechnical | ✚ Construction Management, and Material |
| ✚ Structures | ✚ Structural mechanics |
| ✚ Transportation | ✚ Soil mechanics and Foundation Engineering |
| ✚ Environmental Engineering | ✚ Coastal engineering and River engineering |
| ✚ Earthquakes | |
| ✚ Water Resources | |
| ✚ Hydraulic and Hydraulic Structures | |

- ✚ Ocean Engineering
- ✚ Fluid-solid-structure interactions, offshore engineering and marine structures

- ✚ Constructional management and other civil engineering relevant areas
- ✚ Surveying
- ✚ Transportation Engineering

CHEMICAL ENGINEERING

- ✚ Organic Chemistry
- ✚ Inorganic Chemistry
- ✚ Physical Chemistry
- ✚ Analytical Chemistry
- ✚ Biological Chemistry
- ✚ Industrial Chemistry
- ✚ Agricultural & Soil Chemistry
- ✚ Petroleum Chemistry
- ✚ Polymers Chemistry
- ✚ Nanotechnology
- ✚ Green Chemistry
- ✚ Forensic
- ✚ Photochemistry
- ✚ Computational
- ✚ Chemical Physics
- ✚ Chemical Engineering
- ✚ Wastewater treatment and engineering
- ✚ Biosorption
- ✚ Chemisorptions
- ✚ Heavy metal remediation
- ✚ Phytoremediation
- ✚ Novel treatment processes for wastewaters

- ✚ Land reclamation methods
- ✚ Solid waste treatment
- ✚ Anaerobic digestion
- ✚ Gasification
- ✚ Landfill issues
- ✚ Leachate treatment and gasification
- ✚ Water and Wastewater Minimization
- ✚ Mass integration
- ✚ Emission Targeting
- ✚ Pollution Control
- ✚ Safety and Loss Prevention
- ✚ Conceptual Design
- ✚ Mathematical Approach
- ✚ Pinch Technology
- ✚ Energy Audit
- ✚ Production Technical Knowledge
- ✚ Process Design
- ✚ Heat Transfer
- ✚ Chemical Reaction Engineering
- ✚ Modeling and simulation
- ✚ Process Equipment Design

ELECTRICAL ENGINEERING

- ✚ Power Engineering
- ✚ Electrical Machines
- ✚ Instrumentation and control
- ✚ Electric Power Generation
- ✚ Transmission and Distribution
- ✚ Power Electronics
- ✚ Power Quality and Economic
- ✚ Renewable Energy

- ✚ Electric Traction, Electromagnetic Compatibility and Electrical Engineering Materials
- ✚ High Voltage Insulation Technologies
- ✚ High Voltage Apparatuses
- ✚ Lightning Detection and Protection
- ✚ Power System Analysis, SCADA and Electrical Measurements

MECHANICAL ENGINEERING

- ✚ Fluid mechanics
- ✚ Heat transfer
- ✚ Solid mechanics
- ✚ Refrigeration and air conditioning
- ✚ Renewable energy technology
- ✚ Materials engineering
- ✚ Composite materials
- ✚ Marine engineering
- ✚ Petroleum and mineral resources engineering

- ✚ Textile engineering
- ✚ Leather technology
- ✚ Industrial engineering
- ✚ Operational research
- ✚ Manufacturing processes
- ✚ Machine design
- ✚ Quality control
- ✚ Mechanical maintenance
- ✚ Tribology

MANAGEMENT

- | | |
|-----------------------------|----------------------------|
| ✚ Accounting and Finance | ✚ Information technology |
| ✚ Marketing | ✚ Business Economics |
| ✚ Operations Management | ✚ Public Sector management |
| ✚ Human resource management | ✚ Organizational behavior |
| ✚ Management Strategy | ✚ Research methods |

SPIRITUALITY

- | | |
|---|---|
| ✚ Relevance of Science and Spirituality in decision and Policy making | ✚ Spiritual Wisdom in disaster management |
| ✚ Rigors in Scientific Research and Insights from Spiritual wisdom | ✚ Techno-Spiritual aspects of development |
| ✚ Dividends from Scientific research and Spiritual Temper | |

BIO-TECHNOLOGY

- | | |
|--|-----------------------------------|
| ✚ Molecular biology and the chemistry of biological process to aquatic and earth environmental aspects as well as computational applications | ✚ Plant biotechnology |
| ✚ Policy and ethical issues directly related to Biotechnology | ✚ Animal biotechnology |
| ✚ Molecular biology | ✚ Marine biotechnology |
| ✚ Genetic engineering | ✚ Environmental biotechnology |
| ✚ Microbial biotechnology | ✚ Biological processes |
| | ✚ Industrial applications |
| | ✚ Bioinformatics |
| | ✚ Biochemistry of the living cell |
| | ✚ Bioenergetics |

IJSSBT prides itself in ensuring the high quality and professional standards.

All submitted papers are to be peer-reviewed for ensuring their qualities.

Frequency : Two issues per year

Page charges : There are no page charges to individuals or institutions.

ISSN : 2277-7261 (Print version) and 2278-3857 (on-line)

Subject Category : Science, Engineering, Business and Spirituality

Published by : Shram Sadhana Bombay Trust's, College of Engineering and Technology, Bambhori, Jalgaon, M.S., India

REQUIREMENTS FOR MANUSCRIPT PREPARATION

The following information provides guidance in preparing manuscript for IJSSBT.

- Papers are accepted only in English.
- Papers of original research, research review/systematic literature review, short articles on ongoing research, preliminary findings, and technical reports/notes should not exceed 15 typeset, printed pages.
- Abstracts of 150-200 words are required for all papers submitted.

- Each paper should have three to six keywords. Section headings should be concise and numbered sequentially as per the following format.
- All the authors (maximum three authors) of a paper should include their full names, affiliations, postal address, telephone and fax numbers and email address on the cover page of the manuscript as per following format. One author should be identified as the Corresponding Author.
- Biographical notes on contributors are not required for this journal.
- For all manuscripts non-discriminatory language is mandatory. Sexist or racist terms should not be used.
- Authors must adhere to SI_units . Units are not *italicized*.
- The title of the paper should be concise and definitive (with key words appropriate for retrieval purposes).

Manuscript Format

Document : The **Manuscript** should be prepared in English language by using MS Word (.doc format). An IJSSBT paper should not exceed 15 typeset, printed pages including references, figures and abstract etc.

Paper : Use A4 type paper page (8.27"x 11.69").

Paper format: two columns with equal width and spacing of 0.25".

Margins : Leave margins of article 1.3" at the left and for top, bottom, and right sides 1".

Font Size and Style: 10 Point Times new roman, and typed in single space, Justified.

Title Page :

- Title of the paper should be in bold face, Title case: font size 16, Times New Roman, centered.
- Name of the authors in normal face, Title case: font size 11 italic, Times New Roman.
- Addresses and affiliations of all authors: normal face, title case font size 10, Times New Roman.
- Email address: normal face, lower case font size 10, Times New Roman.

Abstract (Font size 10, bold face)

Abstract should be in brief and structured. The abstract should tell the context, basic procedure, main findings and principle conclusions. It should emphasize new aspect of study or research. Avoid abbreviation, diagram and references in abstract. It should be single spaced and should not exceed more than 200 words.

Keywords: (Font size 10, bold face, italic)

I. INTRODUCTION (Font size 10, bold face)

Provide background, nature of the problem and its significance. The research objective is often more sharply focused when stated as a question. Both the main and secondary objectives should be clear. It should not include data or conclusions from the work being reported.

All Main Heading with Roman numbers (Font size 10, bold face)

With Subheading of (Font size 10, bold face, Title Case with A, B, C.....Numbering)

Picture / Figure : Pictures and figures should be appropriately included in the main text, e.g. Fig No. 1 (Font size 9).

Table format : Font: Times New Roman, font size: 10
e.g. Table No. 1 (Font size 9)

References (font size 8, Times New Roman)

References should be arranged alphabetically with numbering. References must be complete and properly formatted. Authors should prepare the references according to the following guidelines.

For a book:

References must consist of last name and initials of author(s), year of publication, title of book (italicized), publisher's name, and total pages.

[1] Name and initial of the Author, "Topic Name", title of the book, Publisher name, Page numbers, Year of publication.

For a chapter in a book:

References must consist of last name and initials of author(s), year of publication, title of chapter, title of book (italicized), publisher's name, and inclusive pages for the chapter.

[1] Name and initial of Author, "Title of chapter", *title of the book*, Publisher name, total pages of chapter, year of publication.

For a Journal article:

Journals must consist of last name and initials of author(s), year of publication of journal, title of paper, title of journal (italicized), volume of journal, page numbers (beginning of article - end of article).

[1] Name and initial of the Author, "topic name", *title of journal*, volume & issue of the journal; Page numbers of article, year of publication.

Conference Proceedings:

References must consist of last name and initials of author(s), year of publication, title of paper, indication of the publication as proceedings, or extended abstracts volume; name of the conference (italicized or underlined), city and state and Country where conference was held, conference sponsor's name, and pages of the paper.

[1] Name and initial of the Author, title of the paper, Proceedings, *name of the conference*, City, State, country, page numbers of the paper, Year of publication.

The title of the journal is italicized and font size 8, Times New Roman.

Final Submission:

Each final full text paper (.doc, .pdf) along with corresponding signed copyright transfer form should be submitted by email

editor@ijssbt.org, deshmukh.ijssbt@gmail.com

Website: www.ijssbt.org/com

**S.S.B.T.'S COLLEGE OF ENGINEERING & TECHNOLOGY, BAMBHORI,
JALGAON**

GOVERNING BODY

<i>Dr. D. R. Shekhawat</i>	<i>Chairman</i>
<i>Shri Rajendrasingh D. Shekhawat</i>	<i>Managing Trustee & Member</i>
<i>Shri V. R. Phadnis</i>	<i>Member</i>
<i>Shri Jayesh Rathore</i>	<i>Member</i>
<i>Mrs. Jyoti Rathore</i>	<i>Member</i>
<i>Dr. R. H. Gupta</i>	<i>Member</i>
<i>Arch. Shashikant R. Kulkarni</i>	<i>Member</i>
<i>Dr. K.S. Wani</i>	<i>Principal & Ex-Officio Member Secretary</i>
<i>Shri S. P. Shekhawat</i>	<i>Asso. Prof. & Member</i>
<i>Shri Shantanu Vasishtha</i>	<i>Asstt. Prof. & Member</i>

LOCAL MANAGEMENT COMMITTEE

<i>Dr. D. R. Shekhawat</i>	<i>Chairman</i>
<i>Shri Rajendrasingh D. Shekhawat</i>	<i>Managing Trustee & Member</i>
<i>Shri V. R. Phadnis</i>	<i>Member</i>
<i>Dr. R. H. Gupta</i>	<i>Member</i>
<i>Arch. Shashikant R. Kulkarni</i>	<i>Member</i>
<i>Dr. K.S. Wani</i>	<i>Principal & Ex-Officio Member Secretary</i>
<i>Shri S. P. Shekhawat</i> <i>(Representative of Teaching Staff)</i>	<i>Asso. Prof. & Member</i>
<i>Shri Shantanu Vasishtha</i> <i>(Representative of Teaching Staff)</i>	<i>Asstt. Prof. & Member</i>
<i>Shri S. R. Girase</i> <i>(Representative of Non-Teaching Staff)</i>	<i>Member</i>

EDITOR(s)-IN-CHIEF

Prof. Dr. K. S. Wani,

M. Tech. (Chem. Tech.), D.B.M., Ph. D.
LMISTE, LMAFST, MOTAI, LMBRSI
Principal,
S.S.B.T.'s College of Engineering and Technology,
P.B. 94, Bambhori,
Jalgaon-425001 Maharashtra, India
Mobile No. +919422787643
Phone No. (0257) 2258393,
Fax No. (0257) 2258392,
Email id: wani.kishor@gmail.com

Prof. Dr. Dheeraj Sheshrao Deshmukh

D,M.E., B.E.(Mechanical), M.Tech. (Heat power engineering)
Ph.D. (Mechanical Engineering)
LMISTE
Professor,
Department of Mechanical Engineering,
S.S.B.T.'s College of Engineering and Technology,
P.B. 94, Bambhori,
Jalgaon-425001, Maharashtra State, India
Mobile No. +91 9822418116
Phone No. (0257) 2258393,
Fax No. (0257) 2258392.

Email id : **editor@ijssbt.org**
deshmukh.ijssbt@gmail.com

Web Address : **www.ijssbt.org/com**

EDITORIAL BOARD

Prof. Subramaniam Ganesan

Director, Real Time & DSP Lab.,
Electrical and Computer Engineering Department,
Oakland University, Rochester, MI 48309, USA.
IEEE Distinguished Visiting Speaker (2005-2009) and Coordinator.
IEEE SEM CS chapter Chair, Region 4 and CS Society Board member
SAE, ASEE, ACM member

Prof. Alok Verma

Old Dominion University
Norfolk
Virginia, USA

Prof. Evangeline Gutierrez

Programme Manager, Global Science and Technology Forum Pvt. Ltd
10 Anson Road, Singapore

Dr. G.P. Patil

Distinguish Professor of Mathematics Statistics
Director, Center for Statistical Ecology and Environmental Statistics
Editor-in-Chief, Environmental and Ecological Statistics
Department of Statistics
The Pennsylvania State University, USA

Dr. Abad A. Shah

Professor, Department of Computer Science & Engineering
University of Engineering and Technology
G. T. Road Lahore, Pakistan

Dr. Anshuman Tripathi

Ph. D.
Principal Engineer
VESTAF, SINGAPORE

Dr. Muhammad Masroor Ali

Professor, Department of Computer Science and Engineering
Bangladesh University of Engineering and Technology
Dhaka-1000, Bangladesh mmasroorali@cse.buet.ac.bd

Dr. Ramesh Chandra Goel

Former Director General
Deharadun Institute of Technology
Deharadun, Uttarakhad, India

Dr. Dinesh Chandra

Ph. D.
Professor
Department of Electrical Engineering
Motilal Nehru National Institute of Technology
Allahabad-U.P., India

Dr. Bharti Dwivedi

Ph. D.
Professor
Department of Electrical Engineering
Government Institute of Engineering & Technology
Luknow, India

Dr. L. A. Patil

Ph. D.
Professor & Head
Dept of Physics
Pratap College Amalner
Jalgaon, India

Dr. M. Qasim Rafiq

Ph. D. (Computer Engineering)

Professor

Senior Member IEEE (USA)

FIETE, FIE, LMCSI

Department of Computer Engineering

Z.H. College of Engineering & Technology

Aligarh Muslim University (A.M.U.) Aligarh, India

Dr. Razaullah Khan

Ph. D. (Civil Engineering)

Professor

Department of Civil Engineering

Z.H. College of Engineering & Technology

Aligarh Muslim University (A.M.U.)

Aligarh, India

Dr. K. Hans Raj

Professor

Department of Mechanical Engineering

Faculty of Engineering

Dayalbagh Educational Institute, Dayalbagh

AGRA-India

Dr. Durgesh Kumar Mishra

Professor and Head (CSE), Dean (R&D)

Acropolis Institute of Technology and Research, Indore, MP, India

Chairman, IEEE Computer Society, Bombay Chapter

Chairman IEEE MP Subsection

Chairman CSI Indore Chapter

Dr. Sudhir Chincholkar

Ph.D. Microbiology

Professor & Head (Microbiology)

N.M.U. University, Jalgaon, India

Dr. M. A. Lokhande

Ph. D.

Professor and Head

Department of Commerce

Member Indian Commerce Association

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, India

Dr. K. K. Shukla

Ph.D.

Professor

Department of Civil Engineering

Motilal Nehru National Institute of Technology

Allahabad- U.P., India

Dr. Rahul Caprihan

Ph.D.
Professor
Department of Mechanical Engineering
Faculty of Engineering
Dayalbagh Educational Institute
Dayalbagh, Agra, India

Dr. Satish Kumar

Ph. D.
Professor
Department of Electrical Engineering
Faculty of Engineering
Dayalbagh Educational Institute
Dayalbagh, Agra, India

Dr. Ved vyas j. Dwivedi

Professor (Electronics and Communication Engineering)
Director
Noble Group of Institutions, Junagadh, Gujarat, India
Editor-in-Chief
International Journal on Science and Technology

Dr. Ram Pal Singh

Ph.D.
Professor
Department of Civil Engineering
Motilal Nehru National Institute of Technology
Allahabad- India

Dr. Anurag Tripathi

Ph.D.
Professor
Department of Electrical Engineering
Government Institute of Engineering & Technology
Luknow, India

Dr. (Mrs.) Arunima De

Ph.D.
Professor
Department of Electrical Engineering
Government Institute of Engineering & Technology
Luknow, India

Dr. A.P. Dongre

Ph. D.
Department of Management Studies
North Maharashtra University, Jalgaon India

Dr. V. Venkatachalam

Principal, The Kavery Engineering College,
Mecheri. Salem District.

Dr. T. Ravichandran

Research Supervisor,
Professor & Principal
Hindustan Institute of Technology
Coimbatore, Tamil Nadu, India

Dr. Bhushan Trivedi

Professor & Director, GLS-MCA, Ahmedabad.

Dr. Neeraj Bhargava

HoD, Department of Computer Science,
MDS University, Ajmer.

Dr. Cristina Nita-Rotaru

Purdue University

Dr. Rupa Hiremath

Director, IIPM, Pune

Dr. A. R. Patel

HoD, Department of Computer Science,
H. North Gujarat University, Patan. Gujarat

Dr. Priyanka Sharma

Professor, ISTAR, VV Nagar,
Gujarat.

Dr. V.P. Arunachalam

Principal
SNS College of Technology
Sathy Main Road,
Coimbatore - 35.

Dr. B. S. Agrawal

Gujarat

Dr. Satyen Parikh

Professor, Dept of Comp Sci.
Ganpat University, Mehsana. Gujarat.

Dr. P. V. Viraparia

VV Nagar, Gujarat.

Dr. Arumuganathan

Professor, Department of Mathematics and Computer Applications
PSG College of Technology, Coimbatore-641 004
Tamilnadu, INDIA.

Dr. H. B. Bhadka

Director (I/c)
C. U. Shah College of Master of Computer Application
Campus of C. U. Shah College of Engineering & Technology
Surendranagar-Ahmedabad

Dr. Mohammed Mussadiq

Ph. D.
Professor & Head, Department of Microbiology,
Shri Shivaji College of Arts, Commerce & Science, Akola.

Dr. Zia-Ul Hasan Khan

Ph. D.
Professor & Head, Department of Biochemistry,
Shri Shivaji College of Arts, Commerce & Science, Akola.

Dr. Shailendra Kumar Mittal

Ph.D. (Electrical Engineering)
Professor
Member IEEE, Senior Member IACSIT, LMISTE

Dr. Manish Sheshrao Deshmukh

Ph.D. (Mechanical Engineering)
Professor & Head, Mechanical Engineering Department,
Guru Nanak Institute of Engineering & Management, Nagpur.

PUBLICATION SECRETARY

PRAVIN D. PATIL

Assistant Professor
Mechanical Engineering Department
S. S. B. T.'s College of Engineering and Technology, Bambhori, Jalgaon (M.S.)

DHANESH S. PATIL

Assistant Professor
Electrical Engineering Department
S. S. B. T.'s College of Engineering and Technology, Bambhori, Jalgaon (M.S.)

LOCAL REVIEW COMMITTEE

Dr. K. S. Wani

Principal
S.S.B.T.'s College of Engineering &
Technology,
Bambhori, Jalgaon

Dr. M. Husain

Professor & Head
Department of Civil Engineering

Dr. I.D. Patil

Professor & Head
Department of Bio-Technology

Dr. S.L. Patil

Associate Professor & Head
Department of Applied Science

Dr. M. N. Panigrahi

Professor
Department of Applied Science

Dr. V.R. Diware

Assistant Professor
Department of Chemical Engineering

S. R. Suralkar

Associate Professor & Head
Department of Electronics &
Telecommunication Engineering

J. R. Chaudhary

Associate Professor & Head
Department of Mechanical Engineering

K. P. Adhiya

Associate Professor & Head
Department of Computer Engineering

D. U. Adokar

Associate Professor & Head
Department of Electrical Engineering

Archana K. Bhavsar

Assistant Professor & Head
Department of Information Technology

V. S. Rana

Assistant Professor & Head
Department of Business Administration

**PRATIBHA: INTERNATIONAL JOURNAL OF SCIENCE,
SPIRITUALITY, BUSINESS AND TECHNOLOGY
(IJSSBT)**

Table of Contents

Volume 1, No.2, February, 2013

Improving the Reliability of Linear Dynamic Transformer by Using Thermal Modelling.....	01
<i>Prof K. R. Patil, Miss S. S. Thakare, Miss N. B. Pawar,</i>	
Analysis of Adaptive Group Key Management Protocol Using Network Simulator 2	09
<i>Mr. Rahul B. Mapari, Mr. Jaykumar S. Dhage, Ms. Dipa D. Dharmadhikari</i>	
Electric Arc model for High Voltage Circuit Breakers Based on MATLAB / SIMULINK.....	15
<i>N. S. Mahajan, K. R. Patil, S. M. Shembekar</i>	
Academic Self Study Report: a Strategic tool to measure the Institutional Performance.....	22
<i>S. P. Shekhawat, Vishal. S. Rana</i>	
Application of Phasor Measurement Unit In Smart Grid.....	26
<i>Chandarani Sutar, Dr. K. S. Verma</i>	
Examine the Effect of Wind Turbine Parameter on Its Dynamic Behavior	32
<i>Prof K. R. Patil, Miss N. B. Pawar, Miss S. S. Thakare</i>	
Marketing Strategies of Indian Automobile Companies: A Case Study of Maruti Suzuki India Limited	40
<i>Dr. M. A. Lokhande, Vishal Sunil Rana</i>	
A Detailed Model of The Space Vector Modulated Control Of A VVVF Controlled Ac Machine Including The Overmodulation Region.....	46
<i>Vandana Verma, Anurag Tripathi</i>	
Seasonal Variation of Heavy Metal in Tapti River	51
<i>A. A. Patil, C. P. Sawant</i>	
Impact of Fluoride on Environment & Human Health	56
<i>Durgesh Pratap and Dhananjay Singh</i>	
An Overview of Government Agriculture Subsidies in India	62
<i>Harshal A Salunkhe, Dr.B.B.Deshmush</i>	
The Medical Image Compression with Embedded Zerotree Wavelet	67
<i>ABDUL SATTAR</i>	

Classification of Faults on 400 KV Transmission Line.....	71
<i>Dr. M. A. Beg, N. G. Bundhe, S. R. Paraskar</i>	
Investigation of Human Resource Management Practices (HRM) in Hospitals of Jalgaon District	76
<i>Saroj B. Patil, Dr. P.T.Choudhari</i>	
Role of Constitutional Ruling System	82
<i>Sakina Husain, Dr. M Husain and, Dr. K S Wani</i>	
Response Spectrum Analysis of Asymmetrical Building.....	85
<i>Pravin Ashok Shirule, Bharti V. Mahajan</i>	
Spherical Electrical Machines	89
<i>Bhagat Singh Tomar, Apeksha Narendra Rajput</i>	

Improving the Reliability of Linear Dynamic Transformer by Using Thermal Modelling

1. Prof K. R. Patil, 2. Miss S. S. Thakare 3. Miss N. B. Pawar,

Dept of Electrical Engg, K.C.E. C.O.E. &I.T., Jalgaon (ME EPS Students)

E-mails: 1. patil_kautik@rediffmail.com, 2. sneha.thakare26@gmail.com 3. nampaw@gmail.com.

Abstract

Improving the utilisation of transformers requires that the hot-spot and top-oil temperatures be predicted accurately. Using measured (noisy) data to derive equivalent linear dynamic thermal models yields performance that is superior to the ANSI standard model, but the reliability of these model coefficients must be assessed if the user is to have confidence in the model. By adding arbitrarily large amounts of data in the modelling process it was expected to make the reliability measures of these models arbitrarily small. When this did not happen, an investigation Began that showed why there is a limitation to the accuracy of models derived from noisy data. It is also shown that a standard technique for assessing the reliability of model coefficients is invalid because of the absence of unmeasured driving variables. An alternative method for assessing Transformer model reliability is provided.

Keywords: - Reliability analysis, thermal modelling, FFT to filter TOT noise

I. INTRODUCTION

Transformers of distribution-class capacity or higher, will eventually be dynamically loaded using thermal models derived from field data. These models are not only more accurate, but also allow derivation of statistics of the model's accuracy. These statistics can be used in probabilistic transformer loading. The traditional ANSI/IEEE top-oil rise model is known to perform poorly compared to top-oil models trained with measured data Models trained using measured data are superior because they naturally account for many undetected phenomena in operating transformers, such as fouled heat exchangers, inoperative pumps/fans, etc. The inability to account for undetected faults and to detect erroneous test report parameters is likewise a limitation of the IEEE/ANSI Appendix G model using the Appendix G model also requires

parameters that most utilities do not have. There is a need in this field of research to define measures of acceptability of "model and method," that can be used by researchers and model users alike.

When used by researchers, these measures should allow evaluation of the model's structure. For model users, these measures should give assess the model consistency and accuracy. One goal of this paper is to identify models from the many available that require parameters available from heat run data and need only measurements utilities routinely monitor. We express these models using a common notation that allows their similarities and difference to be assessed easily. Our second goal is to define metrics to quantitatively measure adequacy, consistency, and accuracy, and then, in a companion paper, apply these metrics to rank models according to their acceptability Of the potential first and higher-order, linear and nonlinear models we selected four top-oil model.

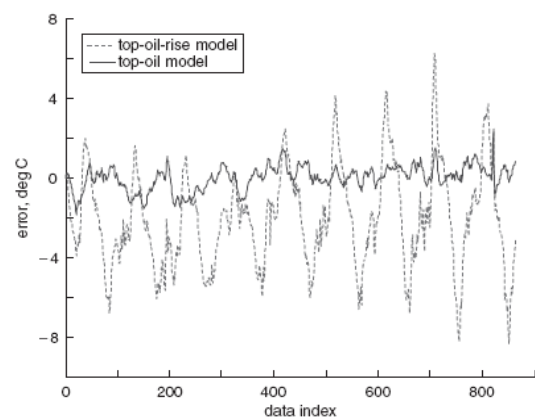


Fig. 1 Comparison of top-oil model and top-oil-rise model

Figure 1 shows the typical errors we observe when predicting transformer top-oil temperature using a linear model (i.e. top-oil model) constructed from data measured in situation against a nonlinear ANSI model constructed from transformer test report coefficients.

The model created from field data is superior because it accurately represents what is in

the field which is often different from OEM equipment. The model created from field data is superior also because it neither relies on a single transformer test, which may be inaccurate, nor does it rely on the existence of transformer test reports, which are sometimes lost, making determining the parameters of the transformer

2 Fundamental model

The traditional top-oil-rise model [1] is governed by the differential equation

$$T_o \frac{d\theta_o}{dt} = -\theta_o + \theta_u \quad (1)$$

which has the solution

$$\theta_o = (\theta_u - \theta_i)(1 - e^{-(t/T_o)}) + \theta_i \quad (2)$$

where

$$\theta_u = \theta_{fl} \left(\frac{K^2 * R + 1}{R + 1} \right)^n \quad (3)$$

$$T_o = \frac{C\theta_{fl}}{P_{fl}} \quad (4)$$

and

θ_o	top-oil rise over ambient temperature ($^{\circ}\text{C}$)
θ_{fl}	top-oil rise over ambient temperature at rated load ($^{\circ}\text{C}$)
θ_u	ultimate top-oil rise for load L ($^{\circ}\text{C}$)
θ_i	initial top-oil rise for $t=0$ ($^{\circ}\text{C}$)
θ_{amb}	ambient air temperature ($^{\circ}\text{C}$)
T_o	time constant
C	thermal capacity ($\text{Wh}/^{\circ}\text{C}$)
P_{fl}	total loss at rated load (W)
n	oil exponent
K	ratio of load L to rated load
R	ratio of load loss to no-load loss at rated load.

The TOT is then given by,

$$\theta_{vp} = \theta_o + \theta_{amb} = (\theta_u - \theta_i)(1 - e^{-(t/T_o)}) + \theta_i + \theta_{amb} \quad (5)$$

The top-oil model [3] (cf. top-oil-rise model) corrects the dynamic limitations of the top-oil-rise model by including in (1) the dependence of the time rate of change of θ_{top} on ambient temperature θ_{amb}

$$T_o \frac{d\theta_{top}}{dt} = -\theta_{top} + \theta_{amb} + \theta_u \quad (6)$$

This equation has the solution

$$\theta_{top} = (\theta_u + \theta_{amb} - \theta_i)(1 - e^{-(t/T_o)}) + \theta_i \quad (7)$$

To obtain a discrete-time model we discretise (6) by applying the forward Euler discretisation rule

$$\frac{d\theta_{top}[k\Delta t]}{dt} = \frac{\theta_{vp}[k\Delta t] - \theta_{top}[(k-1)\Delta t]}{\Delta t} \quad (8)$$

to yield (with the assumption that $n = 1$)

$$\theta_{vp}[k] = K_1 I[k]^2 + K_2 \theta_{amb}[k] + (1 - K_2) \theta_{vp}[k-1] + K_3 \quad (9)$$

Where K_1 & K_3 are functions of the differential equation coefficients and $I[k]$ is the per-unit transformer current (based on the rated value of the transformer) at time-step k .

To obtain a model based on measured field data we choose the coefficients that best fit the measured data (rather than using the formulas for the K_x s from test report data).

We have examined many optimisation techniques of finding the best K_x s and have observed linear regression (least-squares method) to be among the best and easiest to use. To use the least-squares method to obtain K_1 & K_3 is reformed as

$$Y[k] = K_1 X_1[k] + K_2 X_2[k] + K_3 \quad (10)$$

where

$$Y[k] = \theta_{vp}[k] - \theta_{top}[k-1]$$

$$X_1[k] = I[k]^2$$

$$X_2[k] = \theta_{amb}[k] - \theta_{top}[k-1]$$

Assuming m sets of independent X measurements, (10) can be rewritten in matrix format as

$$Y = K_1 X_1 + K_2 X_2 + K_3 [1 \quad 1 \quad \dots \quad 1]_{1 \times m}^T \quad (11)$$

where

$$Y = [Y[1] \quad Y[2] \quad \dots \quad Y[m]]^T$$

$$X_i = [X_i[1] \quad X_i[2] \quad \dots \quad X_i[m]]^T, \quad i = 1, 2$$

Averaging both sides of (11) over time-step index k yields

$$\bar{Y} = K_1 \bar{X}_1 + K_2 \bar{X}_2 + K_3 \quad (12)$$

where the over-bar represents variables averaged over time. For example

$$\bar{X}_1 = \frac{1}{m} \sum_{k=1}^m X_1[k]$$

Subtracting (12) from each equation in (11) gives

$$\tilde{Y} = K_1 \tilde{X}_1 + K_2 \tilde{X}_2 \quad (13)$$

where the tilde represents variables of zero mean and

$$\tilde{Y} = [Y[1] - \bar{Y} \quad Y[2] - \bar{Y} \quad \dots \quad Y[m] - \bar{Y}]^T$$

$$\tilde{X}_i = [X_i[1] - \bar{X}_i \quad X_i[2] - \bar{X}_i \quad \dots \quad X_i[m] - \bar{X}_i]^T \quad i = 1, 2$$

Equation (13) can be rewritten as

$$\tilde{Y} = \tilde{X} K \quad (14)$$

where

$$\tilde{X} = [\tilde{X}_1 \quad \tilde{X}_2]$$

$$K = [K_1 \quad K_2]^T$$

With the least-squares method the formula to calculate these coefficients is

$$K = (\tilde{X}^T \tilde{X})^{-1} \tilde{X}^T \tilde{Y} \quad (15)$$

After K_1 and K_2 are obtained, K_3 can be calculated from (12) as

$$K_3 = \bar{Y} - K_1 \bar{X}_1 - K_2 \bar{X}_2 \quad (16)$$

Using these equations for K_x we can calculate the transformer thermal time constant and top-oil rise at full load.

III. CAUSE OF MODEL VARIABILITY

When using (15) and (16) to calculate the Kx coefficients we found our models were not as consistent as we expected, even when derived from load and temperature data that seem, to the eye, to be consistent. For example, we constructed eight models using data measured from one transformer over a period of two summer months in Arizona. During this time the daily variation of load and ambient temperature was relatively uniform; however the coefficients resulting from our model building, listed in Table 1, show variations as high as 19%. We suspected that these variations were due to noise in the input data. We expected that if we put sufficient data into the modelling procedure, the random effects of measurement noise would average out and that we could bring the Kx coefficients into an arbitrarily narrow band. To test this hypothesis we designed experiments to duplicate the effect of measurement noise. Using simulated data allowed us to eliminate the effects of nonlinearities that may be present in the physical process and to eliminate the effects of any unknown missing driving variables.

Table 1: Variability of transformer thermal model coefficients

Data set	K_1	K_2	K_3
1	3.1068	0.0961	0.5277
2	3.0589	0.0905	0.3901
3	3.1632	0.0911	0.4277
4	2.8474	0.0797	0.2667
5	2.7130	0.0814	0.4367
6	2.9740	0.0843	0.3706
7	2.8518	0.0864	0.4621
8	2.8679	0.0936	0.4860
Mean	2.9479	0.0879	0.4210
STD	0.1538	0.0059	0.0801
STD%	5.22%	6.66%	19.02%

3.1 Observation in coefficients:-

Figure 2 shows K1 against the standard deviation of the Gaussian noise added to the TOT data. It can be seen that K1 becomes larger than its true value when the TOT data is noisy. Further, it increases monotonically as the magnitude of the noise increases. Results show that plots of K2 and K3 Against the standard deviation of the noise have a similar pattern.

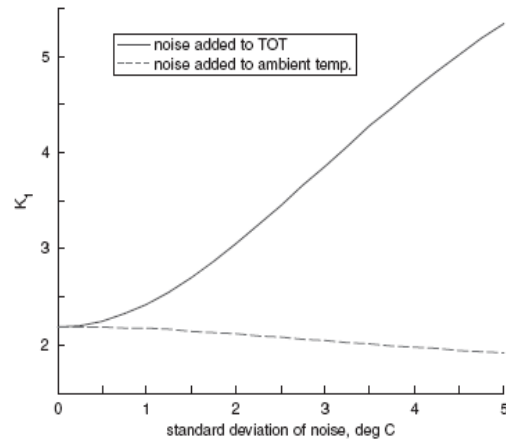


Fig. 2 K_1 against the standard deviation of gaussian noise added to the TOT data, and the ambient temperature data

We obtained similar results when we applied uniformly distributed random noise to TOT data. We found that all the coefficients were much less sensitive to noise added to the ambient temperature data or load Data than noise is added to TOT as shown in Fig. 2 and that regardless of the amount of data we put in our Modelling procedure, we could not bring the Kx values to Within an arbitrarily narrow range.

3.2.1 Ill-conditioned matrix:

To discover why the modelling process is sensitive to noise we first looked at the condition number of the coefficient matrix. Consider the equation used to calculate the coefficients (15), written in an equivalent form

$$(\tilde{X}^T \tilde{X})K = \tilde{X}^T \tilde{Y} \quad (17)$$

To show the effect of a large condition number graphically we expand (17) as

$$\begin{bmatrix} \tilde{X}_1^T \tilde{X}_1 & \tilde{X}_1^T \tilde{X}_2 \\ \tilde{X}_2^T \tilde{X}_1 & \tilde{X}_2^T \tilde{X}_2 \end{bmatrix} \begin{bmatrix} K_1 \\ K_2 \end{bmatrix} = \begin{bmatrix} \tilde{X}_1^T \tilde{Y} \\ \tilde{X}_2^T \tilde{Y} \end{bmatrix} \quad (18)$$

which can be expressed as

$$\begin{bmatrix} (m-1)\text{var}(X_1) & (m-1)\text{cov}(X_1, X_2) \\ (m-1)\text{cov}(X_1, X_2) & (m-1)\text{var}(X_2) \end{bmatrix} \begin{bmatrix} K_1 \\ K_2 \end{bmatrix} = \begin{bmatrix} (m-1)\text{cov}(X_1, Y) \\ (m-1)\text{cov}(X_2, Y) \end{bmatrix} \quad (19)$$

Where, var is the variance operator, and is the covariance operator. Equation (19) represents two lines in the K_2 against K_1 co-ordinate plane, the intersection of which is the solution of (19)

$$\text{line1: } K_2 = \frac{\text{cov}(X_1, Y) - \text{var}(X_1) \cdot K_1}{\text{cov}(X_1, X_2)} \quad (20)$$

$$\text{line2: } K_2 = \frac{\text{cov}(X_2, Y) - \text{cov}(X_1, X_2) \cdot K_1}{\text{var}(X_2)} \quad (21)$$

When the relatively small amount of uniformly distributed random noise in TOT, 70.51C, is applied to measured TOT data.

$$\tilde{X}^T \tilde{X} = \begin{bmatrix} 32.654 & -240.650 \\ -240.650 & 24490.0 \end{bmatrix}$$

$$\tilde{X}^T \tilde{Y} = \begin{bmatrix} 51.5844 \\ 1565.61 \end{bmatrix}$$

And the solution of the K_x coefficients becomes

$$K = \begin{bmatrix} K_1 \\ K_2 \end{bmatrix} = \begin{bmatrix} 2.2110 \\ 0.08565 \end{bmatrix}$$

Analysing coefficient matrix when noise is present:-

Analyse the coefficient matrix after introducing a noise model. The results of this analysis, shown in approximations (22) and (23), shows that line 1 is (approximately) unaffected by noise, while the approximation for line 2 differs from (21) by the presence of an additional term $\text{var}(N_1)$. This new term the variance of the added noise to the simulated TOT.

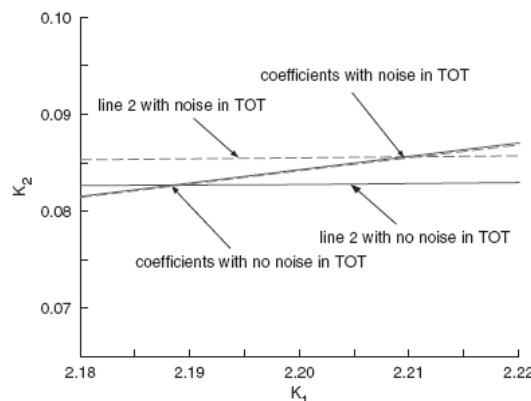


Fig. 3 Effect on coefficients with slight noise in TOT

$$\text{line1: } K_2 \approx \frac{\text{cov}(X_1, Y) - \text{var}(X_1) \cdot K_1}{\text{cov}(X_1, X_2)} \quad (22)$$

$$\text{line2: } K_2 \approx \frac{\text{cov}(X_2, Y) + \text{var}(N_1) - \text{cov}(X_1, X_2) \cdot K_1}{\text{var}(X_2)} \quad (23)$$

This analysis shows that K_1 and K_2 will always increase when noise in TOT is added, which is consistent with the numerical results we observed and shown in Fig. 2. Further, it shows that regardless of the number of points in the data set, the coefficients obtained from data sets with different amounts of noise cannot be brought into an arbitrarily small range unless either the variance of the applied noise is Reduced or the variances and covariance shown in made invariant, something that is not within our control with field data. To eliminate or reduce the value of $\text{var}(N_1)$ in (23), we investigated using the FFT as a low-pass filter to reduce noise in the TOT input data. We chose to investigate noise in TOT because this source of noise has the most severe effect on the variance of the coefficients. We first applied this filter to simulated data and then to field data

4 Using FFT to eliminate TOT noise

4.1 Applying FFT to filter TOT noise in Simulated data:-

Because the time constant associated with a transformer's TOT is about 3 to 5 hours, only the relatively low frequencies of the TOT have information that comes from the TOT heating process. Measurement noise introduced into the TOT manifests itself mainly as high-frequency components. Our hypothesis was: we can reduce in (23) by eliminating the high-frequency components.

Using the simulated data constructed earlier, normally distributed zero-mean random noise with 1.51C standard deviation was first added to the TOT and then the FFT was applied to the noisy TOT with different cut off frequencies

Table 2: Applying FFT to one simulated data set

Cutoff freq. (cycle/day)	K_1
3	2.0741
5	2.0992
8	2.1156
10	2.1266
17	2.1546
21	2.1903
30	2.3187
40	2.5286
no FFT	2.7000
true value	2.1882

It can be seen from Table 2 that when the cut off Frequency is too low, the K_1 coefficient strays far from its true value: too many frequency components are eliminated which eliminates signal in addition to noise. On the other hand, when the cut off frequency is too high, K_1 strays far from its true value also: too much noise is preserved. Our experiments showed that the optimum filter involved retaining about 21 cycles per day. In another test we repeated the experiment on many independent data sets and used the variation of the model coefficients as the evaluation of the effectiveness of the FFT.

The assumption here is that if the FFT is removing noise, the models derived should have a narrower range of coefficients. Table 3 shows results obtained by using the FFT to filter TOT data with different cut off frequencies applied to 17 sets of simulated data. It can be seen from Table 3 that the FFT reduces the variation in the model coefficients, and the swift reduction continues until the FFT cut off frequency drops below about 21 cycles per day not caused by random measurement noise, but by either missing driving variables or unmodelled nonlinearities. Note that both of these confounding modeling issues (nonlinearities and missing driving variable) will appear as virtual input–data noise leading to unwanted variation in Our coefficients. Since there is no way to eliminate the variation in coefficients it is necessary to quantify the reliability of the model we produce.

Table 3: Applying FFT to many independent simulated data sets

Cutoff freq (cycle/day)	STD% of K_1
3	1.55
5	1.40
8	1.31
10	1.42
17	1.55
21	1.79
30	3.74
40	6.65
no FFT	8.88

4.2 Applying FFT to filter TOT noise in Measured data:-

Since there is no guarantee that the cut off frequency determined will be the same for measured data, the experimental approach to determining the cut off frequency, by minimising the variance of the K_x values, was performed using measured data. The experiment determined the K_x values using 17 independent data sets, and used the variation of the model coefficients as the evaluation of the effectiveness of the FFT. Table 4 shows the results of using the FFT to filter TOT data with different cut-off frequencies. While the variation in these coefficients is acceptable for modelling, it can be seen from Table 4 that the FFT essentially does not reduce the variation in the model coefficients. The lack of change in the field-data STD near 21 cycles a day implies that variability of the coefficients is not caused by random measurement noise, but by either missing driving variables or unmodelled nonlinearities. Note that both of these confounding modelling issues (nonlinearities and missing driving variable) will appear as virtual input–data noise leading to unwanted variation in our coefficients.

Since there is no way to eliminate the variation in Coefficients it is necessary to quantify the reliability of the model we produce.

Table 4: Applying FFT to field data

Cutoff freq. (cycle/day)	STD%		
	K_1	K_2	K_3
3	4.57	4.44	6.60
5	4.76	4.59	6.40
8	4.83	4.72	6.53
10	4.86	4.79	6.63
17	4.90	4.91	6.86
21	4.94	4.98	6.95
30	5.00	5.12	7.16
40	5.03	5.22	7.37
no FFT	5.06	5.29	7.49

5 Reliability analysis:-

5.1 Traditional reliability analysis

For a given confidence level it is possible to calculate the confidence interval of each of the coefficients that result from linear regression

$$CI_{K_i} = [K_i - \sigma \sqrt{(\tilde{X}^T \tilde{X})^{-1}} \cdot t, K_i + \sigma \sqrt{(\tilde{X}^T \tilde{X})^{-1}} \cdot t], \quad i = 1, 2 \quad (24)$$

Where CI_{K_i} is the confidence interval of K_i ($i=1, 2$); σ is the standard deviation of the residuals and t is the number of standard deviations corresponding to a given confidence level.

Assuming a desired confidence level of 95% for K_1 , and then after calculating the corresponding confidence interval we can then say we are confident that the true value of K_1 for our model lies within the calculated confidence interval 95% of the time. That is, we can expect that for each coefficient we calculate, the 95% confidence interval surrounding that coefficient will enclose the true value 95% of time, or 19 out of 20 times.

We first applied the confidence interval approach to the simulated data with TOT corrupted by normally-distributed zero-mean random noise with 0.51C standard deviation. Figure 4 shows the calculated K_1 coefficient with confidence intervals corresponding to a 95% confidence level for data samples taken from various times of the year. This Figure shows that the real value of K_1 as well as the mean value and the median value of calculated K_1 stay in the confidence interval 100% of the time. This is slightly more often that we would expect; however, because our sample was so low (we had only 17 sets of coefficients), the results shown do not violate the theory.

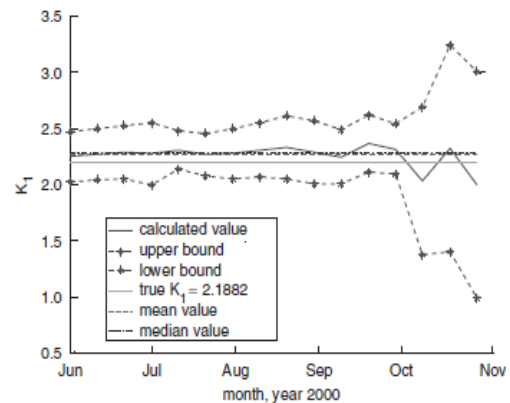


Fig. 4 Applying confidence interval to simulated data with normally distributed noise

We applied this confidence interval approach to the field data, calculating the confidence interval based on a 95% confidence level. Inspection of Fig. 5 (which corresponds to the numerical confidence intervals shown in the middle column of Table 5) shows that there is no way to pick a 'true K_1 ' that is within the calculated confidence intervals 95% of the time. This apparent paradox shows that the inconsistency of the model coefficients is not mainly due to random noises, but to either the incompleteness of the model, e.g. missing driving variables or the nonlinearity in the transformer thermal process. It is impossible with a linear regression approach to distinguish whether the virtual noise in our data comes from unmodelled nonlinearities or unmodelled (and unmeasured) driving variables. Both of these sources of virtual noise are perceived identically by the linear regression process. To show that either of these sources of virtual noise can cause the effect on confidence interval and confidence level observed in Fig. 5,

We generated simulated transformer TOT values using a linear model which was modified by adding an extra driving variable to the model. This extra variable accounted for the increase in heat caused by solar radiation model.

Then we calculated the model coefficients and confidence intervals based on the original model (without a solar-radiation variable). The results of Fig. 6 show that the behavior of the coefficient's confidence interval is similar to that of field

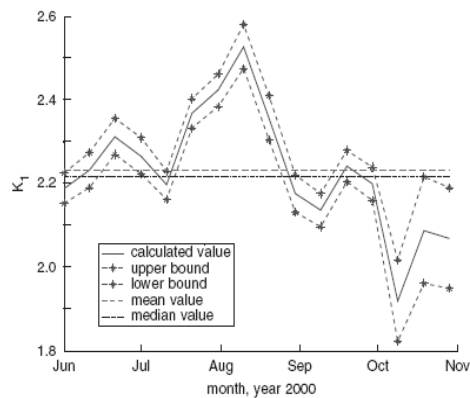


Fig. 5 Applying confidence interval to field data

Table 5: Comparison of linear-regression-based and sample-based confidence intervals

Start date of sample	Magnitude of linear-regression-based confidence interval for K_1	Magnitude of sample-based confidence interval for K_1
Jun 01	0.073	
Jun 11	0.0839	
Jun 21	0.0863	
Jul 01	0.0877	
Jul 11	0.0667	
Jul 21	0.0703	
Jul 31	0.0783	
Aug 10	0.1051	
Aug 20	0.1053	0.5781
Aug 30	0.0879	
Sep 09	0.0789	
Sep 19	0.0728	
Sep 29	0.0789	
Oct 09	0.1961	
Oct 19	0.2538	
Oct 29	0.24	

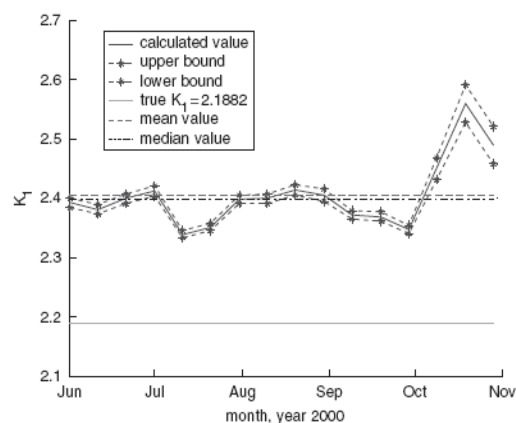


Fig. 6 Applying confidence intervals to simulated data modelling missing driving variable

Data there is no way to pick a ‘true K_1 ’ that it is within the calculated confidence intervals 95% of the time. The failure of the traditional approach to yield consistent

Confidence levels and intervals also explains why using a

Low-pass filter does not increase the reliability of our model. The noise in our data is virtual noise rather than actual measurement noise. To estimate the reliability of our model we needed a different approach.

Table 6: Comparison of linear-regression-based and sample based confidence intervals for two other transformers

Transformer name sample number	Magnitude of linear-regression-based confidence intervals		Magnitude of sample-based confidence interval	
Transformer 1	K_1	K_2	K_1	K_2
1	0.4432	0.0112		
2	0.2764	0.0069		
3	0.2550	0.0062		
4	0.3594	0.0090		
5	0.3570	0.0090		
6	0.2279	0.0059		
7	0.3575	0.0080	1.1465	0.0402
8	0.3700	0.0089		
9	0.2491	0.0059		
10	0.2860	0.0060		
11	0.3035	0.0068		
12	0.5344	0.0065		
Transformer 2	K_1	K_2	K_1	K_2
1	0.2415	0.0074		
2	0.2535	0.0063		
3	0.3033	0.0088		
4	0.2336	0.0057		
5	0.1787	0.0046		
6	0.1490	0.0038	1.0026	0.0285
7	0.2266	0.0059		
8	0.2724	0.0075		
9	0.1822	0.0051		
10	0.2309	0.0053		
11	0.1687	0.0040		
12	0.4712	0.0064		

Loading requires many arbitrary assumptions, such as daily load shape, and daily ambient temperature profile and amplitude. We’ve observed that steady-state loading may be defined with many fewer arbitrary assumptions and further, the changes in predicted steady-state loading Level correlate well with changes in predicted dynamic Loading level. Steady-state loading for a fixed ambient

Temperature of 371C and setting this quantity to the maximum TOT allowed for the transformer in (9) and then solving for load I to get

$$I_{ss} = \sqrt{\frac{K_2(TOT_{max} - 37) - K_3}{K_1}} \quad (25)$$

Where ISS stands for the steady-state loading. A similar result can be obtained if hot-spot temperature is the limiting criteria. We observed that the confidence intervals in Fig. 8 for steady-state load (using field data) are always much smaller than the corresponding intervals (in percentage of respective parameters) for the Kx coefficients. This seeming contradiction can be explained. We observed that K1 and K2 tend to rise and fall in unison from model to model. The variable K1 is proportional to the heat generated per unit load during each time-step. The variable K2 is proportional to the heat lost to air during each time-step. If both K1 and K2 change in synchronism, their effect on loading capability offset, leading to much more consistent predictions of loading level than the variability of K1 or K2 would suggest

We showed, using confidence intervals as a measure that the behavior of real data is very different from the behavior of data contaminated with random noise and that the standard technique for assessing Reliability is invalid when applied to real data. Through numerical experimentation we provided a plausibility argument that this difference is caused by the absence of unmeasured driving variables in the model.

We provided a valid method for assessing model reliability. Rather than using model coefficients as a measure of model reliability.

7 References

- [1] IEEE Guide for Loading Mineral-Oil-Immersed Power Transformers, IEEE C57.91-1995.
- [2] Tylavsky, D.J., He, Q., McCulla, G.A., and Hunt, J.R.: 'Sources of error and quantization on transformer dynamic thermal modeling', IEEE Trans. Power Deliv., 2000, 15, (1), pp. 178–185.
- [3] Lesieutre, B.C., Hagman, W.H., and Kirtley Jr, J.L.: 'An improved transformer top oil temperature model for use in an on-line monitoring and diagnostic system', IEEE Trans. Power Del., 1997.
- [4] He, Q., Si, J., and Tylavsky, D.J.: 'Prediction of top-oil temperature for transformers using neural networks', IEEE Trans. Power Del., 2000, 15, (4), pp. 1205–1211.
- [5] Pierce, L.W.: 'Predicting liquid filled transformer loading capability', IEEE Trans. Ind. App., 1994, 30, (1)

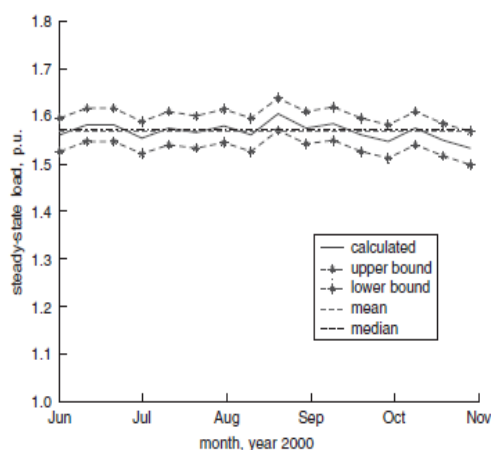


Fig. 8 Sample-based confidence intervals for steady-state load predictions made from field data

6 Conclusions

We have shown that as long as there is noise in the measurement process, inaccuracies in the dynamic thermal models from measured data will persist. Reliability assessment gives the user some measure of confidence in the model they are using. At present there is no method for assessing the reliability of models derived from transformer test reports.

Analysis of Adaptive Group Key Management Protocol Using Network Simulator 2

Mr. Rahul B. Mapari

Department of Computer Science & Engineering, MIT, Dr. Babasaheb Ambedkar Marathwada University,
Aurangabad (MS), India.

rahulmapari@gmail.com
9028084446

Mr. Jaykumar S. Dhage

jaykumardhage2008@gmail.com
9271761969

Ms. Dipa D. Dharmadhikari

dipa.dharmadhikari@gmail.com
9890585475

Abstract— IP Multicast is increasingly used as an efficient communication mechanism for group oriented applications. This success urged the development of security mechanisms for that communication model. In dynamic multicast groups, new members may join or current members may leave the group dynamically. Due to dynamic nature of these multicast groups, the group key is needed to be changed dynamically to maintain group key confidentiality. Existing group key management protocols do not take into consideration the dynamicity of group members. In this paper we first classify proposed protocols for secure multicast and discuss their non suitability for dynamic group. This leads to inefficient solutions for real multicast session. We then propose an efficient protocol, called AKMP, which maintain good performance by adapting the key management process with the membership frequency during the multicast session. A simulation result shows that AKMP is more efficient than existing protocols.

Keywords – secure multicast, dynamic group, forward secrecy, backward secrecy, traffic encryption key.

I. INTRODUCTION

IP multicast is an efficient communication mechanism for group-oriented applications such as video conferencing, interactive group games and video on demand. IP multicast saves bandwidth by sending the source traffic on a multicast tree that spans all the members of the group. Security concerns for IP multicast are very complex because of the important number of communicating participants. This raises the problem of group communication confidentiality and thus group key management. Group communication confidentiality requires that only valid users could decrypt the multicast data even if the data is broadcast to the entire network. We assume in what follows that data is encrypted to ensure confidentiality using asymmetric

cryptosystem. In this case, a symmetric key is used to encrypt data by the source and to decrypt it by receivers. It is generally called Traffic Encryption Key (TEK). The confidentiality requirements can be translated mainly into two key distribution rules [18]:

- *Forward confidentiality*: Users that left the group should not have access to any future key. This ensures that a member cannot decrypt data after it leaves the group.
- *Backward confidentiality*: A new user joining the group should not have access to any old key. This ensures that a member cannot decrypt data sent before it joins the group.

1. Rekeying Process

In order to meet the above requirements, a re-key process should be triggered after each join/leave. It consists in generating a new TEK and distributing it to the members including the new one in case of a join or to the residual members in case of a leave. This process ensures that a new member cannot decrypt old multicast data and prevents a leaving member from eavesdropping future multicast data. Unfortunately, no security mechanisms were foreseen in the initial multicast architectural design [6]. A lot of work has been done these last years to cope with this limitation. We propose to classify current group key management proposals into two approaches:

2. Approach A

In this approach all group members share a unique single symmetric key called the Traffic Encryption Key (TEK). This TEK is used by the source to encrypt multicast packets and by the receivers to decrypt them. This approach is mainly used within a centralized architecture where a single key server is responsible for generating and redistributing the new TEK whenever a member joins or leaves the group. Protocols within this

approach do not meet scalability requirements since the number of transmitted messages to update TEK is proportional to n , where n is the number of group members [12][20]. This is known as the «1 affects n » phenomenon [19] where a single group membership change (join or leave) results in a re-keying process that disturbs all group members to update TEK. In addition, the use of a single key server leads to a bottleneck problem during TEK distribution and suffers from a single point of failure. Some distributed solutions are proposed to share re-keying process among different entities and thereby to cope with scalability, bottlenecks and fault tolerance issues, but they remain suffering from the «1 affects n » phenomenon [14] [4].

3. Approach B

In order to cope with the approach A drawbacks («1 affects n », scalability, bottlenecks), in this approach the multicast group is divided into multiple subgroups. Each subgroup shares a local TEK managed by a special entity: the subgroup controller. The set of protocols proposed within this approach (called also: hierarchical key management protocols) are more scalable than centralized protocols. They also attenuate the «1 affects n » problem. In fact, if a member joins or leaves the group, only the concerned subgroup updates its local TEK. However, this improvement is not for free: as subgroups have different TEKs, multicast packets should be decrypted and re-encrypted by subgroup controllers whenever they pass from a subgroup to another. A common drawback of both approaches A and B is that they are not flexible regarding the dynamicity of the group: for multicast applications with few membership changes, protocols using approach A would fit better than others since re-keying would not be frequent and decryption / re-encryption overhead changes, protocols supporting approach B would fit better because of the attenuation of the «1 affects n » phenomenon and a better scalability. Moreover, the frequency of membership changes is generally unpredictable for a large range of multicast applications. Hence, none of both approaches A and B can be the best during all the secure session lifetime.

In this paper we propose to take advantage of both approaches A and B by dynamically adapting the key management process with respect to the frequency of membership changes. To do so we present a new protocol called the Adaptive Key Management Protocol. Within the same secure multicast session, AKMP begins with using a single TEK (approach A behaviour) and dynamically constructs subgroups with different

local TEKs (approach B behaviour) whenever the join/leave frequency exceeds a certain threshold.

II. ADAPTIVE GROUP KEY MANAGEMENT PROTOCOL

The main idea of AKMP is to meet approach A as long as no frequent membership change is depicted by group members and to switch to approach B whenever members show certain dynamicity. What distinguishes AKMP from other hierarchical solutions [17] [19] [7] is restricting decryption / re-encryption process to the sub-networks that are subject to high dynamicity. In AKMP environment, we have several AKMP enabled routers. The protocol begins with a single group that shares a unique TEK. This group is initially managed by one AKMP router. During the multicast secure session, if an AKMP router detects a local dynamicity, it initiates a subgroup with an independent local key. To do so, this AKMP router generates and distributes the local key to the members in the constructed subgroup. This key is called a Downstream Key (DK). Then, the router decrypts received packets using its parent AKMP-router key (this key is called the Upstream Key (UK) and re-encrypts the packets downstream using DK. We say that this AKMP-router has switched from an inactive state to an active state (or switched to a decryption / re-encryption process). This way, AKMP reduces decryption / re-encryption overhead to the minimum while attenuating the «1 affects n » problem. Each AKMP-router R_i holds:

- A dynamicity-evaluation function I : this measures the level of dynamicity of the group. This function could be based on a probabilistic model of the group dynamicity. In this paper we will use the following dynamicity-evaluation function:

```
if  $mcf > d$  then { switch to decryption/re-encryption proc }
 $f_i = true;$ 
else
 $f_i = false;$ 
end
```

mcf : membership frequency change

d : threshold

- An upstream key UK_i and a downstream key DK_i : the UK_i is used to decrypt upstream packets in order to re-encrypt them downstream using DK_i . Note that if $UK_i = DK_i$ then R_i is not involved in decryption / re-encryption process.
- A pair of private/public keys (K_i^{-1}/K_i) for secure exchanges between AKMP-routers.

AKMP does not require that all routers should be AKMP enabled. All AKMP-routers are grouped in a virtual AKMP tree (Fig.1). Only the AKMP-enabled routers are involved in security mechanisms described below.

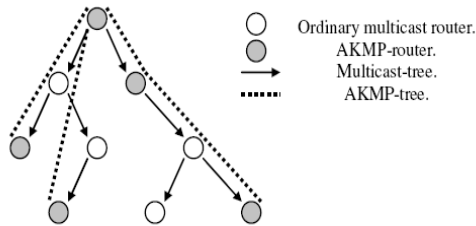


Fig.1. AKMP-tree concept

1. Initialization

Group controller (GC) is responsible for announcing the secure session. It also authenticates the AKMP routers and the members before their registration.

2. Notation

- [a \rightarrow b: m] - "a" send message "m" to "b"
- [{m}_k] - "m" encrypted with "k"
- [<m>_k⁻¹] - "m" signed using the private key k₋₁

3. AKMP dynamic aspect

As AKMP is an adaptive solution, the state of AKMP routers is dynamic. Each AKMP-router could be in one of the three states (active, inactive, or waiting new UK):

- Active: an AKMP-router is "active" if it is involved in decryption / re-encryption process.
- Inactive: an AKMP-router is "inactive" if it does not assure decryption / re-encryption process.
- Waiting new UK: an AKMP-router is in this state if it waits for a new UK from an upward AKMP-router which is already involved in decryption / re-encryption process.

When an AKMP-router detects a membership change that yields f_i true, it becomes "active" (if it is not already "active") and thus generates a new DK_i and switches to decryption / re-encryption process as shown in Figure 3.3. The new DK_i will be considered as the traffic encryption key for the members attached to R_i and as an upstream key UK for the child routers of R_i . Thus DK_i is distributed by R_i to the attached members (resp. the

residual attached members) and the child routers using script 1 (resp. script 2) as shown in Figure 2. A "DK_UPDATED, old DK_i " message is sent to the parent AKMP-router (as shown in Figure 2) in order to update and distribute its DK_j in the case of old $DK_i=DK_j$. Note that this latter update is necessary to ensure backward and forward confidentiality and that it is not a concern since it happens only for the first time that the child AKMP router switches to decryption / re-encryption process.

If f_i remains false after a membership change, R_i forwards this membership change upstream asking a new UK (it sends "NEW_UK_REQUEST" message to its upstream AKMP-router) and changes its state into "WAITING_NEW_UK" (as shown in Figure 3). This request is forwarded upstream until it reaches the first active AKMP-router R_j , it is then discarded by the latter which generates a new DK_j . R_j distributes then the new DK_j (inside a special message "UPDATE_UK") using script 1 (as shown in Figure 2) and each child AKMP-router R_p reacts to the message according to the state chart of Figure 3 depending on its state. When R_i receives DK_j it resumes its "inactive" state (as shown in Figure 3) and, initializes UK_i and DK_i to DK_j and distributes it using script 1 or 2 depending on whether the membership change is a join or a leave.

Script 1:

```
for j=1..nb_attached_members
   $R_i \rightarrow u_j : \{newDK_i\}_{K_{ij}}$ 
```

```
for j=1..nb_child_AKMP-routers
```

```
   $R_i \rightarrow R_j : \langle UPDATE\_UK, \{newDK_i\}_{K_j} \rangle_{K_i^{-1}}$ 
   $R_i \rightarrow PARENT\_ROUTER : \langle DK\_UPDATED, oldDK_i \rangle_{K_i^{-1}}$ 
```

Script 2:

```
/* Distributing newDKi to residual members,  $u_j$  is the
   leaving member */
```

```
for p=1..nb_attached_members, p#j
```

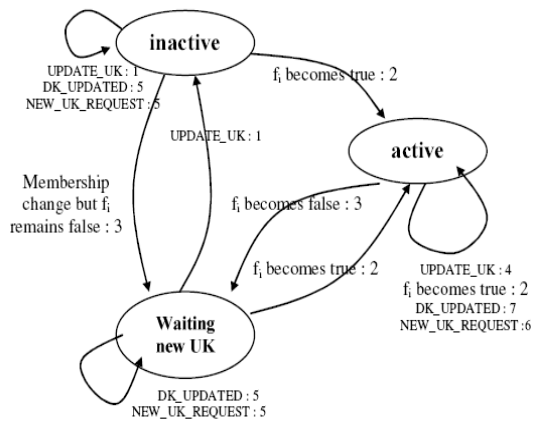
```
   $R_i \rightarrow u_p : \{newDK_i\}_{K_{ip}}$ 
```

```
for p=1..nb_child_AKMP-routers
```

```
   $R_i \rightarrow R_p : \langle UPDATE\_UK, \{newDK_i\}_{K_p} \rangle_{K_i^{-1}}$ 
   $R_i \rightarrow PARENT\_ROUTER : \langle DK\_UPDATED, oldDK_i \rangle_{K_i^{-1}}$ 
```

Fig.2. Distributing New Dk

If an active AKMP-router detects that there is no longer dynamicity among its attached members, it stops decryption / re-encryption process and rejoins "inactive" state. A new DK(s) is (are) generated and distributed according to the above process. This manner of dealing with membership changes adapts easily to partial dynamicity and fits better to applications with unpredictable membership behavior.



Legend : Event : Action

1 : $DK_i = \text{newUK}$.

$UK_i = \text{newUK}$.

Action 2.

2 : Distributes newUK using script (1 or 2) depending on whether the membership change is a join or a leave.

3 : sends $NEW_UK_REQUEST$ upstream.

4 : $UK_i = \text{newUK}$.

5 : forwards the message upstream.

6 : generates and distributes new DK_i using script 1.

7 : if $oldDK_j = \text{current}DK_i$ then action 6.

Fig. 3. AKMP-router state chart

III.RESULTS AND DISCUSSIONS

In this section, we provide an overview of our simulation model and some of the results we obtained by comparing AKMP with centralized solution.

1. Simulation Model

All schemes discussed in this paper have been tested using Network Simulator *NS* version 2.34. *NS* give the facility of defining our own protocols. For defining our own protocol, classes and their functionalities are to be defined using C++. Parallel classes are then need to be defined using OTcl (Object-oriented Tool Command Language) and linking can be done between the OTcl classes and C++ classes.

2. Results

Different test scripts have been written for different sizes of groups as 9, 27, 81, 243, 729 and 1001 members. Trees with 9, 27, 81, 243, 729 members are complete trees whereas those with 1001 members are incomplete trees. These scripts have been written for all CtrMcast and CtrMcastAKMP protocols.

These test scripts are given as input to *ns*. The overall run-time of these scripts is computed by

using the time difference between the start of execution of the script and end of execution of the script. For getting time, the date command with +%r option is used.

Scripts are used for testing time required for join as well as leave operation for all the group sizes. In all these scripts, node labelled '0' is treated as a Group Controller. The internal nodes in the tree are logical; but while simulating the topologies they have been assumed as real nodes.

After simulation the overall runtime for join operation is summarized in table 1 and is briefed in figure 4.

TABLE 4.1
OVERALL RUNTIME OF JOIN OPERATION (IN SECONDS)

No. of Members	CtrMcast (Time in sec)	AKMP (time in Sec)
9	1	0
27	1	0
81	2	1
243	8	3
729	120	80
1001	162	120

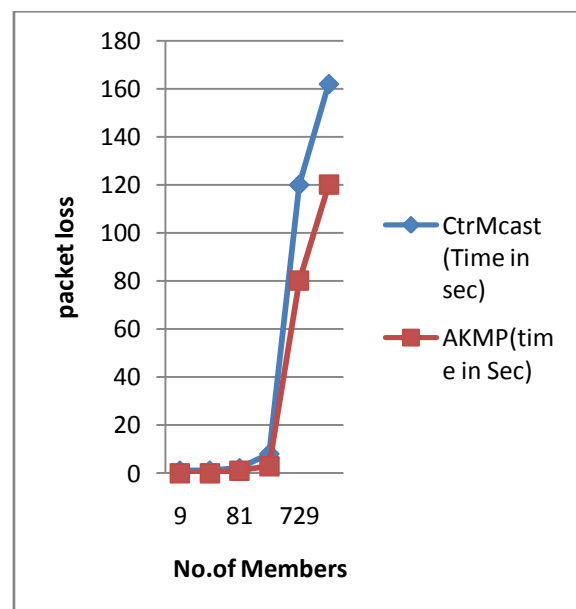


Fig.4. Chart showing performance analysis of Join operation

Using above simulation, overall runtime for leave operation is summarized in table 2 and is briefed in figure 5.

TABLE 4.2
OVERALL RUNTIME OF LEAVE OPERATION (IN SECONDS)

No. of Members	CtrMcast (Time in sec)	AKMP (time in Sec)
9	1	0
27	1	0
81	3	1
243	10	7
729	122	72
1001	164	129

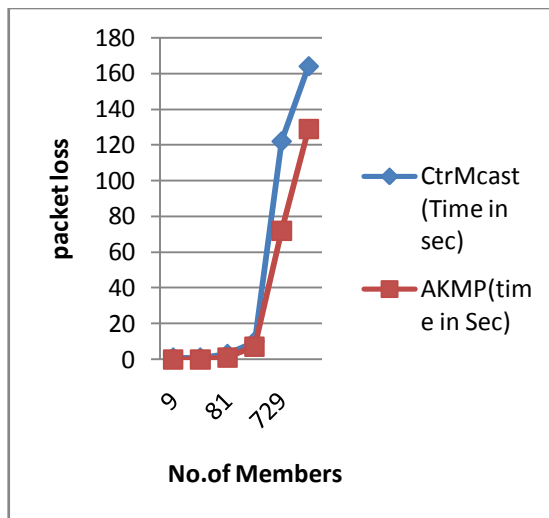


Fig. 5. Chart showing performance analysis of Leave operation

Using above simulation, Overall packet loss for join leave operation is summarized in table 3 and is briefed in figure 6.

TABLE 4.3
OVERALL PACKET LOSS OF JOIN LEAVE OPERATION (IN SECONDS)

No. of Members	Packet Loss CtrMcast	Packet Loss AKMP	Packet Loss Proposed Scheme
9	29	19	9
27	39	26	16
81	44	30	24
243	49	40	29
729	69	59	39
1001	89	74	51

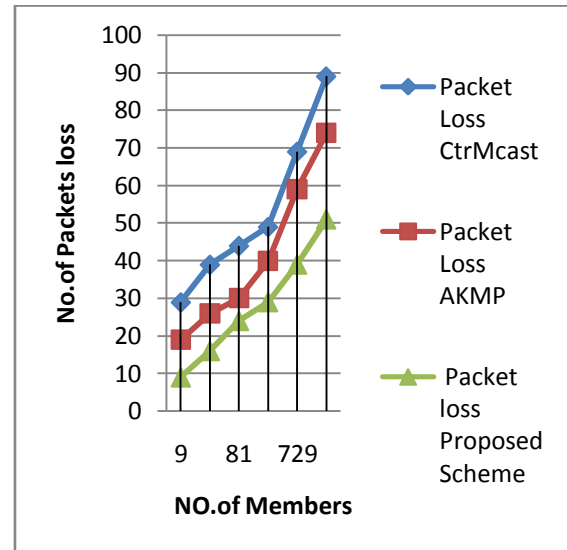


Fig.6. Chart showing Comparison of performance analysis of Join Leave operation with Packet Loss Parameter

IV. CONCLUSION

In this paper, Approach A and Approach B group key management protocols are analysed. A proposed scheme is based on combination of Approach A and Approach B protocols. All schemes are simulated using ns2 simulation tool. When dynamicity in the multicast group is increased, greater overall computational and communication cost (run-time) is required for join/leave operation because of problems such as "1 affects n", decryption and re-encryption overhead.

From performance analysis of all the above schemes for computation and communication cost (i.e. overall run-time) of join / leave operation in dynamic multicast group, it has been observed that overall run-time is minimum for the AKMP.

In comparison with the approach A, approach B and adaptive group key management protocol, performance analysis shows that proposed scheme reduces overall packet loss during the message transfer.

As a result, we can conclude that Adaptive Key Management Protocol takes advantage of both approaches A and B by dynamically adapting the key management process with respect to the frequency of membership changes. Which reduced overall run time cost and packet loss.

As a future scope, the work can be done to reduce the value of parameters like bandwidth, end to end delay, and jitter.

ACKNOWLEDGMENT

The authors wish to thank the anonymous reviewers and the editor for their constructive comments. The authors would also like to thanks to management of MIT, Aurangabad for continuous guidance and support.

REFERENCES

- [1] K. Almeroth and M. Ammar. "Collecting and modeling the join/leave behavior of multicast group members in the Mbone" , In the proceedings of the Symposium on High Performance Distributed Computing, Syracuse NY, 1996.
- [2] K. Almeroth and M.Ammar. "Multicast group behavior in the internet's multicast backbone (Mbone)" , IEEE communications Magazine, 1997.
- [3] A. Ballardie, "Scalable Multicast Key Distribution", RFC 1949 May 1996.
- [4] Ghassen Chaddoud, Isabelle Chrisment, André Shaff , "Dynamic Group Communication Security", 6th IEEE Symposium on computers and communication, 2001.
- [5] Chung Kei Wong, Mohamed Gouda, Simon S. Lam, "Secure Group Communications Using Key Graphs", ACM SIGCOMM' 98, Columbia, 1998.
- [6] S. Deering, "Host Extensions for IP Multicasting", RFC 1112. Stanford University, August 1989.
- [7] Lakshminath R. Dondeti, Sarit Mukherjee, Ashok Samal, " Scalable secure one- to-many group communication using dual encryption", Computer Communications, ELSEVIER Science 2000.
- [8] Lakshminath R. Dondeti, Sarit Mukherjee, Ashok Samal, "Comparison of Hierarchical Key Distribution Schemes" , In Proceedings of IEEE Globcom Global Internet Symposium, 1999.
- [9] Lakshminath R. Dondeti, Sarit Mukherjee, Ashok Samal, "Survey and Comparison of Secure Group Communication Protocols" , Tech Rep, University of Nebraska-Lincoln. 1999.
- [10] Thomas Hardjono, Gene Tsudik, "IP Multicast Security: Issues and Directions", Annales de telecom 2000.
- [11] Peter S. Kruus, "A survey of multicast security issues and architectures", 21st NISSC Proceedings, Virginia (USA). 1998.
- [12] H. Harney, C. Muckenhirn, "Group Key Management Protocol Architecture", RFC 2094 July 1997.
- [13] H. Harney, C. Muckenhirn, "Group Key Management Protocol (GKMP) specification", RFC 2094 July 1997.
- [14] Rolf Oppliger, Andres Albanese, "Distributed registration and key distribution", Proceedings of the 12th International Conference on Information Security IFIP SEC'96, Greece, 1996.
- [15] H. F. Salama, "Multicast Routing for real-Time Communication on High-Speed Networks", PhD thesis, North Carolina State University, 1996.
- [16] Sandro Rafaeli, "A Decentralized Architecture for Group Key Management", Computer Department Lancaster University, September 2000.
- [17] Clay Shiels, J. J. Garcia-Luna-Aceves, "KHIP—A scalable protocol for secure multicast routing", Proceedings of ACM SIGCOMM' 99. 1999.
- [18] Jack Snoeyink, Subhash Suri, George Varghese, "A Lower Bound for Multicast Key Distribution", IEEE INFOCOM 2001.
- [19] Suvo Mittra, "Iolus: A Framework for Scalable Secure Multicasting", In Proceedings of ACM SIGCOMM'97, Cannes, France, 1997.
- [20] D. Wallner, E. Harder, R. Agee, "Key Management for Multicast: Issues and Architecture", RFC 2627, National Security Agency Jun 1999.
- [21] R. Waxman, "Routing of multipoint connections", IEEE Journal on Selected Areas in Communications, December 1988.
- [22] Hatem Bettahar, A. Bouabdallah, Yacine Challal, "AKMP: An Adaptive Key Management Protocol for secure multicast", Computer Communications and Networks, 2002. Proceedings, Eleventh International Conference on 14-16 Oct. 2002 .
- [23] William Stallings, "Cryptography and Network Security-principles & practices", Third Edition.
- [24] B. Schneier, "Applied Cryptography", Second Edition, John Wiley & Sons Inc., 1996.
- [25] Kevin Fall, Kannan Vardhan, "The ns Manual (formerly ns Notes and Documentation)", The VINT Project, October 19, 2008.
- [26] D.R. Stinson and T. van Trung, "Some New Results on Key Distribution Patterns and Broadcast Encryption", Designs, Codes and Cryptography, vol. 14, pp. 261-279, 1998.
- [27] D.R. Stinson, "On Some Methods for Unconditionally Secure Key Distribution and Broadcast Encryption", Designs, Codes and Cryptography, vol. 12, pp. 215-243, 1997.
- [28] C. Blundo, L.A. Frota Mattos, and D.R. Stinson, "Trade-Offs between Communication and Storage in Unconditionally Secure Schemes for Broadcast Encryption and Interactive Key Distribution", Advances in Cryptology—Proc. 16th Ann. Int'l Cryptology Conf. (CRYPTO '96), pp. 387-400, 1996.
- [29] C. Blundo, A. De Santis, A. Herzberg, S. Kutten, U. Vaccaro, and M. Yung, "Perfectly Secure Key Distribution in Dynamic Conferences", Advances in Cryptology—Proc. Workshop Theory and Application of Cryptographic Techniques (EUROCRYPT '93), pp. 471-486, 1993.
- [30] B .A. Forouzan, "Cryptography and Network Security", Second Edition, Mcgraw Hill Publication, pp.001 - 025
- [31] Yacine Challal, Hamida Seba, "Group Key Management Protocols: A Novel taxonomy", International Journal Of Information Technology Volume 2 Number 1 2005 Issn:1305-2403.

Electric Arc model for High Voltage Circuit Breakers Based on MATLAB/SIMULINK

¹N. S. Mahajan, ²K. R. Patil, ³S. M. Shembekar

¹M.E. (EPS) II year Government College of Engineering, Aurangabad (MS), India.

²Professor KCE's College of Engineering & Information Technology, Jalgaon (MS), India.

³Assistant Professor SSBT's College of Engineering & Technology, Jalgaon (MS), India.

Email: ¹nilesh17_mahajan@rediffmail.com, ²patil_kautik@rediffmail.com, ³suhasshembekar@rediffmail.com

Abstract—A circuit breaker is a switching device that the American National Standards Institute (ANSI) defines as: "A mechanical switching device, capable of making, carrying, and breaking currents, under normal circuit conditions and also making, carrying for a specified time and breaking current under specified abnormal circuit conditions such as those of short circuit." High Voltage Circuit Breaker's working base is the electric arc that appears between their contacts when establishing or interrupting the electric current in the circuit. This electric arc is a complex phenomenon where lots of physic interactions take place in a very short time. Over the years, as our knowledge of the interrupting process progressed, many techniques have been developed to test the circuit breakers and simulated arc model. There are three models (Physical Model Black Box Model and Parameter Model) that describe the behavior of the arc. Therefore, the optimization of the operation of high voltage circuit breakers makes necessary a deep understanding of the phenomena involved in the appearance of the electric arc. This knowledge can be achieved by means of modelization and simulation tools. This option allows us to obtain the evolution of physical magnitudes which would be difficult to measure in laboratory tests. The aim of this paper is to describe the phenomena of the electric arc in high voltage circuit breakers, as well as the specification of the mathematical, physical and software needs for its modelization and simulation.

Keywords - Electric arc, high voltage circuit breakers, Physical Model, Black Box Model, Parameter Model

I. INTRODUCTION

Circuit-breakers are very important electric power transmission equipment related to quality of service, because they can isolate faults that otherwise could cause total power system breakdowns. When circuit breaker contacts separate to initiate the interruption process, an

electrical arc of extremely high temperature is always produced and becomes the conducting medium in which current interruption will occur. With modern high-voltage breakers, the arc is blown with gas in the same way as a match is blown out with your breath, but with 100 million times the blowing power.

In simple terms, circuit-breakers consist of a plug that is in connection with a contact when the breaker is closed. The current then flows right through the breaker. To interrupt the current, the plug and the contact is separated with rather high speed, resulting in an electric arc in the contact gap between the plug and the contact. This is illustrated in Figure:1 Since short-circuit currents in most high-voltage power systems frequently reach 50 to 100 kilo amperes, the consequent arc temperature goes beyond 10,000 degrees (C), which is far above the melting point of any known material.

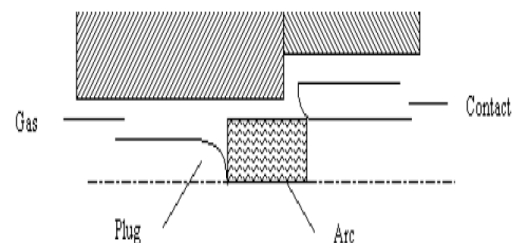


Figure: 1 Simplification of the contact gap

In this paper the characteristics of the electric arc are described with the aim of characterizing the interruption process in high voltage devices. In addition, an overview of the most important models and simulation methods using MATLAB are exposed. [1-2]

II. ELECTRIC ARC PHENOMENON IN HIGH VOLTAGE CIRCUIT BREAKER

The electric arc in a circuit breaker plays the key role in the interruption process and is therefore often addressed as *switching arc*. The electric arc is a plasma channel between the breaker contacts formed after a gas discharge in the extinguishing medium. When current flows through a circuit breaker and the contacts of the

breaker part, driven by the mechanism, the magnetic energy stored in the inductances of the power system forces the current to flow. Just before contact separation, the breaker contacts touch each other at a very small surface area and the resulting high current density makes the contact material to melt. The melting contact material virtually explodes and this leads to a gas discharge in the surrounding medium either air, oil, or SF₆. Physically, the arc is an incandescent gas column, with an approximate straight trajectory between electrodes (anode and cathode) and temperatures over 6000 and 10000 °C. Metallic contact surfaces are also incandescent and a reduction in the cross section of the arc is observed near them. This way, three regions can be defined: a central zone or arc column and the anode and the cathode regions (Figure 2). [3]

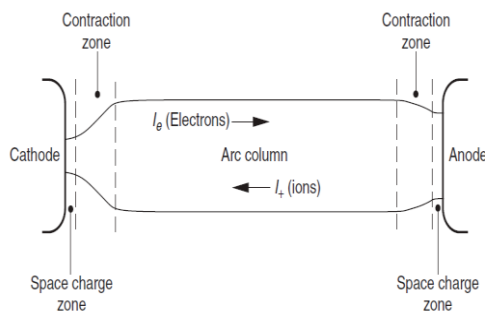


Figure: 2 The arc channel can be divided into an arc column, a cathode, and an anode region

From the arc channel, the potential gradient and the temperature distribution can be measured. Figure 3 shows a typical potential distribution along the arc channel between the breaker contacts.

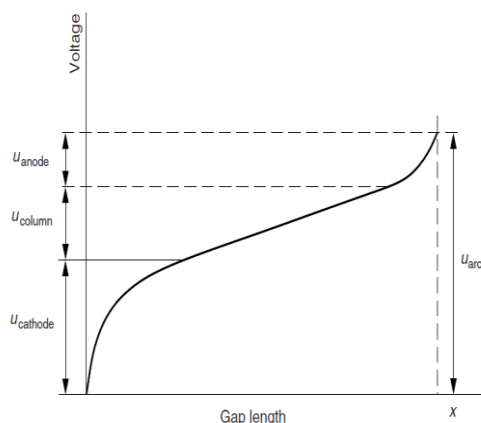


Figure: 3 Typical potential distribution along an arc channel

The peak temperature in the arc column can range from 7000–25000 K, depending on the arcing medium and configuration of the arcing chamber.

The role of the cathode, surrounded by the cathode region, is to emit the current-carrying electrons into the arc column. A cathode made from *refractory material* with a high boiling point, (e.g. carbon, tungsten, and molybdenum) starts already with the emission of electrons when heated to a temperature below the evaporation temperature this is called *thermionic emission*. Current densities that can be obtained with this type of cathode are in the order of 10000 A/cm². The cooling of the heated cathode spot is relatively slow compared with the rate of change of the transient recovery voltage, which appears across the breaker contacts after the arc has extinguished and the current has been interrupted. A cathode made from *non refractory material* with a low boiling point, such as copper and mercury, experience significant material evaporation. These materials emit electrons at temperatures too low for thermionic emission and the emission of electrons is due to *field emission*. Because of the very small size of the cathode spot, cooling of the heated spot is almost simultaneous with the current decreasing to zero. The current density in the cathode region is much higher than the current density in the arc column itself. This results in a magnetic field gradient that accelerates the gas flow away from the cathode. This is called the *Maecker effect*.

The role of the anode can be either *passive* or *active*. In its passive mode, the anode serves as a collector of electrons leaving the arc column. In its active mode the anode evaporates, and when this metal vapor is ionized in the anode region, it supplies positive ions to the arc column. Active anodes play a role with vacuum arcs: for high current densities, anode spots are formed and ions contribute to the plasma. This is an undesirable effect because these anode spots do not stop emitting ions at the current zero crossing. Their heat capacity enables the anode spots to evaporate anode material even when the power input is zero and thus can cause the vacuum arc not to extinguish. Directly after contact separation, when the arc ignites, evaporation of contact material is the main source of charged particles. When the contact distance increases, the evaporation of contact material remains the main source of charged particles for the vacuum arcs. For high-pressure arcs burning in air, oil, or SF₆, the effect of evaporation of contact material becomes minimal with increasing contact separation, and the plasma depends mainly on the surrounding medium. [1-3, 5]

III. MODELING OF ELECTRIC ARC

Arc modeling has always been one of the main topics in circuit breaker research. Arc models can be classified in three categories:

- Black box models (also often called P-τ models) (BB)
- Physical models (PM)
- Parameter models
- Models based on graphics and diagrams (GD)

whose main application fields are shown in Table 1 [4]

Table 1. Application field of different switching models

Problem type	Application		
	Develop- ment	Test	Operation
Physical processes understanding	PM		
Mechanics dimensioning	PM	GD	
Dielectric recovery description	PM, GD	GD	GD
Influence of the arc on the current	PM, GD, BB	GD, BB	BB
HVDC breakers	PM, GD, BB	GD, BB	GD, BB
Small inductive currents	PM, GD, BB	GD, BB	GD, BB
SLF (Short Line Fault)	PM, GD, BB	GD, BB	GD, BB
Design and verification of test circuits	GD	BB	

A. Physical models (PM)

- The circuit breaker design engineers work mostly with physical arc models when designing a new prototype. Physical arc models are based on the equations of fluid dynamics and obey the laws of thermodynamics in combination with Maxwell's equations. They consist of a large number of differential equations.
- The arc-plasma is a chemical reaction and, in addition to the conservation of mass equation, describes the rate equations of the different chemical reactions. In the case of a local thermodynamic equilibrium, the rate

equations become the equilibrium mass action laws and that, in the simplified case of the reaction of a monatomic gas, becomes the Saha equation, describing the degree of ionization in the gas.

- The Navier–Stokes equations represent the fluid dynamics of the quenching gas, composed by three transport equations coupled to each other: (1) mass balance (2) momentum balance (3) and energy balance. These equations can be expressed as follows:

Conservation of mass (continuity equation):

$$\frac{\partial \rho}{\partial t} + \text{div}(\rho \mathbf{u}) = 0 \quad (1)$$

Conservation of momentum (Navier–Stokes equation):

$$\rho \frac{\partial \mathbf{u}}{\partial t} + \rho(\mathbf{u} \cdot \text{grad})\mathbf{u} = -\text{grad}(p) \quad (2)$$

Conservation of energy:

$$\rho \frac{\partial h}{\partial t} + \mathbf{u} \cdot \text{grad}(\rho h) - \sigma E^2 = \text{div}(\rho \mathbf{u}) + \text{div}[K \cdot \text{grad}(T)] - R[T, \rho] \quad (3)$$

Where

p = pressure σ = electric conductivity
 ρ = gas density K = thermal conductivity
 \mathbf{u} = gas flow velocity T = gas temperature
 h = enthalpy of gas R = radiation loss

E = electric field strength r = arc radius

Maxwell equations describe the interaction between electrical and magnetic field intensity, \vec{E} and \vec{H} .

$$\nabla \times \vec{E} = - \frac{\partial \vec{B}}{\partial t}; \nabla \times \vec{H} = \mathbf{j} \quad (4)$$

$$\nabla \cdot \vec{E} = \rho_q; \nabla \cdot \vec{B} = 0 \quad (5)$$

Thus, electric arc physical models consider the conservation laws for mass; momentum and energy for arc macroscopic elements, but extra source terms are added. On one hand Lorentz-force density term ($\mathbf{j} \times \mathbf{B}$) is added in the momentum balance and on the other hand the ohmic heating term ($\mathbf{j} \cdot \mathbf{E}$) in the energy balance. Those extra terms couple flow dynamics with electromagnetic process, described by Maxwell's equation (4, 5) [6-7]. Finally, an important characteristic of physical models is that they require the knowledge of plasma properties such as mass density, specific heat, viscosity, etc. These properties are strongly dependent on temperature and pressure values and, in the presence of vaporized metal or plastic, they depend also on the characteristics of the mixture.

B. Black Box Models

In *Black box models*, the arc is described by a simple mathematical equation and gives the relation between the arc conductance and measurable parameters such as arc voltage and arc current. These black box models are not suited to design circuit breaker interrupters but are very useful to simulate arc-circuit interaction in network studies. Black box models are based on physical considerations but are, in fact, mathematical models; the behavior of the arc rather than the physical processes is of importance. Usually, black box models consist of one or two differential equations.

The classical black box models are the *Cassie model* and the *Mayr model*. Both the Cassie and Mayr equation are a solution of the *general arc equation*. Many of these models are based on the equations proposed by Cassie and Mayr, which represent the variation in the conductance of the arc by a differential equation obtained from physical considerations and implementation of simplifications. On this way, Mayr assumed that the arc has fixed cross-sectional area losing energy only by radial thermal conduction. In contrast, Cassie assumed that the arc has a fixed temperature being cooled by forced convection [8, 2]. The *Cassie model* is well suited for studying the behavior of the arc conductance in the high-current time interval when the plasma temperature is 8000 K or more. The *Mayr model* is suited for modeling of the arc in the vicinity of current zero when the temperature of the plasma is below 8000 K.[3] Thus, "black box" models are in general represented by one differential equation relating the arc conductance with magnitudes such as voltage and arc current.

$$\frac{1}{g} * \frac{dg}{dt} = \frac{1}{T(i,G)} * \frac{ui}{P(i,G)} - 1 \quad (6)$$

Where:

G : Arc conductance

u : Arc voltage

i : Arc current

P, T: Parameters of the model

The fundamental purpose of "black box" models is to obtain a mathematical model that represents the circuit breaker test and can be applied in predicting the behavior of the circuit breaker under different conditions. These models can only be applied if the particular process that takes place is governed by the conductance. In other cases, such as in the dielectric region of breakdown processes, these models are not directly applicable. [9, 2]

C. Models based on graphics and diagrams

Finally, analytic expressions and graphics can be used, which represent a correlation between

parameters of the circuit and different magnitudes associated with the interruption process and the circuit breaker performance. These expressions and graphics can be obtained from tests or from the application of both physical and "black box" models. [4]

IV. SIMULATION SOFTWARE TOOLS

Different software tools can be applied to simulate the behavior of the electric arc, according to the previous classification of arc models. Regarding "black box" models, software for simulation of power systems transients, such as ATP/EMTP and MATLAB/Simulink can be used [3]. These tools allow the analysis of power systems in the time-domain by solving the differential equations that represent the behavior of the various components.

For physical models, software of modeling the coupling between fluid dynamics and electric and magnetic phenomena must be used. In those models, the fluid dynamics part of the problem represented by Navier-Stokes equations is solved by means of a CFD (computational fluid dynamics) solver, whereas for electromagnetic issues Maxwell equations must be solved by a FE (finite element) solver [6]. A typical approach is the use of ANSYS, in combination with a computational fluid dynamics package, CFD, such as FLUENT or CFX. Finally, as models based on graphics and diagrams are derived from the results obtained from simulations of the previous two types of models ("black box" and physical models), software tools to implement them do not really exist.

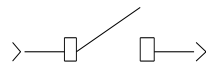
A. Examples

The aim of this section is to show some examples of different simulations, for "black box" models.

Regarding "black box" models, a significant example is the Arc Model Blockset [4]. The Arc Model Blockset is a library that currently contains seven arc models to be used in combination with the Matlab Power System Blockset. In this application, the arc is represented as a non-linear resistance, mathematically defined by a differential equation whose purpose is to the study of arc circuit interaction. In particular, the arc models incorporated in the Arc Model Blockset are: Cassie, Habedank, KEMA, Mayr, Modified Mayr, Schavemaker and Schwarz.

The arc models have been modeled as voltage controlled current sources. and the differential equation representing the electric arc is incorporated by means of the Simulink DEE (Differential Equation Editor). For example, Figure 4 shows the Mayr arc model included in the Arc

Model Blockset, and Figure 5 shows the dialog box for the introduction of model data.



Mayr arc model

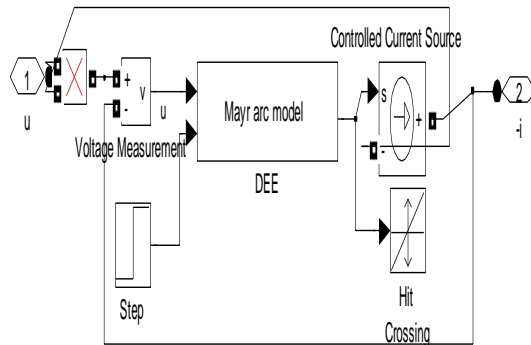


Figure 4 Mayr arc model [10]

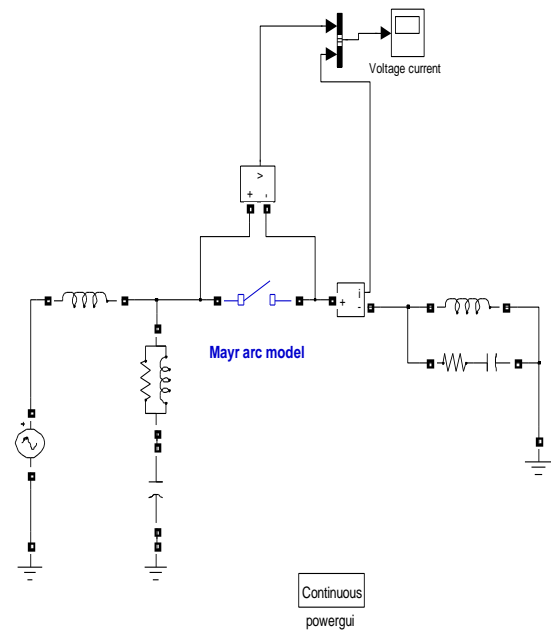


Figure 6 Figure: 2 Arc Model Test Circuit [10]

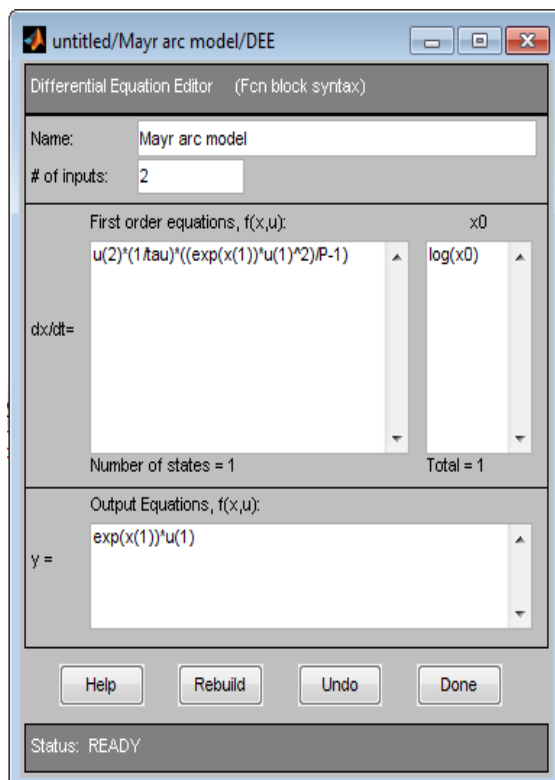


Figure 5 Arc model dialog box [10]

Figure 7 shows an example of the results obtained in the simulation of a circuit with the Mayr arc model.

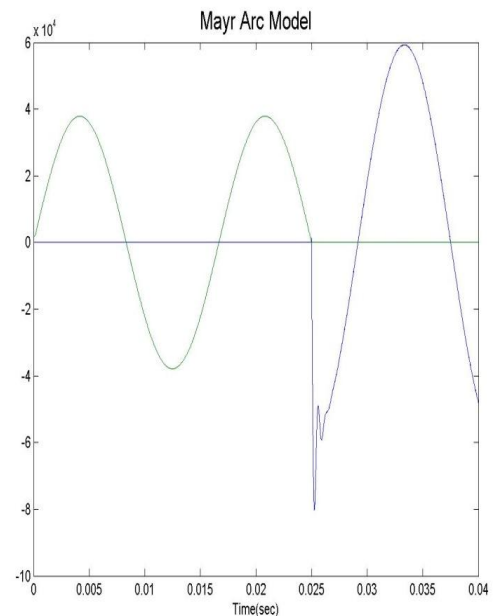


Figure 7 Computed voltage and current of Mayr's arc model [10]

These arc models can be implemented in a test circuit in a straight forward way. [10]

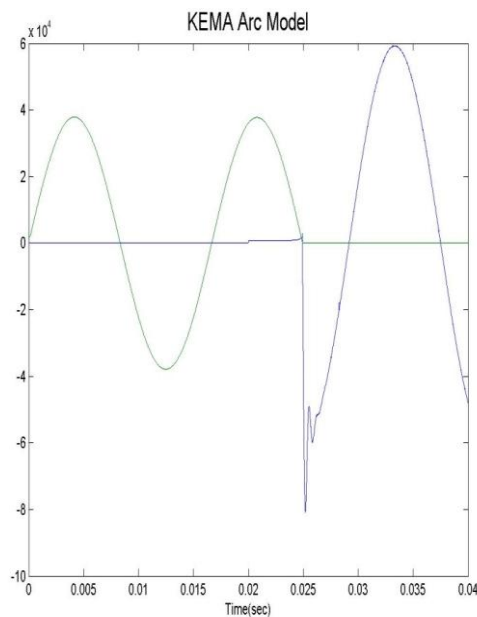


Figure: 8 Computed voltage and current of KEMA arc model [11]

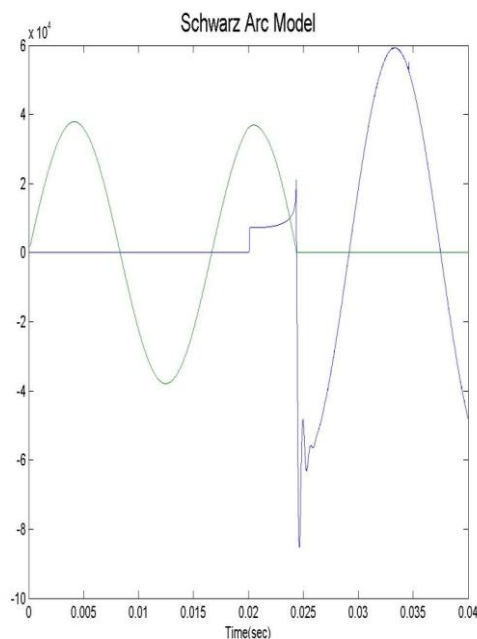


Figure: 9 Computed voltage and current of Schwarz arc model.

In Figure 7, 8, it can be observed the detailed behavior of the voltage and current around the current zero crossing when the circuit breaker contacts starts to separate at $t=0.02s$. As it is shown, the rapid increase in the transient recovery voltage leads to the reduction of the arc current, until it gets the zero value and the arc finally disappears.

V. Conclusion

The electric arc is an important phenomenon which determines the operation of high voltage circuit breaker. The use of modeling and simulation tools can help to improve these devices, reducing the need of prototype development and testing and so, the cost associated to this optimization process. Three main groups of arc models can be defined: physical models, black box models and models based on graphics and diagrams. The type of model to be applied may differ depending on the purpose of the simulation.

Black-box modeling is adequate to study the arc-circuit interaction, whereas in the case of the design of new circuit breakers or to increase the understanding of the interruption process, the most appropriate, despite their complexity, are physical models.

VI. References

- [1] A. Iturregi, E. Torres, I. Zamora, "Analysis of the Electric Arc in Low Voltage Circuit Breakers" in International Conference on Renewable Energies and Power Quality Las Palmas de Gran Canaria (Spain), 13th to 15th April, 2011
- [2] Nilesh S. Mahajan and A. A.Bhole, "Black Box Arc Modeling Of High Voltage Circuit Breaker Using Matlab/Simulink," IJEET, Volume 3, Issue 1, January-June (2012), pp. 55-63
- [3] L. Van der Sluis, Transient in Power Systems. John Wiley & Sons, 2001.
- [4] W. I. O. SC 13, "State of art of circuit-breaker modeling," Cigre, vol. Report N°135, 1998.
- [5] Pieter J. Schaeemaker, Lou van der Suis; Rent PP Smeets Vikror Kert&sz, "Digital Testing of High4oltage Circuit Breakers," IEEE, Computer Applications in Power System.
- [6] F. Karetta and M. Lindmayer, "Simulation of the gasdynamic and electromagnetic processes in low voltage switching arcs," IEEE Transactions on Components Packaging, and Manufacturing Technology, Part A, vol. 21, pp. 96-103, 03, 1998.
- [7] M. Lindmayer, A. Mutzke, T. R  ther and M. Springst  bke, "Some aspects of arc behavior in low-voltage arc chutes," in XVIth Symp. On Physics of Switching Arc, Brno, Czech Republic, 2005, pp. 278-292.
- [8] Smaranda Nitu, Constantin Nitu, and Paula Anghelita "Electric Arc Model, for High Power Interrupters" EUROCON 2005, Serbia & Montenegro, Belgrade, November 22-24, 2005
- [9] Niklas Gustavsson, "Evaluation and Simulation of Black-box Arc Models for High Voltage Circuit-breakers" 2004
- [10] P. H. Schavemaker and L. Van der Sluis, "The arc model blockset," in Proceedings of the Second IASTED International Conference Power and Energy Systems (EuroPES), Crete, Greece, June 25-28, 2002, pp. 644-648.
- [11] L. van der Sluis and W.R. Rutgers. "Comparison of test circuits for High-Voltage Circuit-Breakers by numerical calculations with arc models". paper presented at the 1990 IEEE-PES International Power Meeting, New Delhi, India. 28 Oct. - 1 Nov. 1990. Paper 90 IEC 568-6 PWRD.
- [12] A. M. Cassie, "Theorie Nouvelle des Arcs de Rupture et de la Rigidit   des Circuits," Cigre, Report 102, 1939.
- [13] WG 13.01, "Applications of Black Box Modeling to Circuit Breakers," Electra, no. 149, pp. 41-71, August 1993.



-
- [14] Pieter H. Schavemaker, Lou van der Sluis,” An Improved Mayr-Type Arc Model Based on Current-Zero Measurements,” in IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 15, NO. 2, APRIL 2000

Academic Self Study Report: a Strategic tool to measure the Institutional Performance

S.P.Shekhawat¹, Vishal.S.Rana²

² Head, M.B.A Dept, S.S.B.T's College of Engineering & Technology, Bambhori, Jalgaon, MS
(Corresponding Author)

¹ Director of Academics, SSBT's College of Engineering & Technology, Bambhori, Jalgaon, MS, India.

Emails: ¹vishal.rana1980@yahoo.com, ²spshekhawat@rediffmail.com

Abstract— A College or Institutions may be good at planning academic activities but may fail in self assessing. An Institute many times unaware about the obstacles which may adversely impact on overall academic performance. In this regard designing & implementing appropriate academic self study report may assess the strengths as well as loopholes of departments. Institutions today need to step-up and set higher standards of self regulation. Few effective parameters which act as a driver for an Institution are Teaching aids, Students attendance, Student Result, Effective Lectures, Funding, Faculty work distribution etc. In current changing & challenging environment if College wants to be excelling, it should focus on designing Academic Self study report in such a way that it should meet the expectations of stack holders.

Keywords- Assessment, Vision, Education, Excellence

I. INTRODUCTION

Indian education sector is growing at a fast pace. India's improved education system is often cited as one of the main contributor to the economic rise of India. Educational Institutions today are more conscious about excellence and quality education. Colleges are presently focusing on assessing their overall educational performance as they realized that outstanding performance is the key for societal development and educational excellence. This urge of being excellence and changing academic norms by respective Universities, UGC (University Grants Commission), AICTE (All India Council for Technical Education) forced colleges to focus on adopting distinct style and trends to create new standards of quality education. There are lots of way's by which an institution can measure their academic performance and find the vacuum in various areas. As far as present education system is concerned there is a drastic change in various areas like Infrastructure, Teaching Style, Academic Curriculum, Teaching aids, Preparation of Academic Self study report etc. This research paper basically focuses on various parameters of

Academic self study report which is used for continuous assessment of various academic components. This research paper is a case study of one of the renowned & premier engineering college of North Maharashtra Region which is affiliated to North Maharashtra University, Jalgaon.

II. OBJECTIVES OF THE PAPER

- To focus on importance of Academic Self Study Report in current context.
- To Study the various essential parameters related to Academic Self Study Report.
- To find out weak areas & scope for further developments.

III. RESEARCH METHODOLOGY

This paper is mostly prepared with the help of primary data collection. For the purpose of data collection a common format of Academic Self Study Report has prepared and circulated among eight Departments of College. The study covers two Semesters of academic year 2010-11. The data were collected from each department at the end of each Semester. All data were analyzed systematically and feedback summary given to all the departments for further course of action.

IV. IMPORTANCE OF THE STUDY

It is utmost vital that every activity or task when get fulfilled should be assessed. Today colleges are somewhere lagging to set the benchmark for their self evaluation due to which they are carefully focusing on assessing their academic activities. Colleges now realized that self assessment is important to fulfill the vacuum in particular area. Even a college or department when decides to go for either an Accreditation or reaccreditation process must demonstrate that it meets or continues to meet all the commission's eligibility requirement. Colleges according to their convenience may design the Academic self study report which may be helpful to assess and enhance the overall performance of it. As far as scope of

this study is concerned with the help of this academic self study report the Institutions or Departments may check their strength and weaknesses & accordingly find out the deficiencies.

V. KEY PARAMETERS

With an intention to measure the performance & strengthen the weak areas of departments the college has designed a format of academic self study report which includes of aspects of all stack holders. This format provided to all departments and information was collected. Out of which some key parameter are discussed below.

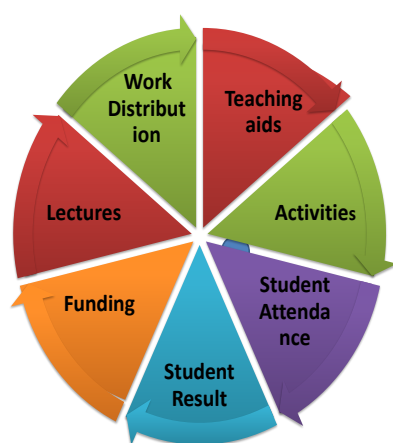


Fig 1: Key Parameters of Academic Self Study Report

1. Brief Introduction of the Department

Under this parameter every department has asked to provide information like Student strength, available faculty, faculties pursuing Ph.D, total number of labs & classrooms with their space allocation. The basic intention of this parameter was to check the availability regarding faculties, labs etc. This parameter also gives the insight about the basic requirement of AICTE.

2. Availability and use of teaching Aids

Teaching aids plays vital role in delivering effective lectures. Proper use of teaching aids makes lecture effective & interesting. With an objective to find out the difficulties while using teaching aid, this parameter is important. This analysis encouraged the faculty members to increase the use of Information and communication Technology (ICT) and to create innovative, effective learning environment.

3. Activities Planned and Conducted

Proper planning is important for effective implementation. Planning and monitoring is one of the vital accreditation parameter. Before commencing academic session, college prepares the academic calendar & plans to organize various activities like Industrial Visit, Expert Lectures, National Seminar, Workshop, Induction function and various co-curricular and extra curricular activities. This parameter facilitates departments in assessing the effectiveness of their Planning & Implementation.

4. Students Attendance Appraisal Report

Regular college attendance is must for student learning and their overall success. Also it is important for parents to ensure that their ward is attending the lecture in college all time. In this study student attendance for the particular course is calculated by a formula- $(\text{Sum of students present} \times 100) / (\text{No. of lectures actually engaged} \times \text{Students on roll})$. On the basis of average % of all the five courses the datum % of student attendance was decided. It is very important because effectiveness of teaching learning process directly reflects in student attendance. It is the most important factor which shows the satisfaction level of the students about content, delivery of that particular course.

5. Student Results

Result is always considered as the receipt of student's as well as faculties efforts. Today institution's ranking is judged by its student's results. A good result is always an identity of college and which directly and indirectly related with new admissions.

6. Leave Record

It is true that the employee who is giving his efforts to the organization must get leave. Maintaining the leave record helps to track the employee attendance for calculation of either salary or leave encashment. Also the College can track the employee and counsel him/her on his habitual going on leave. A College can use it as an effective tool for performance appraisal.

7. Details of Lectures Compensated

This is one of the important parameter in Academic Self Study Report. It is generally assumed that faculties who had availed the leave

should compensate their lectures to cover the syllabus which are missed during leave.

8. Extra Lectures Engaged

Engineering colleges are always adhering to the academic calendar and conscious about Lesson Plans. As per university norms there should be minimum 40-50 lectures of every subject in a semester. Maintaining such records is always helpful to college to focus that whether the syllabus of particular subject has been completed or there is need to conduct extra lecture.

9. Record of Seminar/Conferences/ Workshop/STTP

Department organizes seminars, workshop, conferences, STTP for students and faculties. The data were collected to identify the level of program i.e International, National, University etc, theme of programme -Innovative or not, reputation of speakers, Quality of papers etc. It gives necessary feedback for next year planning and also helps to make competitive environment among the departments.

10. Summary of Faculty work Distribution

As per common observation it is true that apart from regular teaching load, faculties in an engineering college has to perform administrative responsibilities and research work. The basic intention to study this parameter is to check whether some faculties are overburdened with work & responsibilities and some other do not have any extra work. It helps to relocate the work among the faculties properly. Also this parameter focuses on various roles and responsibilities of faculties.

11. Record of Research Papers Published

Research plays vital role in considering the ranking & accessing a college. Many times it is found that faculty' generally very reluctant regarding research papers & research related activities. The intention behind including this parameter is to create awareness & interest about research. With the help of this parameter college may focus on research activities of faculties and may frame the promotion policy with respect to research performance. Also the objective of this parameter is to focus on faculty's contribution in National and International Conferences. With this the college may come to know the performance of faculties in research area. It may

be useful to motivate them if they are lagging in research.

12. Funding

With an intention to promote research and motivate researchers the UGC, AICTE, etc. provide funds. It is imperative that the College should encourage and made aware the faculties as well as departments for sending proposals for funding. The funding agencies provide funds for Seminar, Conferences, Workshop, FDP and Grants like Travel Grant. The college should maintain such data for record purpose.

13. Report of Departmental Meetings

Departmental meeting is very important aspect to create team spirit, better communication, belongingness, mutual understanding among the team member's i.e faculty and staff. Departmental meetings are held in order to smooth running of department. It is always essential to solve the complex problems, issues, for taking review, for improvement and to circulate & update the important information among faculties. It is true that effective departmental meetings lead to better strategy, answers, solutions, decisions and implementation.

VI. FINDINGS OF ACADEMIC SELF STUDY REPORT

- A. Departments are well equipped with state of art infrastructure, faculty and facilities.
- B. As per the careful study and observation it is found that maximum departments use LCD and OHP for effective teaching. There is need to use video lectures, V-Lab etc.
- C. It is found that maximum departments have followed the academic calendar effectively, while very few departments somewhere lagged in implementation of academic calendar properly.
- D. After study it is observed that few departments need to improve their academic calendars.
- E. It is imperative that the departments should periodically conduct the meeting for taking review of syllabus.
- F. It is observed that in few departments faculty involvement in department level activities is less which needs to be improved

- G. It is common observation that few departments have not uploaded their update information on College Website.
- H. Research activities of few departments needs to be improved. They need to start seed financial funding for research work.
- I. The departments should focus on improvement of student attendance, especially at final year.
- J. Student results need to be improved at first year level.

VII. CONCLUSION

In today's stiff competition colleges are adopting various styles to excel in academics. Academic Self Study Report is the best & effective tool which helps the colleges to know their performance. With the help of appropriate Self Study Report the colleges can access their strengths as well as find out the scope for further improvement. Such report may give answers to various questions like where it is? Where it wants to go? How to achieve? The self study report is just like a mirror of colleges. The colleges should set the parameters as per the standards and their needs. During self study, the colleges should carefully consider its educational programs; also it determines that how well these programs accomplish the institution's goal, vision, and mission.

REFERENCES

- [1] Academic Self Study Report, developed by authors
- [2] Dr.Rahul Choudaha, Trends for Indian Education Sector In 2010, <http://www.dreducation.com>, 2010
- [3] Education in India, <http://en.wikipedia.org>
- [4] Self Study Report, <http://www.msche.org>, 2007
- [5] The Importance of workplace meeting, <http://www.flexstudy.com>
- [6] The Importance of Student attendance, <http://ses.rocklin.k12.ca.us>, 2008-2009
- [7] The importance of Attendance: Learning is cumulative, Retrieved from <http://www.polson.k12.mt.us>
- [8] <http://www.citehr.com>

APPLICATION OF PHASOR MEASUREMENT UNIT IN SMART GRID

¹Chandarani Sutar, ²Dr. K. S. Verma

¹RRSINT Amethi (U.P.), ²KNIT Sultapur (U.P.)

Email: ¹Chandarani_st@yahoo.com, ²ksv211@rediffmail.com

Abstract-A smart Grid uses two way digital communication with advanced sensors to collect and analyze data for transforming the existing electric grid into intelligent, dynamic self-healing, self optimizing transmission and distribution grid . As critical grid events often require real-time recognition and real time response .A smart grid uses IP-based ,open standard, intelligent communication to measure real-time events such as congestion ,system stability ,equipment performance, outages and demand response events .

Synchrophasor measurement technology is accurate and real-time monitoring with high resolution of actual system conditions in wide area .

The proposed methods has been verified, compared and studied using PSAT Software which incorporated elapsed time, speed, observability of buses in whole system for optimal placement of Phasor Measurement unit .

Keywords: Smart grid control center, Wide area measurement and control and synchronized phasor measurement unit, optimal placement of Phasor measurement unit.

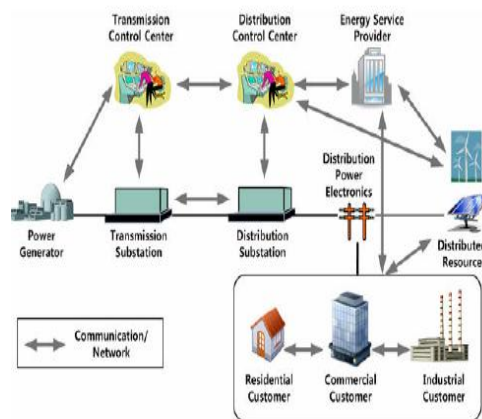
I. INTRODUCTION

From the time that Thomas Edison commissioned the world's first power system in 1882 the electric power industry has continually moved forward working to improve the functionality, efficiency and availability of electricity. Through evolutionary advancements in technology the electrical power industry has transformed the way we generate, deliver and consume power today. Smart grid is the term generally used to describe the integration of the elements connected to the electrical grid with an information infrastructure to offer numerous benefits for both the providers and consumers of electricity. It is an intelligent future electricity system that connects all supply, grid, and demand elements through an intelligent communication system. The backbone of a successful smart grid operation is a reliable, resilient, secure, and manageable standards-based open communication infrastructure that provides

for intelligent linkages between the elements of the grid while participating in the decision making that delivers value to the utility and supply and demand entities connected to it.

II. ADVANTAGES OF SMART GRID

- i) Enables active participation by of consumers by providing choices and incentives to modify electricity purchasing patterns and behavior.
- ii) Autonomous control actions to enhance reliability by increasing resiliency against component failures and natural disasters actions.
- iii) Efficiency enhancement by maximizing asset utilization.
- iv) Resiliency against malicious attacks by virtue of better physical and IT security protocols.
- v) Integration of renewable resources including solar, wind, and various types of energy storage.
- vi) Real-time communication between the consumer and utility.
- vii) Improved market efficiency. It enables new products, services, and markets through a flexible market providing cost benefit tradeoffs to consumers and market participants.
- viii) Higher quality of service – free of voltage sags and spikes as well as other disturbances and interruptions – to power an increasingly digital economy.
- ix) Consumers have more control over the source of their power and the price they pay for it [2],[3].



Control Center in all parts of grid

Fig 1.control center in smart grid

III. APPLICATION DOMAINS

A. Wide-area monitoring and control

Wide-area monitoring and control has been gaining worldwide interest. This involves gathering data from and controlling a large region of the grid through the use of time synchronized phasor measurement units. Analyzing the ability of the Smart Grid to withstand outages of a critical infrastructure element and simulating the effects of various contingency events [4].

B. Inter-Area Oscillation Damping:

Identifying inter-area oscillations and modulating voltage to damp out those oscillations to ensure maximum power transfer and optimal power flow.

IV. WIDE AREA CONTROL SYSTEM FOR SELF HEALING GRID APPLICATION:

- i) Monitoring Distribution Operations:
- ii) Transmission and Distribution Grid Management
- iii) Grid monitoring and control.

Evaluating power system behavior to prepare for combinations of contingency events, prevent wide-area blackouts and fast recovery from an emergency state.

Voltage Security:

Detecting low voltage conditions and initiating corrective action (e.g., load shed). Voltage, VAR and Watt Control: Adjusting loads with respect to voltage tolerances, eliminating overload.

The key application areas include

- Phase angle monitoring
- Slow extended oscillation monitoring
- Voltage stability enhancement
- Line thermal monitoring dynamic rating
- PMU augmented state estimation

V. SYNCHRONISED PHASOR MEASUREMENT UNITS:

Synchronized phasor measurements have become the measurement technique of choice for electric power systems. The phasor measurement units provide synchronized positive sequence voltage and current measurements within a microsecond. This has been made possible by the availability of Global Positioning System (GPS) and the sampled data processing techniques developed for computer relaying applications. In addition to positive sequence voltages and currents these systems also measure local frequency and rate of change of frequency and may be

customized to measure harmonics, negative and zero sequence quantities as well as individual phase voltages and currents. At present there are about 24 commercial manufacturers of phasor measurement units (PMUs) and industry standards developed in the Power System Relaying Committee of IEEE has made possible the interoperability of units from different manufacturers. Synchrophasor technology can help deliver better real time tools that enhance system operators' situational awareness. A synchronized phasor measurement unit with high speed communication network to collect and deliver synchronized high speed grid condition data along with analysis. Other advanced on line dynamic security assessment and control applications will improve real time situational awareness and decision support tools to enhance system reliability.

Real time operations applications

Wide area situational awareness

Frequency stability monitoring and trending

Power oscillation monitoring

Voltage monitoring and trending

Alarming and setting system operating limits and event detection

Resource integration

State estimation

Dynamic line ratings, congestion management

Outage restoration

Operations planning

Wide area controls

In contrast to SCADA system synchrophasor technology allow the collection and sharing of high speed, real time, time synchronized grid condition data across an entire system or interconnection. This data can be used to create wide area visibility across the bulk power system in ways that let grid operators understand real time conditions evidence of emerging grid problems and better diagnose, implement and evaluate remedial actions to protect system reliability [9].

VI. SYNCHROPHASOR TECHNOLOGY:

An AC waveform can be mathematically represented by the equation:

$$X(t) = X_m \cos(\phi + \int_{-\infty}^t \omega(\tau) \cdot d\tau) \quad (1)$$

where: x_m = magnitude of the sinusoidal waveform

$\omega = 2 * \pi * f$ where f is the instantaneous frequency

ϕ = angular starting point for the waveform

Note that the synchrophasor is referenced to the cosine function. In a phasor notation this waveform is typically represented as:

$$\bar{x} = x_m \angle \phi$$

Since in the synchrophasor definition correlation with the equivalent RMS quantity is desired. A scale factor of $1/\sqrt{2}$ must be applied to the magnitude which results in the phasor representation.

$$\bar{x} = \frac{x_m}{\sqrt{2}} \angle \phi$$

Adding in the absolute time mark a synchrophasor is defined as the magnitude and angle of a cosine signal as referenced to an absolute point in time as shown in figure 2

The time strobes are shown as UTC Time Reference 1 and UTC Time Reference 2. At the instant that UTC Time Reference 1 occurs, θ there is an angle that is shown as θ and assuming a steady state sinusoidal (i.e. constant frequency) there is a magnitude of the waveform of X_1 . Similarly at UTC Time Reference 2 an angle with respect to the cosine wave of θ is measured along with a magnitude or X_2 . The range of the measured angle is required to be reported in the range of $\pm \pi$. It should be emphasized that the synchrophasor standard focuses on steady-state signals that is a signal where the frequency of the waveform is constant over the period of measurement.

In the real world the power system seldom operates at exactly the nominal frequency. As such the calculation of the phase angle θ needs to take into account the frequency of the system at the time of measurement. For example if the nominal frequency of operating at 59.5Hz on a 60Hz system (or 50 Hz) the period of the waveform is 16.694ms instead of 16.666ms a difference of 0.167%. [9].

The captured phasor are to be time tagged based on the time of the UTC Time Reference. The Time Stamp is an 8-byte message consisting a 4 byte Second Of Century (S.O.C), a 3-byte Fraction of Second and a 1-byte Time Quality indicator. The SOC time tag counts the number of seconds that have occurred as an unsigned 32-bit Integer. With 32 bits the SOC counter is good for 136 years or until the year 2106. With 3-bytes for the Fraction of Second one second can be broken down into 16, 777,216 counts or about 59.6 n sec/count. If such resolution is not desired the proposed standard (C37.118) allows for a user definable base over which the count will wrap (e.g. a base of 1,000,000 would tag a phasor to the

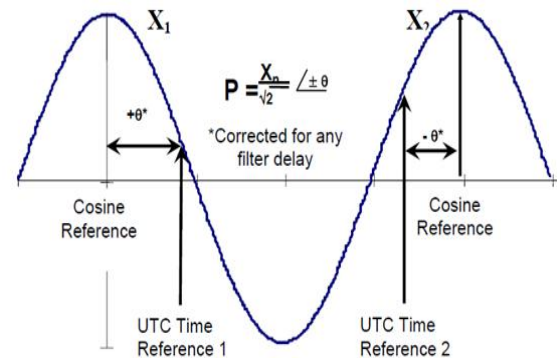


Figure 2: Synchrophasor Definition

nearest microsecond). Finally the Time Quality byte contains information about the status and relative accuracy of the source clock as well as indication of pending leap seconds and the direction (plus or minus). Note that leap seconds (plus or minus) are not included in the 4-byte Second of Century count. Synchronized Phasor Reporting standards the IEEE C37.118 pending 2 proposes to standardize several reporting rates and reporting intervals of synchrophasor reporting. Specifically the proposed required reporting rates are shown in Table 2 below[9].

TABLE .N0.1 SYNCHROPHASOR REPORTING RATES

System frequency	50Hz		60Hz			
Reporting rates	10	2 5	10	1 2	1 5	2 0 3 0

A given reporting rate must evenly divide a one second interval into the specified number of sub-intervals. This is illustrated in figure 3.2 where the reporting rate is selected at 60 phasor per second (beyond the maximum required value which is allowed by the proposed new standard). The first reporting interval is to be at the Top of Second that is noted as reporting interval 0 in the figure. The Fraction of Second for this reporting interval must be equal to zero. The next reporting interval as in Figure. 2 reported 1/60 of a second after Top of Second with the Fraction of Second reporting 279,620 counts on a base of 16,777,216.

VII. MAJOR ELEMENTS OF THE MODERN PMU

Figure. 3. based upon the configuration of the first PMUs built at Virginia Tech .The PMUs are

evolved out of the development of the symmetrical component distance relay. Consequently the structure shown in figure.3 parallels that of a computer relay. The analog inputs are currents and voltages obtained from the secondary windings of the current and voltage transformers. All three phase currents and voltages are used so that positive sequence measurement can be carried out. In contrast to a relay a PMU may have currents in several feeders originating in the substation and voltages belonging to various buses in the substation.

The current and voltage signals are converted to voltages with appropriate shunts or instrument transformers (typically within the range of ± 10 volts) so that they are matched with the requirements of the analog to digital converters. The sampling rate chosen for the sampling process dictates the frequency response of the anti-aliasing filters. In most cases these are analog type filters with a cut-off frequency less than half the sampling frequency in order to satisfy the Nyquist criterion.

VIII. PMU IMPLEMENTATION:

Phasor measurement units are predicted to become a very vital part of power systems state estimation. As such the measurements from PMUs are proven to increase the observability of power systems by strategic placement of a minimal number of phasor

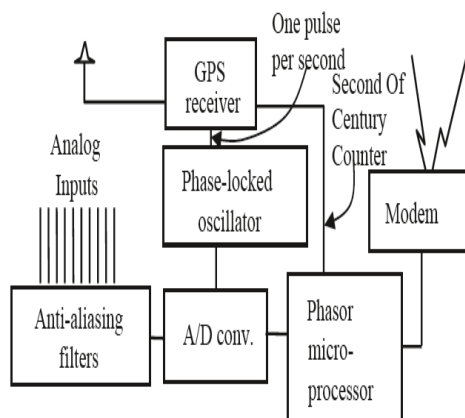


Figure. 3. Major elements of the modern PMU.

As in many relay designs one may use a high sampling rate called oversampling with corresponding high cut-off frequency of the analog anti-aliasing filters. This step is then followed by a digital decimation filter which converts the sampled data to a lower sampling rate thus providing a digital anti-aliasing filter concatenated with the analog anti-aliasing filters. The advantage

of such a scheme is that the effective anti-aliasing filters made up of an analog front end and a digital decimation filter are far more stable as far as aging

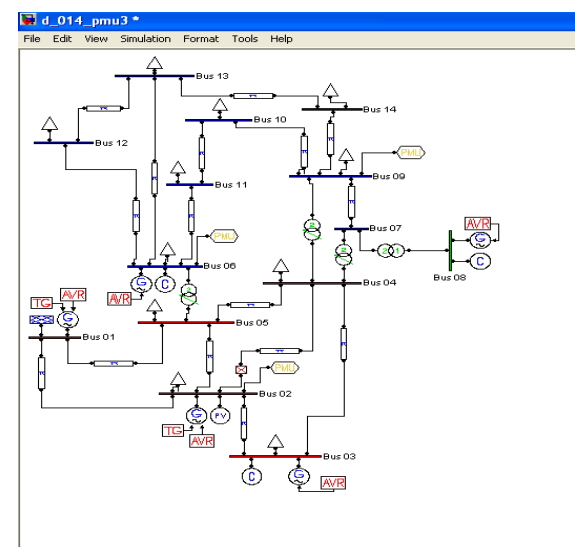
and temperature variations are concerned. This ensures that all the analog signals have the same phase shift and attenuation thus assuring that the phase angle differences and relative magnitudes of the different signals are unchanged. As an added benefit of the oversampling technique if there is a possibility of storing raw data from samples of the analog signals they can be of great utility as high bandwidth digital fault recorders.

The sampling clock is phase locked with the GPS clock pulse. Even higher sampling rates are certainly likely in the future leading to more accurate phasor estimates since higher sampling rates do lead to improved estimation accuracy.

IX. CASE STUDY:

Optimal placement of PMU

Another approach for PMU placement using spanning trees of power systems graphs has been proposed by Nuqui and Phadke [8,9]. Here, in this paper a simulated method has been used to add constraints on the PMU placement algorithm. Performance of IEEE 14 Bus model for optimal placement using PSAT is used as a simulation tool for analyzing PMU implementing methods. Results are carried out for placement of one PMU, three PMU randomly on any buses and optimal PMU placement. The Static report provides power flow through different methods and state variables, total P,Q and plots of theta, frequency, voltage magnitude are calculated for IEEE 14 bus.



IEEE14 Bus PMU Placement using PSAT

This has been discussed by Authors Xu and Abur [8]. In this work the cost of installation of PMUs is taken as the objective function to be minimized with the constraint being the observability of the power systems. The observability can be defined using a matrix containing ones and zeros. If there is a PMU present on a bus or on an adjacent bus then it is given a value of one otherwise a zero. If there are other measurements available then these can be incorporated in the matrix which ultimately reduces the number of PMUs by reducing the cost. Another approach for PMU placement using spanning trees of power systems graphs has been proposed by Nuqui and Phadke [8,9]. Here a simulated annealing procedure has been used to add constraints on the PMU placement algorithm [11].

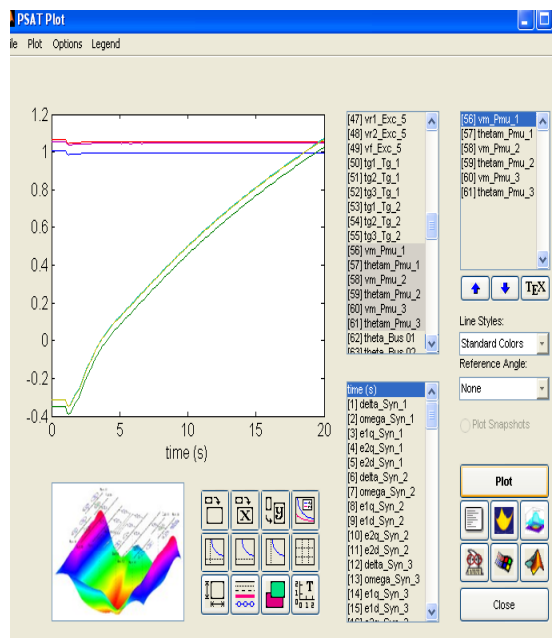


Figure 4. Plot Vm and thita (Pmu1, Pmu2, Pmu 3)

Reactive Power [P.U.] 1.698
Real Power [P.U.] 3.4216
Reactive Power [P.U.] 0.9772
Total Losses
Real Power [P.U.] 0.257382
Reactive Power [p.u.] :0.720781

In this research paper, cost of PMU placement is taken as objective function. Objective function is minimized as per constraints observability of system.

TABLE3: COMPARISON OF DIFFERENT METHODS FOR THREE SET OPTIMAL PLACEMENT PMU

Method	Elapsed time	Number of PMUs	Placement
Depth First	0.031s	6	1,4,6,8,10,14
Graph theory	0.046s	5	1,4,6,10,14
Simulated Annealing	0.531s	4	1,4,6,9
Re-spanning tree	0.719s	3	2,6,9
Direct spanning tree	0.109s	4	2,7,11,13
Mini(N-1)spanning Tree	0.187s	8	2,5,6,7,9,10,13,14
Direct (N1)spanning tree	0.0465s	9	2,3,4,5,6,7,10,13,14

The several methods of optimal placement of PMU is compared using simulation of IEEE fourteen bus system with help of Power System analysis tools (PSAT) and the analysis of their merits and demerits is carried out. On the basis of optimal principle of DFS method, we can obtain Re-spanning tree method by improving its optimization criterion.

This approach overcomes the shortcomings of the poor optimization of DFS method and less elapsed time, high speed of Simulating Annealing method, keeps good balance of quality and efficiency of the optimal placement as well as improves the multi-formity of the results.

X. COPYRIGHT FORMS AND REPRINT ORDERS
I here by declare that, this research paper has been neither published nor submitted for publication, in whole or in part, either in a serial, professional journal or as a part in a book which is formally published and made available to the public.

Acknowledgment

It is my privilege to express sincere gratitude and whole hearted thanks to all which gave me continuous inspiration and guidance for this research work.

CONCLUSIONS

i) Rising fuel costs, under investment in an aging infrastructure, and climate change are all converging to create a turbulent period for the electrical power-generation industry. As utility companies prepare to meet growing demand, greenhouse gas emissions from electricity generation with committed generation capacity may soon surpass those from all distributed energy sources with micro grids.

ii) Smart grid benefits for Advanced smart metering, high power quality, accommodates generation options, load adjustment, wide area measurement and control with PMUs and SCADA system, consumer participation, Demand response support, cyber security and many more for fulfilling consumers demand.

iii) Synchrophasor technology has the potential to greatly improve operator's ability to conduct real time grid operations and detect and respond to potential disturbances. Phasor systems and data will help operators and planners to improve accuracy

iv) The Static report provides power flow through different methods and state variables, total P,Q and plots of angles ,frequency, voltage magnitude are calculated for IEEE 14 bus system. The optimal PMU Placement decreases number of PMUs that reduces cost of system. Using PMU in smart grid increases reliability of power system stability. Therefore it is possible to monitor the power system observability by using PMU.

References

- [1] Towards intelligent smart grid devices with IEC 61850 Interoperability open control architecture, IEEE conference on transmission and distribution new Orleans April 2010
- [2] Management and control of domestic smart grid technology Albert molderink, IEEE transaction smart grid Vol-1 Sept 2010
- [3] Internet based phasor measurement system for phase control of synchronous islands David M Laverty IEEE
- [4] Wide – area frequency monitoring network Architecture and Applications IEEE Transactions on smart grid Vol. 1.NO.2. Sept 2010.
- [5] Next generation monitoring, analysis and control for the future smart control centre IEEE Transactions on SMART GRID, Vol. 1.NO.2. Sept 2010.
- [6] A hybrid smart AC to DC power system IEEE Transactions on SMART GRID ,Vol. 1.NO.2. Sept 2010.
- [7] Management and control of domestic smart grid technology IEEE Transactions on SMART GRID, Vol. 1.NO.2. Sept 2010.
- [8] R. F. Nuqui, A. G. Phadke, "Phasor Measurement Unit Placement Techniques for Complete and Incomplete Observability," IEEE Transaction on Power Delivery, Vol. 20, No. 4, 2381 – 2388, October 2005.
- [9] Synchronized Phasor Measurement sand Their Applications, A.G. Phadke • J.S. Thorp

- [10] J]Practical Considerations for Implementing Wide Area Monitoring, Protection and Control , Elmo Price, ABB Inc., 2006 IEEE 59th Annual Conference for Protective Relay Engineers
- [11] Qiao Li, Student Member, IEEE, Rohit Negi, Member, IEEE, and Marija," Phasor Measurement Units Placement for Power System State Estimation: A GreedyApproach", IEEE

EXAMINE THE EFFECT OF WIND TURBINE PARAMETER ON IT'S DYNAMIC BEHAVIOR

1. Prof K. R. Patil, 2. Miss N. B. Pawar, 3. Miss S. S. Thakare

Dept of Electrical Engg, K.C.E. C.O.E.&I.T., Jalgaon(ME EPS Students)

E-mail- 1. patil_kautik@rediffmail.com, 2. nampaw@gmail.com, 3. sneha.thakare26@gmail.com

Abstract

Numerous models have been proposed for representing variable-speed wind turbines in grid stability studies. Often the values for model parameters are poorly known though. The paper initially uses trajectory sensitivities to quantify the effects of individual parameters on the dynamic behavior of wind turbine generators. A parameter estimation process is then used to deduce parameter values from disturbance measurements. Issues of estimation bias arising from non-identifiable parameters are considered. The paper explores the connection between the type of disturbance and the parameters that can be identified from corresponding measurements. This information is valuable in determining the measurements that are required from testing procedures and disturbances in order to build a trustworthy model.

Keywords:- wind turbine, disturbance measurements, dynamic behavior, trust worth model, DFIG.

I. INTRODUCTION

Accordingly, the impact of wind turbine generators (WTGs) on power system dynamic performance is becoming increasingly important. Inclusion of WTGs in studies of dynamic behavior is difficult though, as many parameters are not well known. The reasons for this are varied, but include: Manufacturers do not wish to disclose their intellectual property. Some wind turbine manufacturers have disappeared, yet their turbines continue to operate. Often manufacturers have very detailed models, but deriving simplified models that are suited to grid stability studies is far from straightforward. Planning studies require typical values for proposed WTGs. Consequently, parameter values are frequently unknown or uncertain. Yet discrepancies may lead to erroneous conclusions regarding dynamic performance. Not all parameters are influential though. In some cases, parameters can be varied over a relatively large range without causing any appreciable change in the dynamic response. Other parameters,

however, exert quite an influence, with small perturbations giving rise to large deviations in the dynamic behavior. It is also quite common for parameters to be influential during certain disturbances but inconsequential Research supported by the National Science Foundation through the project "Impact of Increased DFIG Wind Penetration on Power System Reliability and Consequent Market Adjustment. Parameters that are significant, in the sense that they exert a non-negligible influence on system dynamics, need to be known quite accurately. If they are not otherwise available, then they should be estimated from measurements of WTG response during disturbances. Interestingly, parameters that are influential will also be identifiable from measurements. Conversely, parameters that are not identifiable tend not to be particularly important. The paper uses a nonlinear least squares formulation to estimate significant, but poorly known, parameters. The paper is organized as follows. Section II presents the wind turbine generator model that is used throughout the paper. Parameter sensitivity analysis techniques are discussed in Section III, and parameter estimation is described in Section IV. Conclusions are provided in Section V.

II. WIND TURBINE GENERATOR MODEL

A. Overview

The examples presented in the paper refer to a variable speed wind turbine that is based on doubly-fed induction generator (DFIG) technology. The model used throughout the paper is very similar to that developed in. It is highly simplified from an actual WTG, and is designed to represent only the dynamics of interest in large-scale grid stability studies. Although a DFIG wind turbine was selected for illustration, the concepts presented are nevertheless applicable to other types of turbines. It is convenient to divide a wind turbine system into various subsystems, as shown in Figure 1. The physical device is composed of the wind turbine connected through the drive train to the electromechanical power conversion equipment. The Supervisor Controller (SC) fulfills two main goals:

- 1) Maximize real power production (within equipment rating).

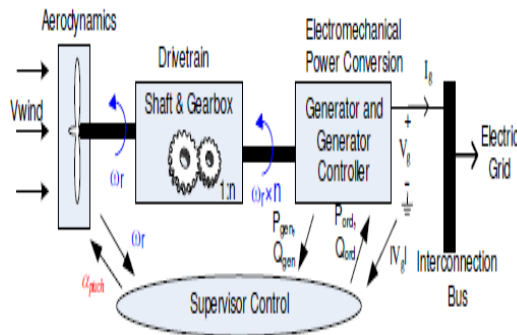


Fig 1 Wind Turbine Generator Subsystem

- 2) Control reactive power.

Older DFIG WTGs usually controlled reactive power to a specified power factor. Newer designs are capable of regulating the terminal bus voltage. The paper focuses on the latter case. Models for the aerodynamic block, the drivetrain block and the generator are well-established from the underlying physics, and do not warrant reproduction. Two simplifications that are common in grid stability studies have been used though:

1. The drivetrain is modeled as a single lumped-mass inertia.
2. The induction generator model neglects stator transients.

Models for the Supervisor Controller (SC) and the Generator Controller (GC) are not well established. Both the SC and GC contain custom control loops designed by the wind turbine manufacturers. The models used here are provided for example purposes only, and may not be reflective of an actual wind turbine.

B. Generator control

The GC regulates the DFIG rotor excitation so that the active and reactive power delivered by the WTG match the setpoint values P_{ord} and Q_{ord} . Unlike traditional synchronous machines, the DFIG requires AC rotor excitation. Varying the rotor voltage magnitude $|V_r|$ and phase $\angle V_r$ allows complete control over complex power generation

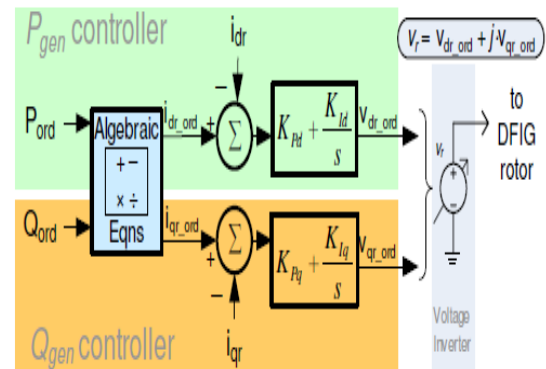


Fig 2 Generator Control

The frequency of the rotor voltage cannot be set independently, but must equal the difference between rotor speed and synchronous grid frequency. Physically, the GC consists of a voltage-source inverter, together with a controller, as shown in Figure 2.

C. Supervisory control

The SC has three major roles. As illustrated in Figure 3, inputs W_r and P_{gen} are used to determine the active power set point P_{ord} that maximizes generated power. Also, the reactive power set point Q_{ord} is adjusted to drive the terminal bus voltage $|V_g|$ to its set point V_{ref} . This SC model is similar to models found in the literature, particularly. The third function, which is not illustrated in Figure 3, is to adjust the blade pitch angle (α_{pitch}) if high winds risk overloading the generator. This blade pitch control system has not been modeled.

2

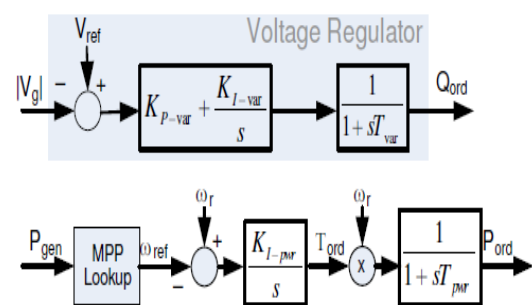


Fig. 3. Supervisor control. "MPP Lookup" provides a lookup table (or polynomial fit) of optimal (P_{gen} ; W_r) pairs resulting in maximum power .

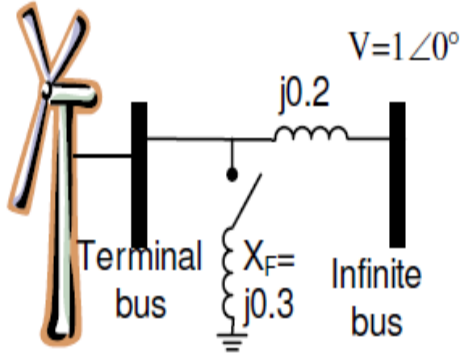


Fig. 4. WTG test network

D. Disturbance models

Three different disturbances are used for various tests throughout the paper:

Wind speed: Ramp decrease in wind speed,

$$v_{wind} = \begin{cases} 11.5 & t < 1 \\ 18 - 6.5t & 1 \leq t \leq 2 \\ 5 & t > 2 \end{cases} \quad (1)$$

where v_{wind} is the wind speed in m/s.

Voltage reference: Step change in V_{ref} from 0.99 pu to 0.95 pu at $t = 0.5$ s.

Fault: The test system, shown in Figure 4, consists of a WTG connected to an infinite bus through a line with reactance 0.2 pu. A fault, with reactance $X_f = 0.3$ pu is applied at the terminal bus of the WTG, and is cleared after 0.23 s.

III. PARAMETER ANALYSIS TECHNIQUES

A. Trajectory sensitivities

The time evolution of system quantities following a disturbance is referred to as a trajectory, and can be compactly expressed as $z(t)$. In the case of a WTG, quantities of interest include currents, voltages, power measurements, rotor speed ω_r , and pitch angle α_{pitch} . The generated complex power is of particular importance in subsequent discussions, so for convenience, P_{gen} and Q_{gen} shall be ordered first among the system quantities,

$$\begin{bmatrix} z_1(t) \\ z_2(t) \end{bmatrix} = \begin{bmatrix} P_{gen}(t) \\ Q_{gen}(t) \end{bmatrix}. \quad (2)$$

System constants are called *parameters*, and are denoted by ν . WTG systems include numerous parameters, with Figures 2 and 3 showing various control system parameters. Subsequent investigations will focus on a subset of the parameters, namely

$$\theta = [K_{Pvar} \ K_{Ivar} \ K_{I_{pwr}} \ K_{Pd} \ K_{Id} \ K_{Pq} \ K_{Iq} \ H]^T. \quad (3)$$

An actual trajectory depends on the choice of parameter values. This parameter dependence is commonly expressed in terms of the system flow, $\Phi(t; \nu)$, with

$$z(t) = \Phi(t; \nu), \quad (4)$$

implying that for a particular value of ν , the point on the trajectory z at time t is given by evaluating the flow Φ at that time. Generally Φ cannot be written explicitly, but instead is obtained numerically by simulation.

Trajectory sensitivities provide a useful way of quantifying the effect that individual parameters have on overall system behavior. A trajectory sensitivity is simply the partial derivative of the trajectory, or equivalently the flow, with respect to the p parameters of interest,

$$S_i(t, \theta) = \frac{\partial \phi_i}{\partial \theta}(t, \theta) = \begin{bmatrix} \frac{\partial \phi_i}{\partial \theta_1}(t, \theta) & \frac{\partial \phi_i}{\partial \theta_2}(t, \theta) & \dots & \frac{\partial \phi_i}{\partial \theta_p}(t, \theta) \end{bmatrix} \quad (5)$$

where ϕ_i refers to the i -th element of the vector function Φ , and θ_j is the j -th parameter. The ordering given by (2) implies

$$S_1(t, \theta) \equiv \frac{\partial P_{gen}}{\partial \theta}(t, \theta), \quad S_2 \equiv \frac{\partial Q_{gen}}{\partial \theta}(t, \theta). \quad (6)$$

Trajectories are obtained by numerical integration, which generates a sequence of points at discrete time steps $t_0; t_1; \dots; t_N$ along the actual trajectory. The discretized trajectory will be described using the notation

$$z = [z(t_0) \ z(t_1) \ \dots \ z(t_N)]^T. \quad (7)$$

Trajectory sensitivities can be calculated efficiently as a byproduct of numerical integration [4]. The corresponding discretized sensitivities can be written,

$$S_i(\theta) = \begin{bmatrix} S_i(t_0, \theta) \\ S_i(t_1, \theta) \\ \vdots \\ S_i(t_N, \theta) \end{bmatrix}. \quad (8)$$

Unfortunately, few of the commercial simulation packages currently calculate trajectory sensitivity information. Approximate sensitivities must be generated by varying each parameter in turn by a very small amount, re-simulating, determining the difference in trajectories, and thus finding the sensitivity.

Table No. 1
PARAMETER SENSITIVITY NORMS FOR Vref
DISTURBANCE

	K_{Pvar}	K_{Ivar}	K_{Ipwr}	K_{Pd}	K_{Id}	K_{Pq}	K_{Iq}	H
$\ S_1\ $	≈ 0	0.01	0.62	1.57	1.49	0.68	0.36	0.05
$\ S_2\ $	0.03	0.31	0.08	0.20	0.19	1.92	0.69	≈ 0
Sum	0.03	0.32	0.70	1.77	1.68	2.60	1.05	0.05

The disadvantage of this method is that it is computationally expensive, and requires an additional simulation for each parameter.

B. Quantifying parameter effects

Trajectory sensitivities can be used directly to identify significant parameters in a model. Parameters that have a large associated trajectory sensitivity (for part or all of the simulation time) have a larger effect on the trajectory than parameters with smaller sensitivities. This relative significance can be quantified by using an appropriate norm. Considering the sensitivity of the i -th system quantity (trajectory) to the j -th parameter, given by $S_{ij}(t; \theta)$, the 2-norm (squared) is given by

$$\|S_{ij}\|_2^2 = \int_{t_0}^{t_N} S_{ij}(t, \theta)^2 dt \quad (9)$$

where the period of interest is $t_0 [t \ t_N]$. In terms of the discrete-time approximation provided by simulation, the equivalent 2-norm can be written

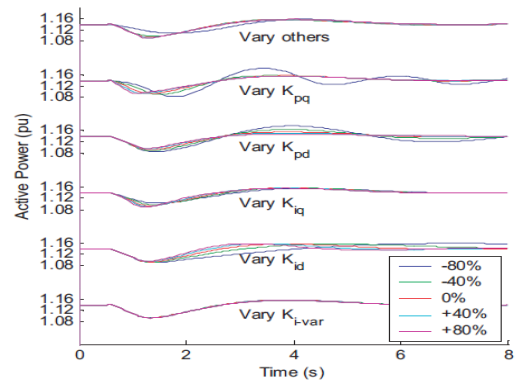
$$\|S_{ij}\|_2^2 = \sum_{k=0}^N S_{ij}(t_k, \theta)^2. \quad (10)$$

For illustration, Table I tabulates the sensitivity norms for the voltage reference disturbance described in Section II-D. From this table, it can be seen that parameters K_{Pvar} , K_{Ivar} , and H have much smaller sensitivities, and thus are likely to have minimal effect on the simulation trajectory, while parameters K_{Ipwr} , K_{Pd} , K_{Id} , K_{Pq} and K_{Iq}

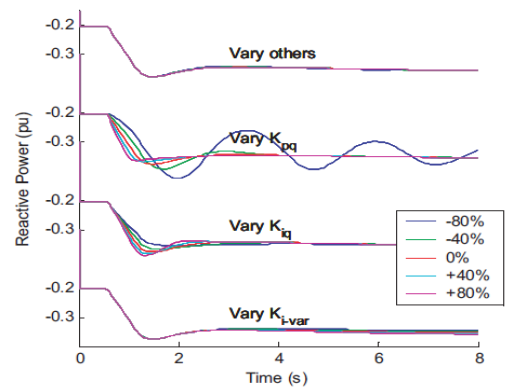
are likely to have a larger effect on the trajectory. Figure 5 verifies this conclusion. Notice that parameters K_{Pd} , K_{Id} , K_{Pq} and K_{Iq} all have a significant influence on the P_{gen} trajectory, in good agreement with Table I. Parameters, K_{Pq} , K_{Iq} and to a lesser extent K_{Ivar} all affect the Q_{gen} trajectory, also in good agreement with Table I.

Parameters that had little effect on the trajectory resulted in nearly identical plots, and so are shown by one representative graph labeled “Vary Others.” The parameters included in this category are K_{Pvar} , K_{Ivar} , and H in Figure 5(a), and parameters K_{Pvar} , K_{Ipwr} , K_{Pd} , K_{Id} and H in Figure 5(b).

Keep in mind that the sensitivities in Table I were obtained for a single disturbance, and thus are applicable only for similar disturbances. Different forms of disturbances may excite the system in ways that accentuate the impact of other parameters. As a general rule, more severe disturbances yield higher sensitivities.



(a) P_{gen} trajectories



(b) Q_{gen} trajectories

Fig. 5. Effect of varying parameters by $\pm 80\%$, for the V_{ref} disturbance.

V. PARAMETER ESTIMATION

A. Gauss-Newton solution method

It is often possible to deduce parameter values from disturbance measurements. In the case of WTGs, simply measuring the generated real and reactive power during a disturbance may yield sufficient information to accurately estimate several model parameters. The aim of parameter estimation is to determine parameter values that achieve the closest match between the measured samples and the model trajectory. Disturbance measurements are obtained from data acquisition systems that record sampled system quantities. Let a measurement of interest be given by the sequence of samples

$$m = [m_0 \ m_1 \ \dots \ m_N]^T \quad (11)$$

with the corresponding simulated trajectory being given by

$$z_i = [z_i(t_0) \ z_i(t_1) \ \dots \ z_i(t_N)]^T, \quad (12)$$

which is the i -th column of z defined in eq 7. The mismatch

between the measurement and its corresponding model trajectory can be written in vector form as

$$e(\theta) = z_i(\theta) - m \quad (13)$$

where a slight abuse of notation has been used to show the dependence of the trajectory on the parameters θ . The best match between model and measurement is obtained by varying the parameters so as to minimize the error vector $e(\theta)$ given by (13). It is common for the size of the error vector to be expressed in terms of the cost,

$$\mathcal{C}(\theta) = \|e(\theta)\|_2^2 = \sum_{k=0}^N e_k(\theta)^2. \quad (14)$$

The desired parameter estimate θ is then given by

$$\hat{\theta} = \underset{\theta}{\operatorname{argmin}} \mathcal{C}(\theta). \quad (15)$$

This nonlinear least squares problem can be solved using a Gauss-Newton iterative procedure. At each iteration j of this procedure, the parameter values are updated according to

$$S_i(\theta^j)^T S_i(\theta^j) \Delta\theta^{j+1} = -S_i(\theta^j)^T e(\theta^j) \quad (16)$$

$$\theta^{j+1} = \theta^j + \alpha^{j+1} \Delta\theta^{j+1} \quad (17)$$

where S_i is the trajectory sensitivity matrix defined in (8), and α^{j+1} is a suitable scalar step size. An estimate of μ which (locally) minimizes the cost function $\mathcal{C}(\theta)$ is obtained when $\Delta\theta^{j+1}$ is

close to zero. Note that this procedure will only locate local minima though, as it is based on a first-order approximation of $e(\theta)$. However if the initial guess for θ is good, which is generally possible using engineering judgement, then a local minimum is usually sufficient.

B. Parameter conditioning

Often there is insufficient information in a measured trajectory to estimate all the parameters. In Section III it was seen that some parameters have little effect on trajectory shape. These parameters are usually not identifiable.

When developing a parameter estimation algorithm, it is necessary to separate identifiable parameters from those that are not, in order to avoid spurious results. This can be achieved using a subset selection algorithm. This algorithm considers the conditioning of the matrix $S_i^T S_i$ that appears in (16). If it is well conditioned, then its inverse will be well defined, allowing (16) to be reliably solved for $\Delta\theta^{j+1}$. On

the other hand, ill-conditioning of $S_i^T S_i$ introduces numerical difficulties in solving for $\Delta\theta^{j+1}$, with the Gauss-Newton process becoming unreliable. The subset selection algorithm considers the eigenvalues of $S_i^T S_i$ (which are the same as the singular values of S_i .)

TABLE II
PARAMETER CONDITIONING. (AN 'x' DENOTES WELL-CONDITIONED.)

	K_{Pvar}	K_{Ivar}	K_{Iprw}	K_{Pd}	K_{Id}	K_{Pq}	K_{Iq}	H
v_{wind}			x	x	x			x
V_{ref}		x	x	x	x	x	x	
Fault			x	x	x	x	x	

Small eigenvalues are indicative of ill-conditioning. The subset selection algorithm therefore separates parameters into those associated with large eigenvalues (identifiable parameters) and the rest which cannot be identified. The latter parameters are then fixed at their initial values. Interestingly, the diagonal elements of $S_i^T S_i$ are exactly the values given by the 2-norm (10). If the trajectory sensitivities corresponding to parameters were orthogonal, then $S_i^T S_i$ would be diagonal, and separating the influences of parameters would be straightforward. This is not generally the case though, with the impacts of parameters often being partially correlated. For that reason, large values of (10) are not sufficient to guarantee parameter identifiability. From a numerical (and practical)

standpoint, it is best to initially estimate parameters using a disturbance that results in the highest number of well-conditioned parameters. Having too many ill-conditioned parameters can prevent good estimation. Even though each individual ill-conditioned parameter has little effect on the trajectory, when several ill-conditioned parameters take incorrect initial values, they may irrecoverably bias the estimation process. Table II summarizes parameter conditioning for the three disturbance scenarios described in Section II-D. A V_{ref} disturbance results in the fewest ill-conditioned parameters, and thus this disturbance was used first in parameter estimation. Notice that the results in Table II are fairly intuitive. A change in V_{ref} predominantly disturbs the WTG reactive power control system. All GC parameters are well-conditioned because of the coupling that occurs through the “algebraic equation” block, see Figure 2. Parameter K_{Ipwr} is on the borderline of the conditioning classification, and in fact is ill-conditioned for slightly different V_{ref} disturbances. In the first row of Table II, a V_{wind} disturbance affects only turbine active power production, thus only parameters associated with active power are well-conditioned.

The justification for the last row in Table II is less obvious but relates to response time. A fault is a relatively quick disturbance, compared to the other two. In WTGs, it is typical for the SC to have time constants that are far slower than GC controller time constants. For the particular parameter values chosen in this paper, the SC is so slow that it does not even “notice” the fault; P_{ord} and Q_{ord} remain almost constant throughout the entire simulation.

C. Parameter estimation results

Unfortunately no measurements of actual wind farms were available for use in this paper. Measurement data was therefore fabricated by simulation, using a certain set of parameters henceforth called “actual” parameters. White noise of magnitude 0.02 pu was added to make the measurements slightly more realistic.

TABLE III
PARAMETER ESTIMATION USING V_{ref} DISTURBANCE. (ASTERISK
DENOTES ILL-CONDITIONED.)

	$K_{P_{uqr}}^*$	$K_{I_{uqr}}$	$K_{I_{pwr}}$	K_{Pd}	K_{Id}	K_{Pq}	K_{Iq}	H^*
Actual	20	2	0.6	0.3	0.5	0.3	0.5	4.64
Initial	20	4	0.2	0.5	0.7	0.15	0.2	6
Estim	20	1.99	0.76	0.28	0.54	0.31	0.46	6

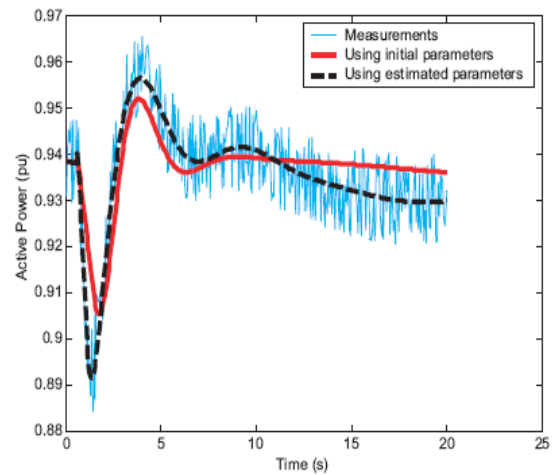


Fig. 6. Measured and simulated P_{gen} for a V_{ref} disturbance. (Results from Table III.)

A simulation was run where V_{ref} was changed according to Section II-D. The wind speed during the entire simulation was steady at 11.5 m/s. The resulting turbine output active and reactive power trajectories were corrupted with noise, and saved as the measurement vector m . The estimation process was then initialized with the parameter values shown in the second row of Table III. After five iterations, the process converged to the values given in the third row of Table III. The results are promising, with accurate estimation of most well-conditioned parameters. The exception is K_{Ipwr} , where its marginal conditioning led to reduced accuracy. Figure 6 shows that these estimated parameters yielded a good match in trajectories. Ill-conditioned parameters are denoted with an asterisk in Table III, and were maintained at their initial (typical) values. Whilst the parameter values in Table III yield a good model for V_{ref} disturbances, the error in H , and to a lesser extent K_{Ipwr} , may prevent accurate replication of other events. Figure 7 shows the results of using Table III “estimated parameters” to model a wind disturbance. The model does not perform near as well.

The solution to this problem is to estimate more parameters.

According to Table II, if the model is intended to predict WTG response to a wind disturbance, then both K_{Ipwr} and H should be estimated because these parameters are influential. However, if the model is intended for fault studies only, then the parameters in Table III should be sufficient, because the influential parameters K_{Pd} , K_{Id} , K_{Pq} , and K_{Iq} have already been accurately estimated.

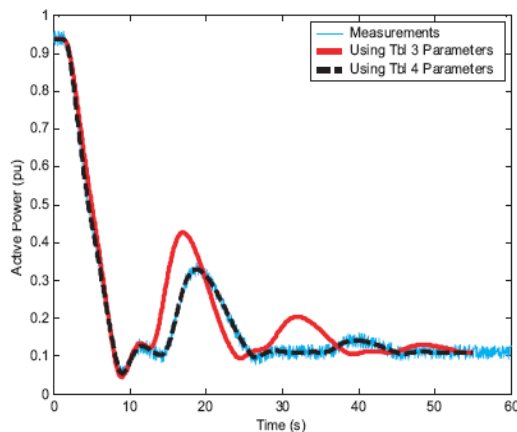


Fig. 7. Measured and simulated P_{gen} for a V_{wind} disturbance.
(Comparison of results from Tables III and IV.)

TABLE IV

PARAMETER ESTIMATION USING v_{wind} DISTURBANCE. (ASTERISK DENOTES ILL-CONDITIONED.)

	K_{Pvar}^*	K_{Ivar}^*	K_{Ipwr}	K_{Pd}	K_{Id}	K_{Pq}^*	K_{Iq}^*	H
Actual	20	2	0.6	0.3	0.5	0.3	0.5	4.64
Initial	20	1.99	0.76	0.28	0.54	0.31	0.46	6
Estim	20	1.99	0.6	0.3	0.5	0.31	0.46	4.64

To create the best model possible, the parameter estimation process should be repeated, this time using measurements from a wind disturbance. Initial parameter values are provided by the “estimated” values in Table III. The results of this second estimation run are given in Table IV and Figure 7. It is clear that improved estimates for K_{Ipwr} and H have been obtained.

D. Parameters that cannot be estimated

Sometimes parameters cannot be estimated from available measurements. According to Table II, K_{Pvar} is such a parameter. Table I suggests that behavior is quite insensitive to variations in K_{Pvar} . It is therefore to be expected that incorrect values for K_{Pvar} would have only a marginal impact on the model accuracy. Table V shows the effect of incorrect K_{Pvar} initialization during parameter estimation. The third and fourth rows in this table show estimation for a V_{ref} disturbance. The last two rows show a second estimation for a V_{wind} disturbance. In this way, the results follow the same procedure used to produce Tables III and IV. Comparing the last line of Table V with the last line of Table IV, it is clear that the estimated parameters are not as good as when K_{Pvar} was initialized correctly. This illustrates a certain compounding effect of using incorrect values for an illconditioned parameter. Though small, the influence of K_{Pvar} is still sufficient to bias the

trajectory slightly. In striving for a better match between simulation and measurements, the estimation process adjusts other parameters to compensate for the bias. This results in somewhat poorer parameter estimates. In general, parameter estimation should be repeated using different initial guesses for all non-identifiable parameters. If the results show significantly different values for estimated parameters, then the non-identifiable parameters cannot be ignored. Another interesting outcome is that K_{Ivar} became illconditioned during the first parameter estimation run.

TABLE V

PARAMETER ESTIMATION FOR INCORRECT K_{Pvar} . (ASTERISK DENOTES ILL-CONDITIONED.)

	K_{Pvar}	K_{Ivar}	K_{Ipwr}	K_{Pd}	K_{Id}	K_{Pq}	K_{Iq}	H
Actual	20	2	0.6	0.3	0.5	0.3	0.5	4.64
Init 1	30	4	0.2	0.5	0.7	0.15	0.2	6
Est 1	30*	4*	0.62	0.24	0.5	0.28	0.6	6*
Init 2	30	4	0.62	0.24	0.5	0.28	0.6	6
Est 2	30*	4*	0.6	0.31	0.5	0.28*	0.6*	4.64

Apparently this is caused by the close relationship between K_{Pvar} and K_{Ivar} in the SC. It is possible for larger values of K_{Pvar} to overwhelm the K_{Ivar} integrator, causing the voltage controller to have mostly proportional response. It was noted in Table I that K_{Ivar} had relatively small sensitivity. The increase in K_{Pvar} negatively impacted the conditioning of K_{Ivar} . These observations highlight the complex manner in which parameters may interact.

V. CONCLUSIONS

It is an unfortunately reality that many parameters of wind turbine models are poorly known. In order to investigate the dynamic performance of wind turbine generators, parameter values must be assigned. Not all parameter values need to be known with the same accuracy though. Using trajectory sensitivities, it has been shown that for a particular disturbance, some parameters are much more influential than others. This pattern of influential parameters may change for different disturbances. A subset selection method has been used to determine parameters that are well-conditioned. Such parameters may be reliably estimated from disturbance measurements. The estimation process is formulated as a nonlinear least-squares problem, which is solved using a Gauss-Newton iterative algorithm. For the case considered in the paper, a two stage estimation process was found to be useful. The first stage used a disturbance in the voltage setpoint to estimate most of the parameters. The next stage considered a wind speed disturbance in order to estimate further parameters that were not initially identifiable. Even with such a multi-step process, some parameters are still not identifiable. Errors in the assumed values for these parameters may bias the

estimation results. In such cases, it may be useful to repeat the parameter estimation process using different initial guesses for non-identifiable parameters.

REFERENCES

- [1] F. Van Hulle, "Large scale integration of wind energy in the European power supply: analysis, issues and recommendations," European Wind Energy Association (EWEA), December 2005.
- [2] R. Wiser and M. Bolinger, "Annual report on U.S. wind power installation, cost, and performance trends: 2006," U.S. Department of Energy DOE/GO-102007-2433, May 2007.
- [3] P. Frank, Introduction to System Sensitivity Theory. New York: Academic Press, 1978.
- [4] I. Hiskens and M. Pai, "Trajectory sensitivity analysis of hybrid systems," IEEE Transactions on Circuits and Systems I: Fundamental Theory and Applications, vol. 47, no. 2, pp. 204–220, February 2000.
- [5] I. Hiskens, "Identifiability of hybrid system models," in Proceedings of the 9th IEEE Conference on Control Applications, Anchorage, AK, September 2000.
- [6] J. Slootweg and W. Kling, "Modelling wind turbines for power system dynamics simulations: an overview," Wind Engineering, vol. 28, no. 1, pp. 7–25, January 2004.
- [7] A. Hansen, "Generators and power electronics for wind turbines," in Wind Power in Power Systems, T. Ackermann (Editor), John Wiley and Sons, England, 2005, pp. 53–78.
- [8] J. Slootweg, H. Polinder, and W. Kling, "Dynamic modelling of a wind turbine with doubly fed induction generator," in Proceedings of the IEEE Power Engineering Society Summer Meeting, vol. 1, Vancouver, Canada, July 2001, pp. 644–649.
- [9] J. Ekanayake, L. Holdsworth, and N. Jenkins, "Control of doubly fed induction generator (DFIG) wind turbines," IEE Power Engineer, vol. 17, no. 1, pp. 28–32, February 2003.
- [10] J. Ekanayake, L. Holdsworth, X.-G. Wu, and N. Jenkins, "Dynamic modeling of doubly fed induction generator wind turbines," IEEE Transactions on Power Systems, vol. 18, no. 2, pp. 803–809, May 2003.
- [11] J. Slootweg, S. de Haan, H. Polinder, and W. Kling, "General model for representing variable speed wind turbines in power system dynamics simulations," IEEE Transactions on Power Systems, vol. 18, no. 1, pp. 144–151, February 2003.
- [12] M. Hughes, O. Anaya-Lara, N. Jenkins, and G. Strbac, "Control of DFIG-based wind generation for power network support," IEEE Transactions on Power Systems, vol. 20, no. 4, pp. 1958–1966, November 2005.

Marketing Strategies of Indian Automobile Companies: A Case Study of Maruti Suzuki India Limited

Dr.M.A.Lokhande¹, Vishal Sunil Rana²

¹Prof & Head, Dept of Commerce, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad, (M.S)

²Asst Prof & Head, Dept of Business Administration, S.S.B.T's College of Engg & Tech., Jalgaon (M.S)

Emails: ¹murlidhar_lokhande@yahoo.com, ²vishal.rana1980@yahoo.com

¹Corresponding Author

Abstract— In today's competitive era the word 'Strategy' is very crucial for all business organizations. Presently organizations started realizing that customer centric and aggressive marketing strategies plays vital role to become successful leader. Though globalization has opened the doors of opportunities for all, the market is still crowded with some unknown risks and lot of competition. Because of this competition, a marketing strategy must aim at being unique, differential-creating and advantage-creating. To obtain unique and differential advantage, an organization has to be creative in its marketing strategy. Today due to innovative marketing strategies Maruti Suzuki has become the leading & largest seller of automobiles in India. Company has adopted various Brand positioning, Advertising, Distribution strategies to capture the market. Maruti's few unique promotional strategies include Teacher Plus Scheme, 2599 scheme, Change your life campaign. The objective of this paper is to focus on various marketing strategies of Maruti Suzuki India Ltd.

Keywords- Strategy, Brand Position, Marketing, Promotion, Distribution

I. INTRODUCTION (HISTORICAL REVIEW)

The automobile manufacturing industry in India dates back to 1948. At that time there were just three companies manufacturing passenger cars i.e. Premier Automobiles in Mumbai, Hindustan Motors (HM) in Kolkata & Standard Motors Products India in Chennai. In early years the Indian automobile Industry faced several challenges and road blocks to growth because in those days automobile manufacturing was subject to restrictive tariff structure, strict licensing and limited avenues for expansion. Due to lack of competition initially the prices of cars were extremely high. And the customers had to wait for a long period of time for car. Before Independence India was considered as a market for imported

vehicles. In the 1950s the arrival of Tata Motors, Mahindra & Mahindra & Bajaj Auto led to steadily increasing vehicle production in India. In 1953 the government of India and the private sector launched efforts to create an automotive component manufacturing industry to supply to the automobile industry. By the end of 1970s, significant changes in the automobile industry were witnessed. After 1970 the automobile industry started to grow, but that growth was mainly driven by scooters, tractors and commercial vehicles.

In 1983, the government of India made a tie-up with Suzuki Motor Corporation of Japan to manufacture low-cost cars in India. The Maruti 800 which is still known rolled out the factory of Maruti Udyog Limited in December 1983 and changed not just India's automobile industry but also the way people commuted and travelled. In 1990s through liberalization initiatives India opened its gates for all the countries and in 1993, the government followed up its liberalization measures with noteworthy reductions in the import duty on automobile components. Today the Indian automobile market has a mix of large domestic automobile players like Tata Motors, Mahindra & Mahindra, Bajaj, Hero Motocorp, Ashok Leyland and major international giants including Suzuki, Honda, BMW, Audi, DaimlerChrysler, Volvo, Hyundai, Toyota, Nissan, General Motors and Ford etc.

II. OBJECTIVES OF THE PAPER

- To Review the progress of Indian Automobile Sector
- To understand the Marketing Strategies of Maruti Suzuki India Limited

III. REVIEW OF LITERATURE

- Sumit Jain & Dr.R.K.Garg, in their research paper described about current scenario of automobile industry and challenges facing by Industry. They pointed that, the companies have to shorten product lifecycles in order to

react to the expectations of individualize and fast changing consumer demands with innovative products, and the integration of strategic partners with more responsibility into the value chain should be intensified.

- Exim bank's occasional paper highlighted that the global financial meltdown of the year 2008 has created a precarious condition across various sectors, which has forced countries and industries to take a fresh look at their future strategies. The paper also pointed out that the Indian automotive industry holds significant scope for expansion, both in the domestic market, where the vehicle penetration level is on the lower side as compared to world average and in the international market, where India could position itself as a manufacturing hub.
- Rajkumar Gautam & Sahil Raj, in their research paper depicted the scenario of automobile sector of the world and India. In their paper they have investigated that the globalization process has affected the sector in all the areas of manufacturing, sales, personal research & development and financing. They also concluded that, in order to meet the challenges posed by globalization the Indian automobile manufacturers need to ensure the technological advancement, appropriate marketing strategies and adequate customer care feedback system in their organizations.
- P Krishnaveni in her article focuses on the current details and some future plans of Maruti Suzuki India Ltd. The article also highlighted the various innovation of company like introduction of Electronic power Steering (EPS), introduction of superior quality of 16*4 hyperteck engines.

IV. PROFILE OF MARUTI SUZUKI INDIA LIMITED

Maruti Suzuki India Limited (formerly known as Maruti Udyog Ltd) is a subsidiary of Suzuki Motor Corporation, Japan and has been the leader of the Indian car market for over two decades. Maruti Suzuki revolutionized the industry and put a country on wheels. Since inception Maruti is credited with having catalyzed and led the modernization of the Indian passenger car industry. Over its 26 years of journey, Maruti Suzuki transformed itself from a successful Public Sector Company (PSU) to a vivacious and listed Multi-National Company (MNC), sustained its leadership position and remained profitable despite tough competition. In October 2, 1982 the company signed the license and joined venture agreement with Suzuki Motor Corporation, Japan. It was the

first company in India to mass produce and sell more than a million cars. In the year 1983 the company started their productions and launched Maruti 800. In the year 1987 the company forayed into the foreign market by exporting first lot of 500 cars to Hungary. In the year 2005 company launched world strategic car model popularly known as Maruti Suzuki Swift which hit the Indian car market.

The core values of company include:

- Openness and learning
- Innovation and Creativity
- Fast, Flexible and First mover
- Customer Obsession
- Networking and Partnership

Currently Maruti Suzuki India Ltd offers 14 brands which include Maruti 800, Omni, Eeco, Zen Estilo, Alto, Alto-K10, A-Star, Wagon-R, Swift, Ritz, Swift Dzire, Sx4, Gypsy, and Grand Vitara. Maruti Suzuki has a market share of 44.9% of the Indian passenger car market as of March 2011. Today Maruti Suzuki has built a strong sales network of 600 outlets spread over 393 towns and cities. The maintenance support is offered to the customers through 2628 workshops spread over 1200 towns and cities.

V. PERFORMANCE OF MARUTI SUZUKI INDIA LIMITED

A. The Sales trend of Maruti Suzuki from year 97 to 2008 is illustrated in Figure 1.1

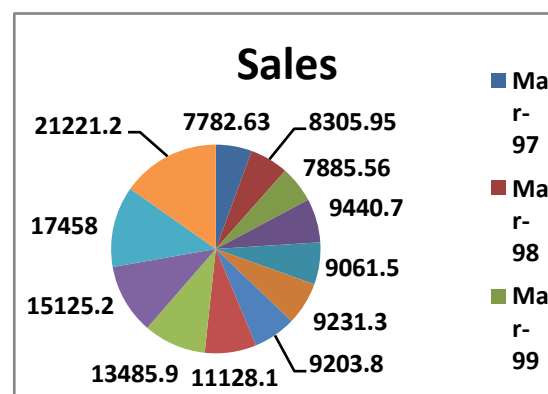


Fig 1, Source: CMIE Prowess Database (97-2007)
(Rs.in Crore)

From the above pie chart it is observed that in the March 2008 Maruti Suzuki's sales was 21221 Crore which is 21.55 % more than March 2007.

B. The Industrial Sales trend of Maruti Suzuki from year 97 to 2008 is illustrated in Figure 1.2

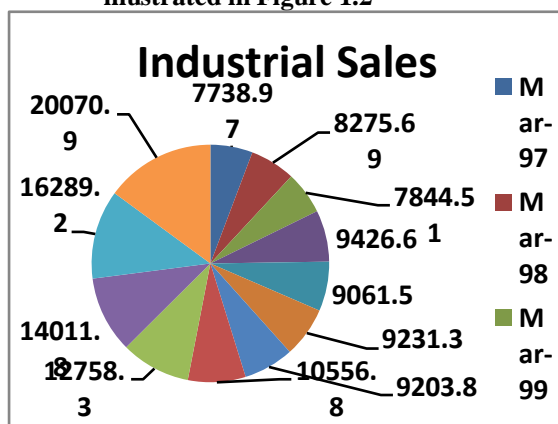


Fig 2, Source: CMIE Prowess Database (97-2007)
(Rs.in Crore)

As observed in the above chart it is revealed that the Industrial sales grew for the period Mar 04 to Mar 08. The Industrial sales of Maruti Suzuki in the year March 2008 was 20070.9 Crore which is 23.26 % greater than previous year.

VI. MARKETING STRATEGIES OF MARUTI SUZUKI INDIA LIMITED

In earlier days when the market was dominated by only few brands like Ambassador & Premier Padmini, Maruti Suzuki India Limited entered the Indian market with different strategy. The strategy of the company was to offer a compact, modern and fuel efficient car. Maruti released its first Maruti 800 car on 14 December 1983 to fulfill the dreams of Indian customers and became the market leader. Since 1983 till date Maruti Suzuki gradually offered several choices to the consumer. Due to aggressive competitors today Maruti Suzuki believes in Innovative Marketing Strategies. With the changing needs, wants & requirements of customers and markets, Maruti Suzuki is altering their Brand Positioning, Advertising and Distribution strategy.

VII. BRAND POSITIONING STRATEGY OF MARUTI SUZUKI INDIA LIMITED

Brand Positioning is the most vital concept in a brand's strategy. Brand Positioning is also linked with managing a brand's meaning. Today several brand of cars are positioning themselves on the features like Price, Comfort dimensions, Safety, Mileage etc. Currently Maruti Suzuki followed a very effective multi-segmentation strategy to grab the different segments of the market with different

versions of its brands. About brand positioning Mayank Pareek says that, Maruti Suzuki believe in research and before launching a product the Maruti team does an extensive research on the needs of the customer. Maruti try to understand the customer's demography and psychology to position a brand. Also the company follows the suggestions made by existing customers.

1. Maruti 800

Considering the middle class & small families the Maruti 800 was launched. The car was also targeted at the urban professionals. It was projected as a car with minimum maintenance needs and with greater fuel efficiency. Later the company added some features like MPFI (Multi Point Fuel Injection) technology & few changes in front grill, head light, and rear light.

2. Omni:

Earlier the Omni was known as Van. The van was targeted more at businessman, tourist taxis and large families. It was positioned as a vehicle offering benefits of a car with more space. But due to some different perceptions of consumers regarding van, after some time the van was renamed as Omni and was repositioned as the most spacious car. Recently Maruti Suzuki launched new variant called Omni Cargo which has been positioned as a vehicle for transporting cargo and meant for small traders.

3. Alto:

Maruti launched Alto with tagline 'Let's Go'. In the TVC of Alto, a young married couple goes to different destinations in their Alto. By this TVC Maruti positioned Alto as a car for young people. Also the car has highlighted as fuel efficient car.

4. Wagon R:

Maruti Suzuki launched the Wagon R brand in February 2000. This is one of the successful brand from Maruti portfolio in the premium segment of compact cars. Wagon R was initially positioned on the basis of the functionality platform. Earlier this car was promoted as a family car with the baseline, 'Feel at Home'. Then as per the changing pattern of market, competition and customers Maruti altered the positioning of Wagon R from Feel at Home to 'Inspired Engineering' to "As Interesting as you are" and finally to "For a Smarter Race".

5. A-Star:

While speaking about A-Star Mr. Shashank Srivastav says that the A-Star was the only car in the Indian market that was targeted at the urban youth. "It is about the new generation of Indians who are confident". Also in the second campaign,

which was done around July 2009, the company's focus was to inform the consumers about the A-Star's K-Series engine. The current campaign of A-Star focuses on self belief and confidence. Considering the fact that self belief and confidence are the attributes of youths, Maruti has positioned A-Star very well. In the current ad campaign a focus has given to a young person who goes for an Interview & with his confidence and self belief he impresses all.

VIII. PROMOTIONAL STRATEGY OF MARUTI SUZUKI INDIA LIMITED

Every company is it a big or small needs an innovative promotional strategy because promotional campaigns tend to have a huge effect on the reception of the product. Maruti Suzuki India Ltd has a formidable line-up of vehicles in its stable and has been quite aggressive about promoting each of its automobile brands. With an intention to face with cutthroat competition and due to declining market shares, in 2000 Maruti Suzuki cut the prices of few models like Wagon R, Omni and Maruti 800 because Maruti knew very well that the Indian consumer is very sensitive about price & this price cut will definitely beneficial for company. In Jan 2002 to attract the customers, Maruti decided that some of its corporate assets in Delhi including Maruti's manufacturing plant and children's park should be promoted. With an intention to promote road safety and efficient driving the company held 'carnivals' periodically at IDTR.

In 2003, to attract the customers Maruti Suzuki launched attractive campaign like "Change Your Life". The company also offered vehicle insurance for One rupee only. In this campaign the customers were asked to write down the chassis and engine number of their vehicles on the entry form and had to answer the question. In this contest the winners were chosen by a draw of lots and were entitled to gifts worth Rs.50 million.

In 2004, Maruti introduced the '2599' offer under which by paying an EMI of Rs. 2599 for seven years after a down payment of Rs.40000, a consumer could buy a Maruti 800. In 2004 Maruti introduced the 'Teacher Plus' scheme, in a tie up with SBI. In this scheme the bank offered reduced rates of interest for teachers who were interested in buying a new car.

Rural India is a fast emerging as a focus area in the country's economy. Maruti knew that there is a great potential in rural markets & in rural markets, the endorsements of opinion makers takes precedence over an informed objective Judgment. Considering this fact, Maruti Suzuki launched a panchayat scheme for such opinion makers which

covers the village Sarpanch, doctors and teachers in government institutions, rural bank officers where in an extra discount is given to make a sell. As a part of customer engaging strategy and to attract the potential customers Maruti organized various melas wherein local flavor is added by organizing traditional social activities like Gramin Mahotsava are conducted round the year. As a part of promotional approach Maruti Suzuki promoted Swift & other brands through sponsoring various live programmes (Dancing shows) like Dance India Dance.

IX. ADVERTISING STRATEGY OF MARUTI SUZUKI INDIA LIMITED

Advertising is one aspect of brand building. Whenever Maruti launched any brand, it supported that brand with an ad campaign. Maruti's advertising campaigns included TVCs, Radio and Print ads, Point of Sale, Mobile promotions, online marketing, Outdoor promotions. Maruti's advertising strategy focused both on building up its corporate image and promoting its cars. Maruti's campaigns emphasized different aspects of its cars, including fuel efficiency, looks, space, etc.

In the late 1990s, Maruti's advertising campaigns were handled by Lowe India (later known as Lowe Lintas & Partners, India) and Rediffusion DY&R. While advertising related to Esteem, Zen and Baleno were handled by Lowe India and the ad campaign of Maruti 800, Gypsy, Omni and Wagon-R were handled by Rediffusion. With an intention to promote the all brands effectively, in 2000 Maruti decided to appoint Capital Advertising. In 2003, Maruti Suzuki came up with an innovative advertising that became popular for its simplicity and clear message. In this ad one child plays with his toy car & when the father asked him, he replies, 'Kya karoon papa petrol khatam hi nahi hota'. This ad depicted the fuel efficiency of Maruti Suzuki.

X. BRAND RELATED ADVERTISEMENTS OF MARUTI SUZUKI INDIA LIMITED

Maruti segmented the customers by designing its brand specific advertisements. The advertising of Maruti was targeted towards the needs and wants of a particular consumer segment.

1. Wagon R

Maruti launched Wagon R in 2000 and launched an ad campaign with the tagline, 'A Car Full of Ideas'. In May 2009, Maruti launched an outdoor campaign for Wagon R using billboards, mobile vans, unipoles etc. The outdoor ads of WagonR were placed on 23 outdoor sites in and around

airports of several cities across India. In the ads different backgrounds were highlighted and each ad displayed a landmark structure from each city with different messages. For e.g, in Mumbai it was, 'Welcome to the city of film stars and WagonR', in Hyderabad, the message was 'Welcome to the city of Charminar & WagonR'.

2. Swift

In 2005, Maruti came up with an ad campaign for its new Swift. The ad campaign included print ads, teaser TV ads and a TVC. In the TVC ad a Maruti Swift car being driven by a young couple at high speed on the road without stopping & car stopped only after chased by a traffic police.

3. A-Star

Maruti has always been advertised A-Star with the tagline of 'Stop at Nothing' which shows the attitude that this car has always stood for. In this ad Farhan Akhtar was the brand ambassador during the launch and the launch TVC also shared elements with the Bollywood hit film 'Rock On' to make it more relatable to the young adult seeking an expression for his passion. According to Mayank Pareek, Head of Marketing, Maruti Suzuki India Ltd says that Cyber media is the best Marketing tool. The company has displayed their banners on various internet sites. And due to boom of Cineplex's and Malls, marketing has become easy.

XI. DISTRIBUTION STRATEGY OF MARUTI SUZUKI INDIA LIMITED

Distribution is an important marketing mix. In earlier days the consumers used to book for a car and wait for more than a year to actually buy it. Also the concept of Show rooms was non-existent. Even worse thing was the state of the after sales service. With an objective to change this scenario & to offer better service to customers, Maruti took initiative. To gain competitive advantage, Maruti Suzuki developed a unique distribution network. Presently the company has a sales network of 802 centres in 555 towns and cities, and provides service support to customers at 2740 workshops in over 1335 towns and cities.

The basic objective behind establishing the vast distribution network was to reach the customers even in remote areas and deliver the products of the company. The company has formed the Dealer territories and the concept of competition amongst these dealers has been brought about. Periodically corporate image campaigns in all dealership are carried out. In 2003, to increase the competition the company implemented a strategy for its dealers to increase their profitability levels. Special awards

were sometimes given by company for sales of special categories. Maruti Suzuki had given an opportunity to dealers to make more profits from various avenues like used car finance and insurance services.

In 2001, Maruti started an initiative known as 'Non Stop Maruti Express Highway'. As a part of this initiative Maruti developed 255 customer service outlets along with 21 highway routes by 2001-02. Also with an intention to provide fast service in less time Maruti had offered Express Service Facility. In the year 2008, Maruti had near about 2,500 rural dealer sales executives, among the total 15,000 dealer sales executives.

CONCLUSION

Automobile market today is very dynamic & competitive with a range of players and products. There are many reasons for the impressive growth of the Indian passenger car Industry. Some of these are easy availability of vehicle finance, attractive rate of interest and convenient installments. In today's cutthroat competition it is very difficult to survive. Stiff competition has forced manufacturers to be innovative and responsive to customer demands and needs. Maruti Suzuki India Limited is a leading company in Indian Automobile sector which occupies prominent place due to its innovative strategic marketing, promotional, Brand positioning, advertising strategies. In today's scenario the success of company lies in structuring and restructuring the marketing strategies and continuous innovation of product and services.

REFERENCES

- [1] Bhargava R.C, "Assembling a Dream", The Maruti Story, Collins Business (HarperCollins Publishers), 13, 2010.
- [2] CMIE, Prowess database (Fig 1.1, 1.2), Prowess.cmie.com
- [3] Dr.Garg R.K & Jain Sumit, Business Competitiveness: Strategies for Automobile Industry, Global Competition & Competitiveness of Indian Corporate, Kozhikode, Kerala, India, 2009, retrived from dspace.iimk.ac.in
- [4] Dr.Lokhande M.A & Rana V.S, "Scenario of Indian Automobile Industry", Vision Research, volume-I, Issue-1, P.no 80, July 2011.
- [5] Gautam R & Sahil Raj, Growth of Indian Automobile Sector in the Era of Globalization, Indian Management Studies Journal, Volume 13 Number 1, April 2009.
- [6] Gulyani Sumila, "Introduction", Innovating with Infrastructure, Palgrave publishers ltd, 22, 2001.
- [7] Importance of advertising in your business, retrieved from www.articlebase.com (article)
- [8] Maruti Suzuki India Ltd, Annual Report 09-10, retrieved from www.marutisuzuki.com.
- [9] Nayyar Anita, "Brands need to build sustainable power", Nov 2010, Indiatelevision.com team (article)
- [10] Neelamegham S, "Maruti Udyog Limited-I", Marketing In India, Vikas Publishing House Pvt Ltd, 9, Reprint 2010.



- [11] Neelamegham S, “Maruti Udyog Limited-II”, Marketing In India, Vikas Publishing House Pvt Ltd, 22, Reprint 2010.
- [12] Pillai R.S.N & Bagavathi, “Product Related Strategy”, Marketing Management, S.Chand & Company Ltd, 27, 2010.
- [13] Ramesh Kumar S, “Application of Product & Brand Related Strategies”, Marketing and Branding, the Indian Scenario, Pearson education, 68, First impression , 2007. Speech by Pareek Mayank, Managing Executive officer (Maruti Suzuki India Ltd), “How to make brands meaningful & powerful”, Exploding Marketing Power, AIMA 2nd World Marketing Congress, New Delhi 02 & 03 March 2012. Retrieved from www.mxmindia.com.

A Detailed Model of The Space Vector Modulated Control Of A VVVF Controlled Ac Machine Including The Overmodulation Region

Vandana Verma¹, Anurag Tripathi²

^{1,2}Authors are with Institute of Engineering. & Technology, Lucknow

Abstract: This paper proposes a method of speed control of three phase Induction motor which is mainly governed by the Space Vector Modulation technique. The purpose is to show the smooth working of the model in the overmodulation regions of the inverter modulation operation. It is a completely simulated work and the results show that the model can very well be tested in the actual experimental setup. In the scheme, the speed command is compared with the actual speed and the error is processed to generate the gating patterns for the space vector modulated voltage source inverter. The scheme ensures smooth variation and control of the speed and torque in the overmodulation region and even beyond it i.e. in the field weakening region.

Keywords: *vvvf method, SVPWM, field weakening region, Overmodulation.*

I. INTRODUCTION

The Induction motors need to be fed through three phase inverters to run them at high speeds. Constant switching frequency Field Oriented Control uses either the carrier based sine-triangle methods, [1] or SVM, [2] for switching. Due to simplicity in digital implementation, Direct Torque Controlled SVM schemes use conventional space vector modulation, for switching the inverter, [3]. In [4], the overmodulation range is divided into two sub-regions and the inverter switching is defined based upon the unique characteristics of the two regions. In the first sub-region, a pre-processor modifies the magnitude of the reference voltage vector before it is being processed by the conventional space vector modulator. In the second sub-region, the pre-processor modifies both the angle and magnitude of the reference voltage vector. To avoid the solution of nonlinear equations, two look up tables are used and continuous control of voltage is obtained until six-step region. While the fundamental voltage cannot be obtained in every sampling period, [4] gets it in a fundamental cycle. The other overmodulation schemes like [5], [6], [7], and [8] use the basic geometrical understanding provided in [4].

The normally adopted method of speed control is the variable voltage variable frequency method where the ratio of the applied voltage to the input supply frequency is kept constant in the region of interest. In order to increase the speed of the motor, the frequency is usually increased which results in the increase of the synchronous speed of the rotating magnetic field and if the operating slip is held constant, the speed accordingly increases. The *vvvf* method necessitates that the applied voltage should also be increased proportionately in order to maintain the magnetic flux in the machine constant. This constant value of the magnetic flux ensures that the capacity torque utilization of the machine is made and also the machine does not go deep into the saturation region.

II. A DETAILED SVM MODEL

The scheme developed in this paper is implemented through a detailed model as shown below in figure (1).

The model starts with three constant blocks representing step inputs for speeds in per unit (pu) which are applied such that they cover all the regions viz. linear, overmodulation and six step.

The first step input command is given at $t = 0.075$ seconds of the value 0.01pu . The second input is applied at $t = 0.15$ seconds of the value 0.8pu thus ensuring the total speed input to be $0.01 + 0.8 = 0.81\text{pu}$.

The third input is given at $t = 0.3$ seconds of the value 0.4pu making the total speed command to be $0.81 + 0.4 = 1.21\text{pu}$ which is well above the six step operation of 1.0pu . The sum of these step input speed values in pu is next subtracted from the actual speed to get the speed error which is given as input to a PI controller.

The output of this controller is fed to a MATLAB function file which decides the reference value of the torque depending upon the various values of the speed error. The reference torque thus calculated is next subtracted from the actual torque value (estimated) and the error is given to another PI controller whose output is given to a MATLAB function file which gives speed in pu as its output.

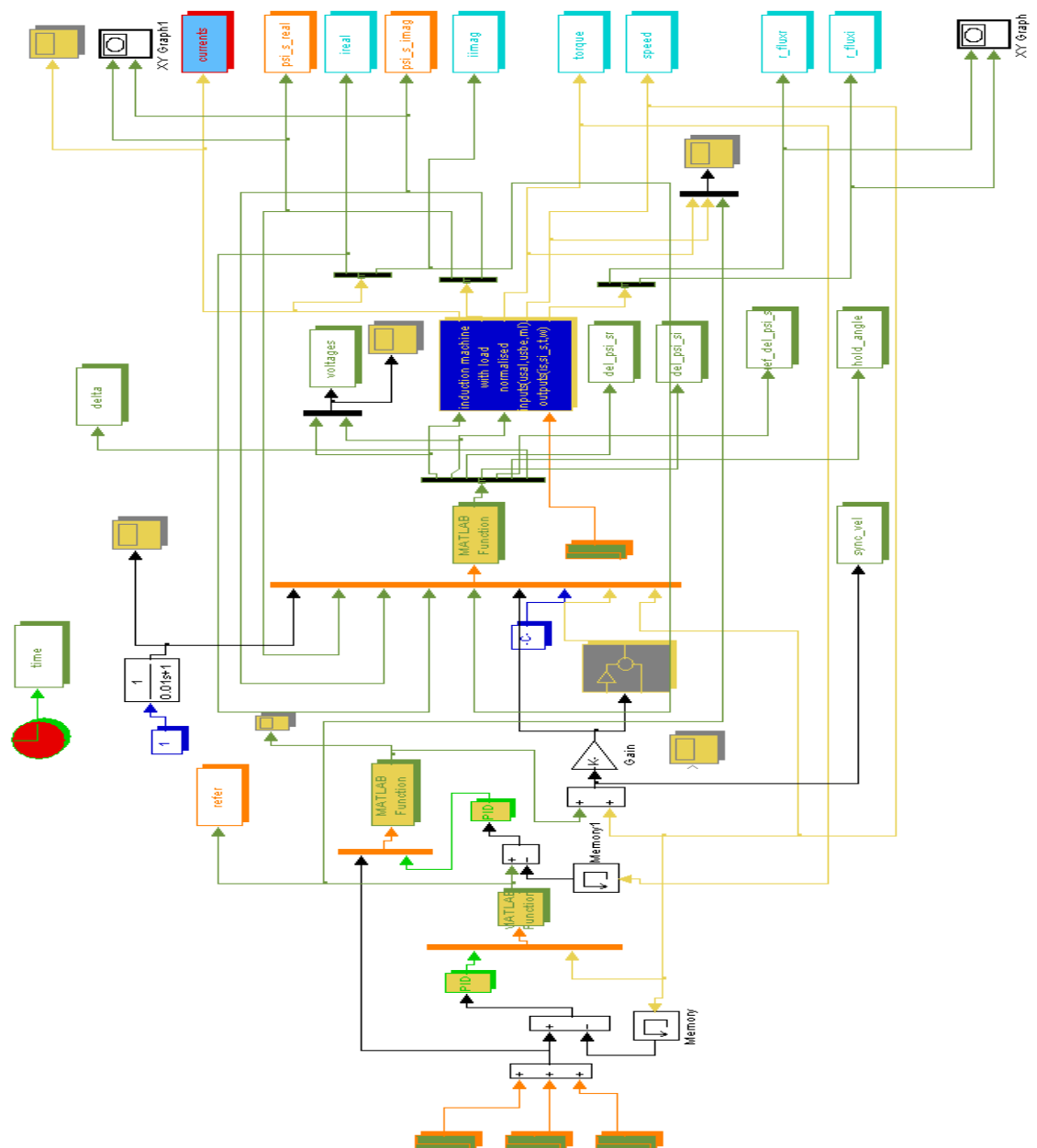


Figure 1: Model for torque control combining the SVM with DTC

The emphasis is that the difference between the reference and actual values of torques decides the value of the slip speed. This slip speed value is next added with the actual speed (which is also derived in pu) to get the value of the synchronous speed in pu. This synchronous speed is multiplied by a gain of 314.159 to get the actual speed value. This actual speed is made to pass through a discrete integrator block in order to get the position (angle) of the reference stator flux vector.

The model proceeds with another MATLAB function file containing nine inputs :

- 1) 'psi_s_ref_mag' i.e. reference flux magnitude (initial) is taken as unity,
- 2) 'psi_s_alpha' i.e. the alpha component of the actual flux vector (taken from the motor model) ,
- 3) 'psi_s_beta' i.e. the beta component of the actual flux vector (taken from the motor model) ,
- 4) 'is_alpha' i.e. the alpha component of the stator current (taken from the motor model),
- 5) 'is_beta' i.e. the beta component of the stator current (taken from the motor model),
- 6) ω_s i.e. the synchronous speed which is achieved by the manner as explained above,
- 7) ' T_s ' i.e. the time period of the discrete inverter output,
- 8) 'ref_angle' is the angle of the stator flux vector obtained by integrating the synchronous speed as explained above and
- 9) ' ω ' i.e. the actual motor speed taken from the motor model.

With the help of these nine inputs the main 'M-file' is developed. It starts with the calculation of the alpha and beta components of the reference flux vector with the help of the first and the eighth inputs i.e. the starting reference flux vector magnitude and the reference angle which is already calculated. Next step is the calculation of the predicted stator flux vector at the following (i.e. next) sampling interval. The difference of this predicted vector and the actual flux vector is then added to the product of the stator resistance voltage drop and the sampling period τ_s to get the

value of the reference flux error vector $\Delta\Psi_s^*(k)$.

The alpha and beta components of this flux error vector give us the expression for delta which is the angular position of $\Delta\Psi_s^*(k)$. Next the sector number and the angle gamma within a particular sector is calculated and based on the sector number six pairs of active voltage vectors is formulated. This is followed by the algorithms for various regions of modulation i.e. normal, OVM I and OVM II. Finally the outputs of the function file are derived which include the alpha and beta components of the voltage vectors and those of the flux error vectors. These outputs are shown in the figures to follow. The voltage vectors are taken from the MATLAB function file and fed to the

three phase induction motor model. The results are displayed and discussed below.

III. RESULTS AND DISCUSSIONS

Figure (2) shows the variation in the stator current values. The d and q components of the stator current vary according to the speed requirements as shown. After the initial starting current values it can be seen that the currents shoot up at $t=0.075$, $t=0.15$ and $t=0.3$ seconds when the speed inputs are applied as discussed before.

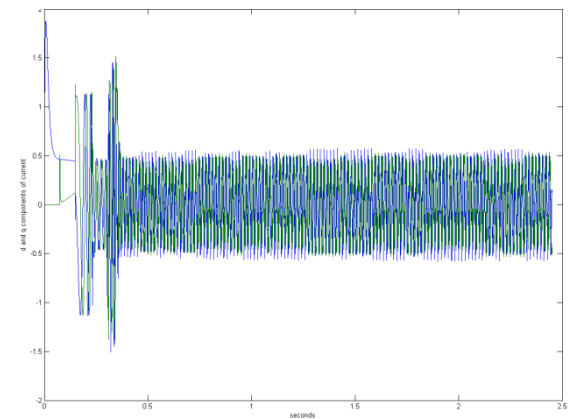


Figure 2 : Stator currents d and q components

Figure (3) represents the variation of the real component of the stator flux error vector with respect to time. The step demand of speed at $t=0.15$ and $t=0.3$ seconds indicates that the rate of change of flux increases at these points thus causing an upward shoot in the value of the flux error vector as can be seen.

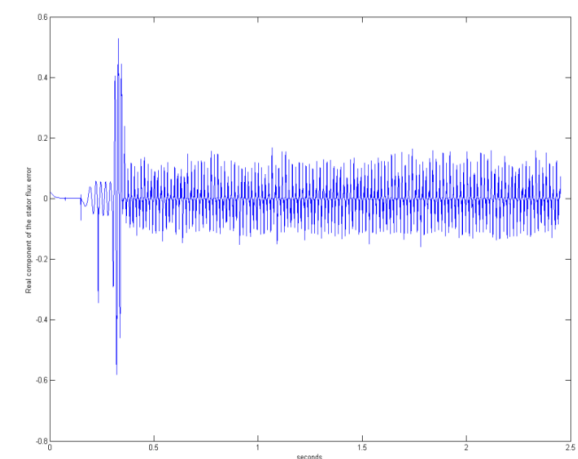


Figure 3: Stator flux error vector (real component)

The real and imaginary components of the stator flux vector are shown in figures (4a) and (4b).

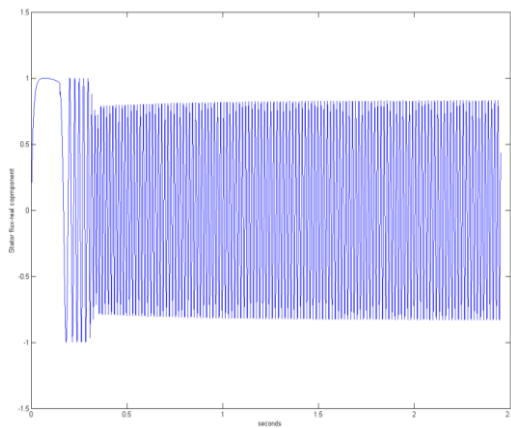


Figure 4a: Stator flux vector (real component)

It can be observed clearly that as soon as the velocity of the motor increases and crosses the 1.0 pu mark, the field weakening region starts and the magnitude of the flux reduces.

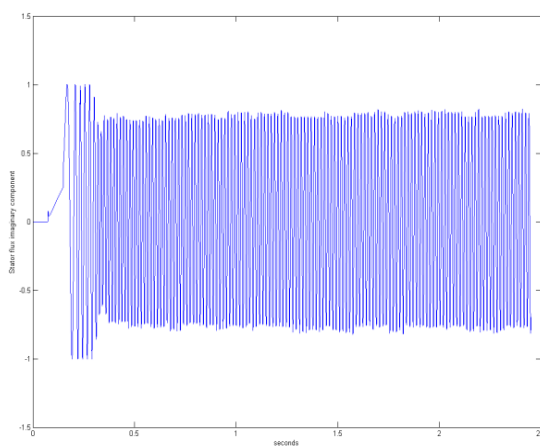


Figure 4b: Stator flux vector (imaginary component)

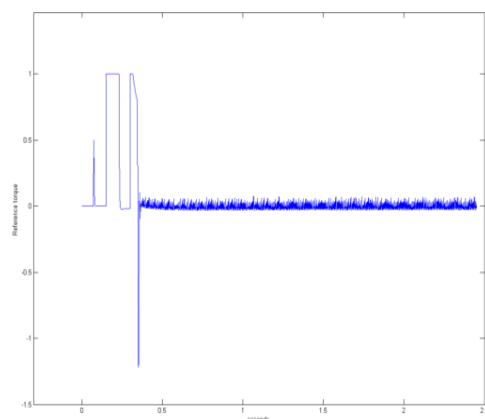


Figure 5: Reference Torque

Figure (5) shows the values of the reference torque at various instances. The reference torque value is decided on the basis of the output of a PI controller

which processes the errors between the demanded and the actual speed values. Hence a sharp shoot in its values are seen at $t=0.075$, $t=0.15$ seconds and also at $t=0.3$ seconds in figure (5).

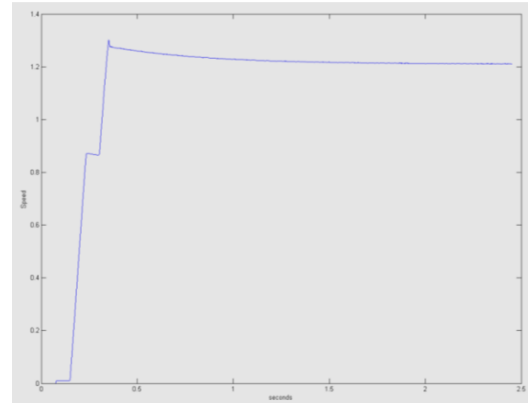


Figure 6: Actual Speed

The variations of the actual speed values are shown in figure (6). The figure shows how the speed shoots up at three various points of times i.e. at $t=0.075$, 0.15 and 0.3 . At $t=0.3$ seconds the speed increases beyond the 1.0 pu value (at 1.21 pu as already discussed), indicating the six-step operation of the three phase inverter. The smooth variation in speed throughout the complete modulation range is the specific advantage of the DTC-SVM scheme used in the model. The speed remains at its demanded value thereafter.

Figure (7) shows the variation in the actual torque value. It can clearly be seen that in the field weakening region (beyond the 1.0 pu speed value after $t=0.3$ seconds), there is a reduction in the value of the torque. The almost zero response time variation in torque is the advantage this scheme offers.

Figure (8) shows the alpha and beta components of the output voltages of the space vector modulated inverter configuration. These voltages are the inputs to the three phase induction motor.

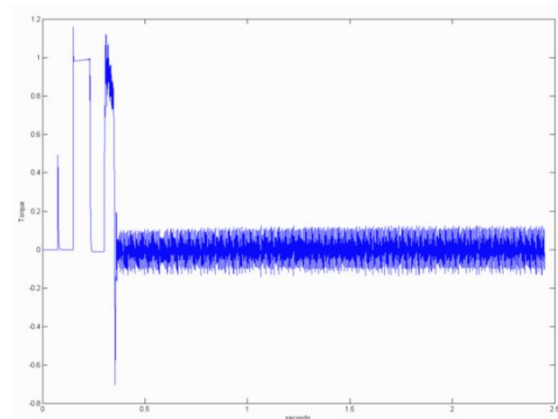


Figure 7: Actual Torque

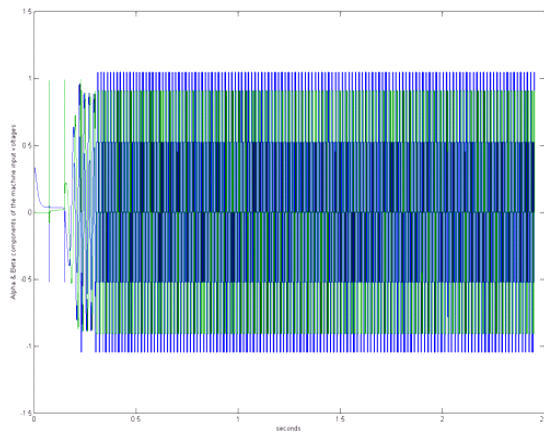


Figure 8: Inverter output voltages (alpha and beta components)

IV. CONCLUSION

The paper has concentrated mainly on the torque and speed control issues of a three-phase inverter fed induction motor drive. The DTC-SVM is improvised for delivering better performance in the overmodulation region of the three phase inverter operation. The proposed algorithm enables an easy transition from the linear modulation state (with $MI \leq 0.907$) to over modulation I and II to six step with the variation only coming in terms of the different expressions of the switching times τ_a, τ_b and τ_0 which is quite easy to realize in the actual hardware setup. A detailed model has been presented in the paper which encompasses all possible speed ranges including the field weakening region. The algorithm developed emphasizes the geometrical equality of the maximum volt-seconds lost at the centre of the hexagonal side and the maximum compensation that can be provided around the vertex region.

REFERENCES

- [1] N. Mohan, T. Undeland, and W. Robbins, "Power electronics converters, applications and design," John Wiley, 1985.
- [2] J. Holtz, "Pulsewidth modulation - a survey," IEEE Trans. on Industrial Electronics, vol. 38, no. 5, pp. 410 – 420, 1992.
- [3] M. P. Kazmierkowski and G. Buja, "Review of direct torque control methods for voltage source inverter-fed induction motors," Industrial Electronics Society, IECON '03. The 29th Annual Conference of the IEEE, November 2003.
- [4] J. Holtz, W. Lotzkat, and A. M. Khambadkone, "On continuous control of PWM inverters in overmodulation range including six-step," IEEE Transaction on Power Electronics, vol. 8, pp. 546–553, 1993.
- [5] A. R. Bakhshai, G'eza, Jo'os, P. K.Jain, and H. Jin, "Incorporating the over-modulation range in space vector pattern generators using a classification algorithm," IEEE Trans. on Power Electronics, vol. 15, pp. 83 – 91, January 2000.
- [6] D.-C. Lee and G.-M. Lee, "A novel overmodulation technique for space-vector PWM inverters," IEEE Trans.

on Power Electronics, vol. 13, no. 6, pp. 1144– 1151, 1998.

- [7] S. Bolognani and M.Zigliotto, "Novel digital continuous control of svm inverters in the overmodulation range," IEEE Trans. on Industrial Applications, vol. 33, no. 2, pp. 525–530, 1997.
- [8] G. Narayanan and V. T. Ranganathan, "Overmodulation algorithm for space vector modulated inverters and its application to low switching frequency PWM Techniques," Electric Power Applications, IEE Proceedings, vol. 148, November 2001.

Seasonal Variation of Heavy Metal in Tapti River

⁽¹⁾ A. A. Patil, C. P. Sawant*

S.J.J.T. University, Rajasthan

Center for P.G. and Research G.T.P., College, Nandurbar (M.S.) India

Email : anilapatil123@rediffmail.com

Abstract Water quality is an index of health and is one of the areas of major concern to environmentalists. Since Industrialization, urbanization and modern agriculture practices have direct impact on the water resources. Hence study of the river water quality is most essential aspect for sustainable development and river conservation. This paper deals with determination of eight heavy metals namely Fe, Cu, Zn, Pb, As, Hg, Ni, Cd in the river water of different sites of Tapti River. The study was done in premonsoon and postmonsoon. Seasons in the period of 2010-11. The samples were analyzed by ICP-AES and data is useful to assess the level of heavy metals in river water.

Key word : River water, Heavy metal, ICP-AES

INTRODUCTION

Rivers play an important role in the life of the people because these are mostly used as a source of water for drinking, bathing, irrigation, recreation and other miscellaneous purposes^[1]. Trace amounts of metals are common in water and these are normally not harmful to human health. In fact some metals are essential to sustain life. Cu, Fe, Zn... are needed at low levels as catalysts for enzyme activities but excess limits can have severe consequences on health^[2,3]. River water contains high levels of these toxic metals such as Cu, As, Cd, Ni, Pb, Hg, may be hazardous to human health. This gives rise to disorders in aquatic organism. Up- take of heavy metal through food chain in aquatic organism may cause various psychological disorders. Availability of heavy metals in the aquatic ecosystem and its impact in flora and fauna has been reported by many investigators^[4]. Among the pollutants present in water, heavy metals are more toxic to the living

organism. Having entered into environment they play a significant role in aquatic ecosystem thereby posing a biological threat to the public health. Thus, to maintain the environmental quality and avoid health hazards^[5]. It is necessary to remove the heavy metals from the water bodies for the detection and assessment of the concentration of these toxic heavy metals becomes very important.

MATERIALS AND METHODS

Study area:- Tapti is one of the three major rivers in central India which flow from east to west with a length of 724 km and of area of 30,000 Sq km, the main reason of contamination of the river Tapti by the heavy metals is due to drainage discharge from all villages and cities on both the banks of the river and its tributaries. Similarly heavy metals contamination also takes place due to small brick industry, small scale industries and farming runoff water containing fertilizer and pesticides. Also Prakash is considered a holy place called Dakshin-Kashi hence many cremations (burning of dead bodies) takes place in all villages nearby and the ash and bones remaining are immersed in the River Tapti leading to pollution of the river water.

Sample Collection:-

For the assessment of heavy metals in Tapti river water five sample were collected in pre-monsoon at different stations during Dec-Jan 2010-11 and five

samples were collected in post monsoon period of May-June 2011 at the same stations. All the water samples were collected and preserved and digested following standard methods and procedures [6,7]. A brief description of sampling sites is represented in table No.1 and 2, Eight heavy metal namely Copper,

Lead, Nickel, Cadmium, Iron, Zinc, Mercury, Arsenic were Analyzed by Inductively Coupled Plasma-Atomic Emission Spectroscopy and most Promising emission technique which has been used for heavy metal analysis./ detection.

RESULT AND DISCUSSION

TABLE -1
Heavy metal concentration in river water Tapi during post monsoon Dec-Jan 2010-11

Sample No.	Metals Contamination mg/L							
	Cu	Zn	Fe	Ni	Pb	Cd	As	Hg
A-1	0.01	0.281	6.723	ND	0.035	ND	ND	ND
A-2	ND	0.035	12.678	ND	0.021	ND	ND	ND
A-3	0.024	0.069	6.791	ND	0.015	ND	ND	ND
A-4	ND	0.077	4.451	ND	ND	ND	ND	ND
A-5	ND	0.056	3.32	ND	0.012	ND	ND	ND

- ND – mean not detected (less than 0.01 mg/L)

TABLE – 2
Heavy metal concentration in Tapi river water during Pre-monsoon season

Sample No.	Metals Contamination mg/L							
	Cu	Zn	Fe	Ni	Pb	Cd	As	Hg
E-1	0.185	0.699	17.122	0.018	0.091	5.469	ND	ND
E-2	ND	0.187	3.992	ND	ND	0.614	ND	ND
E-3	ND	0.428	2.11	ND	0.05	30.157	ND	ND
E-4	ND	ND	ND	ND	ND	ND	ND	ND
E-5	ND	0.151	6.675	ND	ND	0.284	ND	ND

- ND – not detected (less than 0.01 mg/L)

The major source of heavy metal pollution in river water was its tributaries which are following in city, village it carries lot of untreated sewage, industrial waste, metallic solid waste disposal religious festival waste material, human social activity, coal combustion, over use of fertilizer and pesticide invariably discharge into water result in pollution, the heavy metals are biologically non degradable and though the food chain there may pass on to human and can cause significant health concern [8].

Tapi river water samples were analyzed in postmonsoon and premonsoon season for Copper, Zinc, Iron, Nickel, Lead, Cadmium, Arsenic, and Mercury. The presence of essential micronutrients viz copper, zinc, iron. With concentration within the range of 0.017-0.185, 0.103-0.366, 6.792-7.474 mg/L with an overall mean of 0.101, 0.234, 7.133 mg/L respectively besides the presence of the five toxic heavy metals viz lead, cadmium Nickel, Arsenic, and mercury in the range of 0.0207-0.0705 0.0-9.122, 0.0-0.018 mg/L with an overall mean of 0.0456, 9.122, 0.018, mg/L. The overall

mean concentration of the metals were observed in the order of $Cd > Fe > Cu > Zn > Ni > Pb$.

The Annual maximum Iron concentration was found 12.678mg/Land 17.122mg/Lin post and premansoon season at A_2 and E_1 station respectively. It may be assigned to the soil water interaction especially within the middle and lower part of river stretch during post mansoon season^[9] Lowest concentration (2.11 mg/L) was observed in premansoon at E_3 station, Maximum Iron was recorded in Brahmi river in summer and winter season^[9] and lowest Iron was recorded in the range of 0.01 mg/L Cauvery river around KRS dam Karnataka, India^[10]. Toxicity of copper to aquatic life is dependent on the alkalinity of water, as copper is generally more toxic to aquatic funa at lower alkalinities^[11] over doses of copper may also lead to neurological complication. The maximum copper was found 0.024 mg/L and 0.185 Mg/Lat station A_3 and E_1 in post and premansoon season it may be attributed to domestic sewage and from extensive farmed area^[12] low level could be due to the adsorption of copper on to the particulate matter and consequent settlement to the bottom^[13] Minimum copper 0.01 mg/L was recorded at station A_1 in postmansoon season. Copper in Godavari River as in range of 1.755 to 3.640 mg/L the highest concentration of copper in water was recorded in May 2005. While minimum was in Oct. 2005 recorded^[14]

Higher concentration of Zinc in sampling station was 0.281 and 0.699 mg/L in post and premansoon season at stations, A_1 , E_1 respectively it is attributed to the presence of unused remain of Zinc sulphate in fertilizer and pesticides in agriculture^[12]. Zing value in Ganga River as highest 0.031 mg/Lin summer while lowest value 0.019 mg/Lin rainy season^[15]

The maximum value of Nickel was 0.018 mg/L in premansoon season at E_1 station recorded. 9.0 mg/L concentration of Nickel was recorded in Summer.^[9] The previous studies has been ensure that the atmospheric precipitation is very much responsible for metal contamination in surface water^[12, 16, 17].

Exceptionally the maximum concentration of cadmium was 30.157 mg/L was recorded in premansoon season at station E_3 which is much higher than other station so it can be call for farther investigation. The major source of cadmium is the coal combustion metal industry, and west incineration^[18] lowest concentration 0.284 mg/L was recorded in premansoon season. Concentration of cadmium in Damodar River was 0.073 Mg/Lin

precmansoon and 0.02 mg/Lin postman soon season^[19]. High level of cadmium may be due to discharge form industrial waste or by leaching from sewage laden landfill^[20]. Also large use of P.V.C. plastics and Nickel cadmium batteries, insecticides, motor oil and disposal of sludge in dump cities^[21].

Maximum lead concentration was found 0.035 mg/Land 0.091 mg/Lin post and premansoonseason at station A_1 , E_1 . High level of lead during premansoon season due to concentration effect among other factor^[13]. The maximum lead 27.00 mg/L was recorded in premarsoon season^[21]. In present study few sampling station in both season exceeds the WHO guide line due to direct precipitation and subsequent monsoon run-off that supersedes the salinity and pH of the aquatic phase^[9] lead in the present study originates from battery manufacturing units, automobile related subject lowest lead was recorded in post manssoon season at station A_5 . Lowest lead 0.019 mg/L was recorded in Gomati River^[20] Arsenic and mercury was not detected in both seasons. Low level of mercury in river water might have been caused by the higher ingestion rate of organism, re-suspension of sediments and absorption onto the particulates. In present study seasonal variation in metal concentration due to phytoplankton activates, dilution effect, evaporation rate, flow rate of river, also different type of activities caused by human. Low concentration of Zinc and Copper in postmansoon season due to phytoplankton could consume more copper and Zinc. Evidently high density of phytoplankton population during mansoon consumed more copper and zinc leading to their low concentration in mansoon and winter season reported.^[23, 24]

In present study it was concluded that most of the dissolved metals showed slightly higher concentration during premansoon season than that of postmansoon season. This kind of pattern indicate the accumulation of metal concentration during low flow condition of river it may be attributed to high evaporation rate of surface water followed by elevated temp^[25], few metals such as copper, Zinc, Iron, Lead were lower during post mansoon season it may be due to effect of rain.^[26] The previous studies has been ensure that the atmospheric precipitation very much responsible for metal contamination in surface water^[12, 16, 17]. During study period it was observed that concentration of metal increased along with decreased in p^H it is reported by many. The concentration of cadmium and mercury in water depend on acidity of surrounding medium.^[26, 27]

many reveal reported that high water temperature, oxygen concentration, basis p^H , and hardness of river water increases the heavy metals toxicity^[28]. The highest concentration of most of the heavy metals copper, zinc, Iron, Nickel, Lead at stations A₁, E₁ may be due discharge of heavy metals loaded industrial waste water, sewage water, agriculture run off, high evaporation rate, less dilution, high P^H low flow rate^[29]. The concentration of heavy metal in Tapti river water were within prescribe limit of standards of world health organization (WHO) except cadmium in premonsoon and lead in both season. Water sample is suitable for flora and fund and it can be used for drinking purposes only after proper treatment. The analysis of heavy metal in Tapti river water which may be useful for human health and economy. An examination of water quality is basically a determination of the organic, inorganic and mineral contained in the water.

CONCLUSION:

Metal concentration of river basins depends not only on industrial and house hold waste inputs but also on the geochemical composition of the area. The Analysis data of heavy metal concentration in Tapti river water collected in pre-monsoon and Post monsoon Period. The samples are collected in same places in both seasons. In both the seasons concentration of copper varied from 0.0068 to 0.037 mg/Land in Zinc, concentration is 0.1036 to 0.293 mg/L. In Iron, 6.79 to 5.979 mg/L Nickel is not detected in all sample of post monsoon period but in pre monsoon period concentration slowly increase up to 0.036 mg/L. Lead varied from 0.0166 to 0.0282 mg/L there is no much variation among both seasons, Cadmium is also not detected in pre-monsoon period but in post-monsoon period, concentration suddenly increases by 7.30 mg/L, Arsenic and Mercury are not detected in both seasons in all samples. The average concentration is as $Cd > Fe > Cu > Zn > Ni > Pb > As, Hg$. It is also observed that in dry season concentration of heavy metal in water increases due to high water temperature, oxygen concentration, basic pH and hardness of river water. In Tapti river water samples in both seasons it is also observed that some heavy metals are not detected. Main reason is that there are no chemical industries related to the heavy toxic metals near the river, Also these metals are not used in fertilizers, pesticides, insecticides related to agriculture in the Tapti River under study, Hence these metal are not detected. The higher concentration of metals observed in Post-monsoon reason could be attributed to the heavy rainfall and subsequent river run- off, bringing much industrial and land derived material,

along with domestic and agricultural wastes, which include the residues of heavy metals containing pesticides.

ACKNOWLEDGEMENTS

Authors gratefully acknowledge to the Principal G.T.P. College Nandurbar Dist. Nandurbar and Principal S.E.S. College of Engg. Navalnagar Dist Dhule (M.S.) India, for providing necessary laboratory facilities. Authors are also thankful to sophisticated Analytical Instrument facility (RSIC) IIT Powai, Mumbai for ICP – AES facilities.

REFERENCES

- [1] De, A.K. Environment Chemistry (7th edn) New Age international publishers New Delhi, 2010.
- [2] Mishra A., and Pitre K.S.,(2005). J. Indian chem. Soc ; 82 (3) : 265.
- [3] Prabhakaran, G, et.al.2005, Poll. Res., 24(3) ; 625-628.
- [4] Rani R.S. And Reddy P.M., (2003) Pollution Resrarch, 22: 377,
- [5] Swarup D., and Dwivedi S.K., (1998) Indian J. Anim. Sci. 68 ; 814.
- [6] APHA, Standard Methods for examination of water and waste water,American Public Health Association, Washington D.C. 20th edn 1998
- [7] Clesceri L.S., Standard Methods for the examination of water and waste water. In collection and Preservation of samples and metals (Ed, Arnold, E., Greenberg and Eaton, A.D., APHA, AWWA, WEF, Washington, DC, 35, 1998
- [8] Siddle, R.C., Hook J.E. and Kardor L.T., (1976). Heavy metal application and plant up taken in a land disposal system of west water J. Environ Quality 5:97-102.
- [9] Reza R, Singh G (2010) Heavy metal concentration and its indexing approach for river water. Int., J. Environ Sci. Tech. 7 (4) 785-792.
- [10] Mahadev J. and Gholami S. (2010), Heavy metal analysis of Cavery River water around KRS, dam, Karnataka, India J. Adv. Lab Res Biol Vol. 1.
- [11] Train R.E. (1979). Quality criteria for water Washington: UAPPA. (P-256)
- [12] WU, Y.F : Liu C.Q : Tu C. L., (2008) Atmospheric deposition of metals in TSP of guiyang, PR china. Bull Environ cotan. Toxicol 80(5) 465-468.
- [13] Sanker R. Ramkumar L. Rajkumar M. Jun Sun, and Ananthan G. (2010) Seasonal variation in physics chemical parameter, Nagapptinam, India, of Environ Biology 31(5) 681-686.
- [14] Khan A. K., Ansari N.T., Hashimi S, and sayyad N.R. (2006). Heavy metal concentrations in surface water from Godavari river near Aurangabad, Maharashtra J aqua Bio 21(2) :119-122.
- [15] Mishra, M and Tripathi V. (2001) Impact of city sewage discharge on physical chemical characteristics of Ganga river Asian. J. Micro Biotech and Env. Sci, 3(4); 333-338.
- [16] Wong C.S., C; Li, X D; Zhang, G; Qi, S.H; peng, X.Z., (2003). Atmospheric deposition of heavy metal in the Pearl River Delta, china, Atom, Environ, 37(6), 767-776.
- [17] Pandey J., Shubhashish, K; Pandey, R.; (2009), Metal contamination of Ganga River (India) as influenced by atmospheric deposition. Bull Environ contram Toxicol, 83(2), 204-209.
- [18] Brain, S.C., Bhishop, M., (2009). Seasonal and spatial variation of metal loads from natural flows in the upper Tenmile creek watershed, Montana mine water Environ, 28(3), 166-181.

-
- [19] Chatterjee S.K, Bhattacharjee I., Chandra G. (2010). Water quality assessment near an Industrial site of Damodar River, India Environ monit. Ass 161:177-189.
- [20] Singh R. K. , Mohan D., Singh V. K., Malik A. (2005) Studies on distribution of heavy metals in Gomati River Sediments a tributary of Ganges, India. J. of hydrology 312. 14-27
- [21] Jaru P.L., (2003) Hazards of Heavy metal contamination Britishmedia Bulletin, 68(1), 167-182.
- [22] Neal, C; Jarvie, H.P; Whitton , B.A.; Gemmell J; (2000) The water quality of the river water north-east England sci Total Environ; 251-252, 153-172.
- [23] Govindasmy C.L., Kannan and Jayapaul Azariah; (2000) seasonal variation in Physico chemical properties and primary production in the coastal water biotopes of coromandel coastal, India J. Enrion, Biol 21, 1-7
- [24] Ananthan G.P. samp athakumar, P., Soundarapandian and Kannan L.:(2005) Heavy metal concentration in Ariyan kuppam estuary and verampaltinam cost of pondichaery Indian J. Fish. 52- 501-506.
- [25] Abdel Satar, A.M. (2001) Environmental studies on the impact of drains effluents up on the southern sector of Lake Manzalah. Egypt. J. Aquat. Biol Fish 5,17-30.
- [26] Campbell, P.G. and stockes P.M. (1985). Acidification and toxicity of metals to aquatic biota can J. fish. Aquat Sci 42; 2034-2049.
- [27] Wren, C.D. and Stephenson G. L. (1991) the effect of acidification on the accumulation and toxicity fo metals to fresh water invertebrates Environ Pollut, 71; 2-4.
- [28] Abida Begum, Ramaiah M. Hariskrishna, Khan IRFanulla and Veena K (2009). Heavy metal pollution and chemical profile of cauvery river water E- of Che.(1) 47-52.
- [29] Phiri, O, Mumba, P; Moyo, B.H. Z; Kadewa, W, (2005) Assessment of the impact of Industrial effluents on water quality of receiving river in urban areas of malawi Int. J. Environ Sci Tech., 2(3), 237-244.

IMPACT OF FLUORIDE ON ENVIRONMENT & HUMAN HEALTH

*Durgesh Pratap and Dhananjay Singh**

Department of Chemical Engineering

Institute of Engineering and Technology Lucknow, India

*Email: dsa768008@gmail.com, Phone No: 09415660718

ABSTRACT

Fluoride is a threat to the environment and human health. Developed and developing countries are facing so many problems due to presence of fluoride in the drinking water. Human exposure to fluoride has mushroomed since World War II, due to not only fluoridated water and toothpaste but to the environmental pollution by major industries, from aluminum to pesticides, where fluoride is a critical industrial chemical as well as a waste-by product. The current paper deals with the amount of fluoride in the environment and its impact on human health, mainly on the Brain, Endocrine System, Thyroid, Pineal Gland, Immune System, Reproductive System and Organ Systems.

Keywords: Fluoride, Environment, Drinking water, Health effect

I. INTRODUCTION

Fluorides are organic and inorganic compounds containing the fluorine element, formed by halogen family (Fluorine F, chlorine Cl, bromine Br and iodine I). Living organisms are mainly exposed to inorganic fluorides through food and water. Based on quantities released and concentrations present naturally in the environment as well as the effects on living organisms, the most relevant inorganic fluorides are Hydrogen fluoride (HF), Calcium fluoride (CaF_2), Sodium fluoride (NaF), sulfur hexafluoride (SF_6) and Silico fluorides. Fluoride is a nontoxic compound for recommended dose but change to toxic if dose increases up to the standard level. Fluoride is associated with bones and teeth within 24 h of ingestion: that which is not retained is usually eliminated via the kidneys. Various factors affect the retention of fluoride in the body, such as diet and metabolism and age. Required levels of fluoride are estimated to be approximately 0.1 to 0.5 mg F/d for children less than 6 months old, while for adults the range is 4.5 to 4.0 mg F/d. However neither diet nor fluoride by themselves will eradicate dental disease; both proper diet and fluoridation are essential for optimum dental health. Too much fluoride during early childhood

can lead to dental fluorosis as a result of the enamel failing to crystallize properly [1].

II. AMOUNT OF FLUORIDE IN ENVIRONMENT

Fluoride levels in surface waters vary according to location and proximity to emission sources. Surface water concentrations generally range from 0.01 to 0.3 mg/litre. Seawater contains more fluoride than fresh water, with concentrations ranging from 1.2 to 1.5 mg/litre. Higher levels of fluoride have been measured in areas where the natural rock is rich in fluoride, and elevated inorganic fluoride levels are often seen in regions where there is geothermal or volcanic activity (25–50 mg fluoride/litre in hot springs and geysers and as much as 2800 mg/litre in certain East African Rift Valley lakes). Anthropogenic discharges can also lead to increased levels of fluoride in the environment. Airborne fluoride exists in gaseous and particulate forms, which are emitted from both natural and anthropogenic sources. Fluoride released as gaseous and particulate matter is deposited in the general vicinity of an emission source, although some particulates may react with other atmospheric constituents. The distribution and deposition of airborne fluoride are dependent upon emission strength, meteorological conditions, particulate size and chemical reactivity. In areas not in the direct vicinity of emission sources, the mean concentrations of fluoride in ambient air are generally less than $0.1 \mu\text{g}/\text{m}^3$. Levels may be slightly higher in urban than in rural locations; however, even in the vicinity of emission sources, the levels of airborne fluoride usually do not exceed $2\text{--}3 \mu\text{g}/\text{m}^3$. In areas of China where fluoride-rich coal is used as a source of fuel, reported concentrations of fluoride in ambient air have reached $6 \mu\text{g}/\text{m}^3$. Fluoride is a component of most types of soil, with total fluoride concentrations ranging from 20 to 1000 $\mu\text{g}/\text{g}$ in areas without natural phosphate or fluoride deposits and up to several thousand micrograms per gram in mineral soils with deposits of fluoride [2]. Airborne gaseous and particulate fluorides tend to accumulate within the surface layer of soils but may be displaced throughout the root zone, even in calcareous soils. The clay and organic carbon content as well as the pH of soil are

primarily responsible for the retention of fluoride in soils. Fluoride in soil is primarily associated with the soil colloid or clay fraction. For all soils, it is the soluble fluoride content that is biologically important to plants and animals [3].

III. FLUORIDE RELEASED INTO THE ENVIRONMENT

1. Naturally: fluorides are released into the environment through the weathering of rocks and through atmospheric emissions from volcanoes and seawater.

2. Human Activities: releasing fluorides into the environment are mainly the mining and processing of phosphate rock and its use as agricultural fertilizer, as well as the manufacture of aluminums. Other fluoride sources include the combustion of coal (containing fluoride impurities) and other manufacturing processes (steel, copper, nickel, glass, brick, ceramic, glues and adhesives). In addition, the use of fluoride-containing pesticides in agriculture and fluoride in drinking water supplies also contribute to the release of fluorides to the environment [4].

IV. IMPACT ON HUMAN HEALTH

A. Fluoride's effect on the brain

On the basis on information largely derived from histological, chemical and molecular studies, it is apparent that fluorides have the ability to interfere with the functions of the brain and the body by direct and indirect means. A few epidemiologic studies of Chinese populations have reported IQ deficits in children exposed to fluoride at 2.5 to 4 mg/L in drinking water. Although the studies lacked sufficient detail for the committee to fully assess their quality and relevance to U.S. populations, the consistency of the results appears significant enough to warrant additional research on the effects of fluoride on intelligence. Fluorides also increase the production of free radicals in the brain through several different biological pathways. These changes have a bearing on the possibility that fluorides act to increase the risk of developing Alzheimer's disease. Studies of populations exposed to different concentrations of fluoride should be undertaken to evaluate neurochemical changes that may be associated with dementia. Consideration should be given to assessing effects from chronic exposure, effects that might be delayed or occur late-in-life, and individual susceptibility [5].

B. Fluoride's effect on Endocrine System

In summary, evidence of several types indicates that fluoride affects normal endocrine function or response; the effects of the fluoride-

induced changes vary in degree and kind in different individuals. Fluoride is therefore an endocrine disruptor in the broad sense of altering normal endocrine function or response, although probably not in the sense of mimicking a normal hormone. The mechanisms of action remain to be worked out and appear to include both direct and indirect mechanisms, for example, direct stimulation or inhibition of hormone secretion by interference with second messenger function, indirect stimulation or inhibition of hormone secretion by effects on things such as calcium balance, and inhibition of peripheral enzymes that are necessary for activation of the normal hormone. Some of these [endocrine] effects are associated with fluoride intake that is achievable at fluoride concentrations in drinking water of 4 mg/L or less, especially for young children or for individuals with high water intake. Many of the effects could be considered subclinical effects, meaning that they are not adverse health effects. However, recent work on borderline hormonal imbalances and endocrine-disrupting chemicals indicated that adverse health effects, or increased risks for developing adverse effects, might be associated with seemingly mild imbalances or perturbations in hormone concentrations. Further research is needed to explore these possibilities [6].

C. Fluoride's effect on the Thyroid

Several lines of information indicate an effect of fluoride exposure on thyroid function. It is difficult to predict exactly what effects on thyroid function are likely at what concentration of fluoride exposure and under what circumstances. In humans, effects on thyroid function were associated with fluoride exposures of 0.05-0.13 mg/kg/day when iodine intake was adequate and 0.01-0.03 mg/kg/day when iodine intake was inadequate. Intake of nutrients such as calcium and iodine often is not reported in studies of fluoride effects. The effects of fluoride on thyroid function, for instance, might depend on whether iodine intake is low, adequate, or high, or whether dietary selenium is adequate.

D. Fluoride's effect on the Pineal Gland

The single animal study of pineal function indicates that fluoride exposure results in altered melatonin production and altered timing of sexual maturity. Whether fluoride affects pineal function in humans remains to be demonstrated. The two studies of menarcheal age in humans show the possibility of earlier menarche in some individuals exposed to fluoride, but no definitive statement can be made. Recent information on the role of the pineal organ in humans suggests that any agent

that affects pineal function could affect human health in a variety of ways, including effects on sexual maturation, calcium metabolism, parathyroid function, postmenopausal osteoporosis, cancer, and psychiatric disease.

E. Fluoride's effect on Insulin Secretion/Diabetes

The conclusion from the available studies is that sufficient fluoride exposure appears to bring about increases in blood glucose or impaired glucose tolerance in some individuals and to increase the severity of some types of diabetes. In general, impaired glucose metabolism appears to be associated with serum or plasma fluoride concentrations of about 0.1 mg/L or greater in both animals and humans. In addition, diabetic individuals will often have higher than normal water intake, and consequently, will have higher than normal fluoride intake for a given concentration of fluoride in drinking water. An estimated 16-20 million people in the U.S. have diabetes mellitus; therefore, any role of fluoride exposure in the development of impaired glucose metabolism or diabetes is potentially significant [7].

F. Fluoride's effect on Immune System

Nevertheless, patients who live in either an artificially fluoridated community or a community where the drinking water naturally contains fluoride at 4 mg/L have all accumulated fluoride in their skeletal systems and potentially have very high fluoride concentrations in their bones. The bone marrow is where immune cells develop and that could affect humoral immunity and the production of antibodies to foreign chemicals. There is no question that fluoride can affect the cells involved in providing immune responses. The question is what proportion, if any, of the population consuming drinking water containing fluoride at 4.0 mg/L on a regular basis will have their immune systems compromised? Not a single epidemiologic study has investigated whether fluoride in the drinking water at 4 mg/L is associated with changes in immune function [8]. Nor has any study examined whether a person with an immunodeficiency disease can tolerate fluoride ingestion from drinking water. It is paramount that careful biochemical studies be conducted to determine what fluoride concentrations occur in the bone and surrounding interstitial fluids from exposure to fluoride in drinking water at up to 4 mg/L, because bone marrow is the source of the progenitors that produce the immune system cells.

G. Fluoride's Interactive /Synergistic effect

Intake of nutrients such as calcium and iodine often is not reported in studies of fluoride effects. The effects of fluoride on thyroid function, for instance, might depend on whether iodine intake is low, adequate, or high, or whether dietary selenium is adequate. Another possible explanation for increased blood lead concentrations which has not been examined is the effect of fluoride intake on calcium metabolism; indicates that higher blood and tissue concentrations of lead occur when the diet is low in calcium. Increased fluoride exposure appears to increase the dietary requirement for calcium in addition, the substitution of tap-water based beverages (e.g., soft drinks or reconstituted juices) for dairy products would result in both increased fluoride intake and decreased calcium intake. With the increasing prevalence of acid rain, metal ions such as aluminum become more soluble and enter our day-to-day environment; the opportunity for bioactive forms of AIF to exist has increased in the past 100 years. Human exposure to aluminofluorides can occur when a person ingests both a fluoride source (e.g., fluoride in drinking water) and an aluminum source; sources of human exposure to aluminum include drinking water, tea, food residues, infant formula, aluminum-containing antacids or medications, deodorants, cosmetics, and glassware [13].

H. Fluoride's effect on the Reproductive System

A few human studies suggested that high concentrations of fluoride exposure might be associated with alterations in reproductive hormones, effects on fertility, and developmental outcomes, but design limitations make those studies insufficient for risk evaluation.

I. Fluoride's effect on the Gastrointestinal System

The numerous fluoridation studies in the past failed to rigorously test for changes in GI symptoms and there are no studies on drinking water containing fluoride at 4 mg/L in which GI symptoms were carefully documented. GI effects appear to have been rarely evaluated in the fluoride supplement studies that followed the early ones in the 1950s and 1960s. There are a few case reports of GI upset in subjects exposed to drinking water fluoridated at 1 mg/L. Those effects were observed in only a small number of cases, which suggest hypersensitivity. However, the available data are not robust enough to determine whether that is the case.

J. Fluoride's effect on the Kidney

The kidneys play a vital role in preventing the build-up of excessive fluoride in the body. Among healthy individuals, the kidneys excrete approximately 50% of the daily fluoride intake. However, among individuals with kidney disease, the kidneys' ability to excrete becomes markedly impaired, resulting in a build-up of fluoride within the body. It is well recognized that individuals with kidney disease have a heightened susceptibility to the cumulative toxic effects of fluoride. Of particular concern is the potential for fluoride, when accumulated in the skeletal system, to cause, or exacerbate, renal osteodystrophy - a bone disease commonly found among people with advanced kidney disease. In addition, fluoride has been definitively shown to poison kidney function at high doses over short-term exposures in both animals and humans. The impact of low doses of fluoride, given over long periods of time, has been inadequately studied. A recent animal study, conducted by scientists at the US Environmental Protection Agency reported that exposure to just 1 ppm fluoride caused kidney damage in rats if they drank the water for an extended period of time, while a new study from China found an increased rate of kidney disease among humans consuming more than 2 ppm [9]. Hence, the adverse effects to kidney function that fluoride causes at high doses over short periods of time may also be replicated with small doses if consumed over long periods of time.

K. Fluoride's effects on the Teeth

According to the current consensus view of the dental research community, fluoride's primary - if not sole-benefit to teeth comes from TOPICAL application to the exterior surface of teeth, not from ingestion. Perhaps not surprisingly, therefore, tooth decay rates have declined at similar rates in all western countries in the latter half of the 20th century - irrespective of whether the country fluoridates its water or not. Today, tooth decay rates throughout continental Western Europe are as low as the tooth decay rates in the United States - despite a profound disparity in water fluoridation prevalence in the two regions. Within countries that fluoridate their water, recent large-scale surveys of dental health - utilizing modern scientific methods not employed in the early surveys from the 1930s-1950s - have found little difference in tooth decay, including "baby bottle tooth decay", between fluoridated and unfluoridated communities [10,12].

L. Fluoride's causes Cancer

Fluoride appears to have the potential to initiate or promote cancers, particularly of the bone, but the evidence to date is tentative and mixed. As noted above, osteosarcoma is of particular concern as a potential effect of fluoride because of (1) fluoride deposition in bone, (2) the mitogenic effect of fluoride on bone cells, (3) animal results described above, and (4) pre-1993 publication of some positive, as well as negative, epidemiologic reports on associations of fluoride exposure with osteosarcoma risk. Osteosarcoma presents the greatest a priori plausibility as a potential cancer target site because of fluoride's deposition in bone, the NTP animal study findings of borderline increased osteosarcomas in male rats, and the known mitogenic effect of fluoride on bone cells in culture [11]. Principles of cell biology indicate that stimuli for rapid cell division increase the risks for some of the dividing cells to become malignant, either by inducing random transforming events or by unmasking malignant cells that previously were in nondividing states. Fluoride exposure has also been linked to bladder cancer - particularly among workers exposed to excess fluoride in the workplace. According to the US National Research Council, "further research on a possible effect of fluoride on bladder cancer risk should be conducted.

M. Effects on Other Organ Systems

The committee also considered effects on the gastrointestinal system, kidneys, liver, and immune system. There were no human studies on drinking water containing fluoride at 4 mg/L in which gastrointestinal, renal, hepatic, or immune effects were carefully documented. Case reports and in vitro and animal studies indicated that exposure to fluoride at concentrations greater than 4 mg/L can be irritating to the gastrointestinal system, affect renal tissues and function, and alter hepatic and immunologic parameters. Such effects are unlikely to be a risk for the average individual exposed to fluoride at 4 mg/L in drinking water. However, a potentially susceptible subpopulation comprises individuals with renal impairments who retain more fluoride than healthy people do.

V. A CASE STUDY

Fluoride occurs in almost all waters from trace to high concentrations and both, lower (0.6 mg/l) and upper (1.2 mg/l) limits of concentration in drinking water, is responsible for health effect and benefits for human beings. Very low doses of fluoride (<0.6 mg/l) in water promote tooth decay. However, when consumed in higher doses (>1.5 mg/l), it leads to dental fluorosis or mottled enamel

and excessively high concentration (>3.0 mg/l) of fluoride may lead to skeletal fluorosis.

In India, an estimated 62 million people, including 6 million children suffer from fluorosis because of consuming fluoride-contaminated water. Although fluorosis was identified as early as 1937, a programme for controlling the disease through networking between State Rural Drinking Water Supply Implementing Agencies and Health Departments was launched during 1986–87.

Generally, high fluoride contamination in hard-rock terrain is common due to water quality variation and changes in shallow and deep aquifers zones. But, in alluvial plain groundwater, the variation and changes in fluoride levels are usually rare. A number of cases of fluorosis have been reported mostly from the granite and gneissic complex of different states such as Andhra Pradesh, Delhi, Madhya Pradesh and Rajasthan (Table 1).

Table 1: Fluoride concentration in the groundwater in different states of India

S No.	Location	Fluoride (mg/l)
1	Guntur, Andhra Pradesh	0.6–2.5
2	Anantapur, Andhra Pradesh	0.56–5.8
3	Hyderabad, Andhra Pradesh	0.38–4.0
4	Ranga Reddy, Andhra Pradesh	0.4–4.8
5	Delhi	0.2–32.5
6	Chandidongri, Madhya Pradesh	1.5–4
7	Shivpuri, Madhya Pradesh	0.2–6.4
8	Churu, Rajasthan	0.1–14
9	Dungarpur, Rajasthan	0.1–10
10	Varanasi, Uttar Pradesh	0.2–2.1
11	Agra, Uttar Pradesh	0.1–17.5
12	Mathura, Uttar Pradesh	0.6–2.5
13	Sonbhadra District, Uttar Pradesh	0.483–6.7

In the Ganga alluvial plain of Uttar Pradesh (UP), fluoride content has been reported by various researchers, and State and Central Governments in the districts of Varanasi, Unnao, Kanpur, Agra and Mathura (Table 1). Fluoride contamination in many parts of UP (Unnao, 2 mg/l; Debraspur, 2.1 mg/l; Janghai, 3.2 mg/l; Kulpahar, 3 mg/l; Babera, 3.3 mg/l; Karchhana, 2.8 mg/l; Jhansi, 2.8 mg/l, and Etah, 3 mg/l) has been reported mainly in the Quarternary–Upper Tertiary deposits.

The study area located in the Chopan block, experiences semi-arid and arid climate, with an average annual minimum and maximum temperatures 10°C and 47°C respectively. Since fluorite, apatite, mica and various other minerals take part during rock–water interaction and liberate fluoride into the groundwater, it is imperative to know the presence of minerals in the rock specimen microscopically. Normally biotite in granite rocks may contain as high as 0.91% fluorine, hornblende contains 0.17% fluorine and fluorapatite has fluorine concentration as high as 3.72%. The data shows 20–30% quartz, 40–45% feldspar, 5–10% apatite, 20–25% biotite with minor chlorite and sphene. Feldspar is occasionally sericitized. Apatite grains are euhedral to subhedral with variable grain size (elongated grains are

sometimes as long as $200\ \mu\text{m}$) and are closely associated with the hydrous minerals at the boundary of the coarse grained feldspar and quartz. As far as immediate association is concerned, apatite grains are closely related to biotite and at places chlorite and myrmekites. The close association of apatite grains with the hydrous phases and myrmekites at the grain boundary of feldspar megacrysts is probably caused by the late fluid activity from crystallization of the granite body [12,14].

The present study of groundwater quality with reference to fluoride concentration in the Kachnarwa region indicated that the ground water are alkaline in nature. Fluoride concentration in the ground water of the study area varied from 0.483 to 6.7 mg/l. High fluoride concentration was found in the villages covered with granitic gneissic complexes than the other rock formations. The highest fluoride concentration was found to corroborate with low calcium values and high sodium content in the ground water. Weathering and leaching of fluorine-bearing minerals in rock formations under alkaline environment lead to the enrichment of fluoride in the ground water. Among the 13 groundwater samples analysed in the study area, 47% of samples had high fluoride content

than the maximum permissible limit (1.5 mg/l). A high rate of evapo-transpiration, comparatively low rainfall, intensive irrigation and heavy use of fertilizers, alkaline environment, longer residence time of water in the weathered aquifer zone and low rate of dilution are favourable factors for the dissolution of fluorine-bearing minerals and thereby increase of fluoride concentration in the groundwater [14].

VI. CONCLUSION

The present study was confined to a small area in the Kachnarwa region. A more detailed study is necessary for better understanding of the source and effects of fluoride problems in other parts of the Sonbhadra District. Local people ingesting the groundwater have not received medical attention in the study area till date. Since these people are dependent on the groundwater for domestic use, remedial measures such as importing of drinking water and rainwater harvesting are needed. Nutritional diet such as calcium and phosphorus-rich food should be recommended to those affected with fluorosis, as it decreases rate of accumulation of fluoride in the human body. Environmental awareness programme for the health implications of fluoride should be emphasized through education of the public and community participation [12,14].

Public Health Service recommendations for fluoride use include an optimally adjusted concentration of fluoride in community drinking water to maximize caries prevention and limit enamel fluorosis. This concentration ranges from 0.7 ppm to 1.2 ppm depending on the average maximum daily air temperature of the area [1, 2]. In 1991, PHS also issued policy and research recommendations for fluoride use. The U.S. Environmental Protection Agency (EPA), which is responsible for the safety and quality of drinking water in the United States, sets a maximum allowable limit for fluoride in community drinking water at 4 ppm and a secondary limit (nonenforceable guideline) at 2 ppm [3,4]. The U.S. Food and Drug Administration (FDA) is responsible for approving prescription and over-the-counter fluoride products marketed in the United States and for setting standards for labeling bottled water and over-the-counter fluoride products [5]. A dosage schedule for fluoride supplements for infants and children aged ≤ 16 years, which is scaled to the fluoride concentration in the community drinking water, has been jointly recommended by ADA, the American Academy of Pediatric Dentistry (AAPD), and the American

Academy of Pediatrics (AAP). In 1997, the Institute of Medicine published age-specific recommendations for total dietary intake of fluoride. These recommendations list adequate intake to prevent dental caries and tolerable upper intake, defined as a level unlikely to pose risk for adverse effects in almost all persons [6,7].

REFERENCES

- [1] US Department of Health, Education, and Welfare. Public Health Service drinking water standards, revised 1962. Washington, DC: US Public Health Service, Department of Health, Education, and Welfare; PHS publication no. 956.
- [2] CDC. Engineering and administrative recommendations for water fluoridation, 1995. MMWR ; 44(No. RR-13):1-40.
- [3] US Environmental Protection Agency. 40 CFR Part 141.62. Maximum contaminant levels for inorganic contaminants. Code of Federal Regulations 1998:402.
- [4] US Environmental Protection Agency. 40 CFR Part 143. National secondary drinking water regulations. Code of Federal Regulations 1998; 514-7.
- [5] US Food and Drug Administration. 21 CFR Part 355. Anticaries drug products for over-the-counter human use. Code of Federal Regulations 1999:280-5.
- [6] American Academy of Pediatric Dentistry. Special issue: reference manual 1995. *Pediatr Dent* 1994--95; 16(special issue):1-96.
- [7] American Academy of Pediatrics Committee on Nutrition. Fluoride supplementation for children: interim policy recommendations. *Pediatrics* 1995; 95:777.
- [8] O'Reilly MM, Featherstone JD.(1987) Demineralization and remineralization around orthodontic appliances: an in vivo study. *Am J Orthod Dentofac Orthop*.
- [9] Seppä L, Pöllänen L, Hausen H.(1994) Caries-preventive effect of fluoride varnish with different fluoride concentrations. *Caries Res*.
- [10] American Dental Association. Fluoridation Facts. National and International Organizations that Recognize the Public Health Benefits of Community Water Fluoridation for Preventing Dental Decay [on-line 2003]. <<http://www.ada.org/public/topics/fluoride/facts/compendium.asp>>.
- [11] National Cancer Institute. Cancer Facts. Fluoridated Water. [Online reviewed 2000] <<http://fluoride.oralhealth.org/papers/2001/ncicancerfacts101000.htm>>.
- [12] Centers for Disease Control and Prevention (CDC). Recommendations for Using Fluoride to Prevent and Control Dental Caries in the United States. MMWR.2001;50(RR-14):1-42. <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5014a1.htm>.
- [13] Report of the subcommittee on fluoride of the Committee to Coordinate Environmental Health and Related Programs, USPHS. Review of fluoride: benefits and risks. Public Health Service: Department of Health and Human Services. 1991. <<http://www.health.gov/environment/ReviewofFluoride/default.htm>>.
- [14] Raju N. J., Dey S. and Das K. (2009) Fluoride contamination in ground waters of Sonbhadra District, Uttar Pradesh, India" *Current Science*, Vol 96(7), pp 979-985.

An Overview of Government Agriculture Subsidies in India

¹Harshal A Salunkhe, ²Dr.B.B.Deshmush

¹Lecturer, SSBT's College of Engg. &Tech.Bambhori, Jalgaon (Corresponding Author)

²Principal, R.R. Senior College, Jalgaon

Email- harshal.salunkhe@gmail.com

Abstract

The agriculture subsidies are integral part of the farmers in India. The agriculture subsidies play vital role in agriculture sector in every county. The every year's government of India spends lot of money in various agriculture subsidies fro growth of agriculture sector. The total arable & permanent cropland is 169,700 thousand hectors in India.

This paper basically focuses on overview of agriculture subsidies in India with help of provisions of funds for agriculture in five years plans and annual budget. Study types of agriculture subsidies and distribution criteria in India.

Keyword- Subsidies, five years plan & annual budget

Introduction:

Indian Government play vital role in agriculture sector development. The government role is diverse and varied. Some of the cited reasons for vital role are self-sufficiency, employment creation, support to small-scale producers for adopting modern technologies and inputs, reduction of price instability and improvement of the income of farm households. This vital role can take a number of forms such as import-export policies and domestic policies like price support programmes, direct payments, and input subsidies to influence the cost and availability of farm inputs like credit, fertilizers, seeds, irrigation water, etc. Of all the domestic support instruments in agriculture, input subsidies and product price support are the most common. Various benefits are cited in justifying input subsidies: economic, environmental and social (World Bank 2008). Input subsidies can bring economic benefits to society. Inputs like fertilizers, irrigation water and electricity have a significant share in agricultural subsidies in India and fertilizer subsidy has attracted much attention of policymakers, and researchers in the recent past.

An agricultural subsidy is a governmental financial support paid to farmers and agribusinesses to supplement their income, manage the supply of agricultural commodities, and influence the cost and supply of such commodities. A subsidy, often

viewed as the converse of a tax, is an instrument of fiscal policy. Derived from the Latin word 'subsidium', a subsidy literally implies coming to assistance from behind.

In India, as also elsewhere, subsidies now account for a significant part of government's expenditures although, like that of an iceberg, only their tip may be visible.

The objective of subsidies, by means of creating a wedge between consumer prices and producer costs, lead to changes in demand/ supply decisions. The forms of subsidies are a cash payment to producers/consumers is an easily recognizable form of a subsidy. However, it also has many invisible forms. Thus, it may be hidden in reduced tax-liability, low interest government loans or government equity participation. If the government procures goods, such as food grains, at higher than market prices or if it sells as lower than market prices, subsidies are implied.

Review of literature:

The subsidy is very important for growth of farmers in India. Many persons have presented their views on agriculture subsidies in national & internal national level through research papers & articles

Mr.Gajendra Pratap presented his view in article Domestic subsidies, The agriculture subsidies can be broadly discussed under two categories one is export subsidy & another is domestic subsidy, he also focused on following issues -Subsidies pro-poor in the developed country and subsidy impact on the Indian economy. The growing volume of subsidies particularly the "Green Box" subsidies are the new excuse instruments of the developed countries for projecting a pro-poor image.

The Weilong Zhang presents his views in Case Study: Agricultural Subsidies and Development-The paradox of agricultural subsidies, MGMT 6350, International Business February 11, 2005

The subsidies are not only detrimental to the poor farmers in developing countries, but are also, according to the theories of Smith, Ricardo, and Heckscher-Ohlin (Chapter 4 of International Business), a burden to the tax payers of the developed nations and global trade as a whole. It is widely expected that the whole world would be

better off today if agricultural subsidies were eliminated completely.

The Steve Wiggins said, Input subsidies need to be contemplated with caution, with a clear consideration of the costs and benefits compared with conventional best practice of addressing market failures directly and using social policies to address social objectives with respect to poverty and food insecurity. In order to achieve these benefits, there will be a need for complementary spending on public goods. For agriculture, these usually consist of rural roads, agricultural research and extension, education, primary health care, and clean water. The working paper “The Use of Input Subsidies in Developing Countries” published in Global Forum on agriculture 29-30 November 2010 Policies for Agricultural Development, Poverty Reduction and Food Security OECD Headquarters, Paris

Antonio vina, Lindsey Fransen, Paul Faeth & Yuko Kurauchi in their paper REFORMING AGRICULTURAL SUBSIDIES: “NO REGRETS” POLICIES FOR LIVELIHOODS AND THE ENVIRONMENT stated that, Agricultural subsidies and their impacts on the poor and the environment are part of a complex web that determines whether agriculture can serve as an effective vehicle for poverty alleviation and sustainability in all countries. Even if meaningful reductions were agreed to in the Doha negotiations of the WTO, there is no certainty that the purported development goals of this trade round will be achieved. Poor farmers in developing countries may not receive benefits unless these international decisions are accompanied by domestic policy reforms directed at making agriculture pro-poor and pro-environment.

The objective

- 1) To study agriculture sector in India.
- 2) To know the types of government agriculture subsidies & criteria for distribution in India.
- 3) To find out allocation of fund for agriculture sector in last Five years plans & annual budget of India.

Hypothesis

H1. The agriculture subsidies is global phenomenon, where its percent is more in developed countries & less in developing countries.

H2. The investment in agriculture sector is constantly increasing from last years.

RESEARCH METHODOLOGY

The study is based on secondary data which is collected from the published reports, Census Surveys, newspapers, journals, websites etc

➤ Review of Indian Agriculture Sector

Indian agriculture has an extensive background which goes back to 10 thousand years. At present, in terms of agricultural production, the country holds the second position all over the world. In 2009, agriculture and it contributed 16 % of the Gross Domestic Product of the country. In addition, the sector recruited about 52% of the entire manpower.

In spite of the fact that there has been a gradual fall in its contribution to the gross domestic product of the country, agriculture is currently the biggest industry in India.

In terms of agricultural contribution, the following states in India are the most developed states:

Punjab, Uttar Pradesh, Madhya Pradesh, Haryana, Bihar, Andhra Pradesh, Maharashtra, West Bengal

All these states play a key role in the agriculture development of India. The total arable territory in India is 1,269,219 km², which represents about 56.78% of the overall land zone of the country. Arable land in India is diminishing because of continuous strain from an ever-increasing number of inhabitants and growing urbanization.

The overall water surface area of the country is 31440 km² and the country experiences a mean yearly precipitation of 1,100 mm. Irrigation represents 92% of the consumption of water and in 1974, it was 380 km². India holds the second position in production of wheat, rice, cotton, sugarcane, and groundnuts. It is also the second biggest harvester of vegetables and fruit, representing 8.6% and 10.9% of the overall vegetable and fruit production in the world correspondingly.

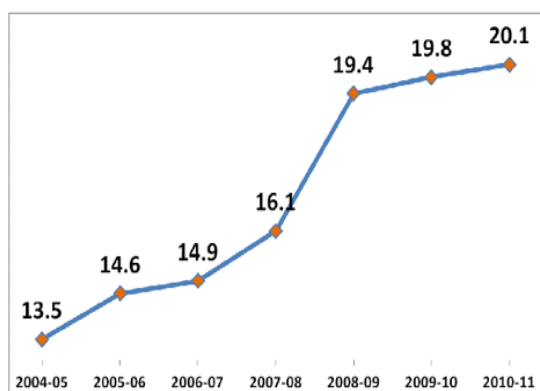
The Investment in Agriculture Sector in India

Capital investment in agriculture and allied sectors has witnessed a steadily increasing trend in recent years. It has risen from 13.5% in 2004-05 to 20.1% in 2010-11. This growth has been possible because of initiatives taken by the Government to make agriculture a sustainable vocation. Investment in public sector includes irrigation works, command area development, land reclamation, a forestation and development of state farms. Private sector investment includes construction activities including improvement/reclamation of land, construction of non-residential buildings, farm

houses, wells and other irrigation works. The capital investment is measured in terms of Gross Capital Formation (GCF) relative to the country's Gross Domestic Product (GDP). As per Annual Report of the Department of Agriculture and Cooperation for the year 2011-12, GCF in agriculture and allied sectors in 2010-11 was Rs. 142254

crore. It was Rs. 76,096 crore in 2004-05

GCF in agriculture and allied sectors from 2004-05 to 2010-11 is represented in the following graph (Graph No.-1)



Sources-India Infoline News Service / 08:37, Apr 11, 2012

These all thing shows that agriculture is one of biggest business in India. Every years Government of India provides lot of financial support in form of subsidies, finance and other support in direct & indirect forms.

The initiatives taken by Government of India for Agriculture sector

The Government of India has been sincerely trying to put into operation different plans to increase investment or outlay in merchandizing and commercializing. The some of the known plans and strategies of the Indian Government include Market Research and Information Network, Construction of Rural Godowns, Grading and Standardization, Development/ Strengthening of Agricultural Marketing Infrastructure.

The Indian Agricultural Research Institute (IARI) was set up in the year 1905. The institute had a key role in the studies and explorations that resulted in the Green Revolution in the decade of the 1970s. The Indian Agricultural Statistics Research Institute formulates new methods for the planning of agricultural testing. The Government of India has established Farmers Commission to fully assess the cultivation plan and state wise agriculture departments in every state

India stands the second position all over the world in terms of agricultural production. During the

period of 2009-10, farming and associated industries such as lumbering, forestry, and fishing represented approximately 16 % of the Gross Domestic Product of the country. Outputs on a unitary basis for every type of harvest have increased from 1950. This has been possible since the government has put particular focus on farming operations in the five-year plans (PanchabarshikiParikalpana) and stable developments in the domains of engineering science, irrigation, implementation of contemporary farming operations, and supply of cultivation loans and grants after the Green Revolution took place in the country.

The major types of agricultural subsidies& distribution criteria in India

There are two major types of subsidies which are fertilizer subsidies and food subsidy. They two account for almost 90 percent of agricultural subsidy. In addition to this one more form which is intangible and uncountable is that, agricultural income is not taxed in India. These days the issue revolves around fertilizer subsidies more.

The following is data on amount of subsidies in year 1990 to 2009

(Table No.1)

	1990	2009	Percentage change
Total subsidy	12158 crore	129243 crore	10.6 time increase
Fertilizer subsidy	4389 crore	75849 crore	17 times increase
Food subsidy	2450 crore	43627 crore	18 times increase

Source- Fertilizer authority of India Report (2010)

The subsidies can be distributed among individuals according to a set of selected criteria

- 1) Merit,
- 2) Income-level
- 3) Social group etc.

The study brings to the fore the massive magnitude of subsidies in the provision of economic and social services by the government. Even if merit subsidies are set aside, the remaining subsidies alone amount to 10.7% of GDP, comprising 3.8% and 6.9% of GDP, pertaining to Centre and State subsidies respectively. The average all-India recovery rate for these non-merit goods/services is just 10.3%, implying a subsidy rate of almost 90%.

Agriculture under the Five-year Plans:

Before the planning period, agriculture was in a deplorable condition. The farmers were generally in heavy debt to the village money-lenders. They were having small and scattered holdings. They had neither the money nor the knowledge to use proper equipment, good quality seeds and chemical fertilizers. Except in certain areas, they were dependent upon rainfall. Productivity of land as well as of labour had been declining and was lowest in the world. In spite of the fact that nearly 60% of our working population was engaged in cultivation, the country was not self-sufficient in food grains but had to depend on food imports. Table 1 gives the total outlay for each plan and correspondingly the outlay on agriculture and irrigation had also increased with every plan.

Table 1: Plan Expenditure on Agriculture and allied Sectors, Irrigation (Rs. crore)
(Table No.2)

5 Years Plan	Total plan Expend.	Agri. & allied sectors	Irrigation	% of total outlay
1 st plan	1960	289.9	441.8	37.3
2 nd plan	4671.8	549	541.6	23.3
3 rd plan	8576.5	1088.9	1019.1	24.6
4 th plan	15778.8	2120.4	2415.7	28.7
5 th plan	39426.2	4864.9	3925.8	22.3
6 th plan	109291.7	6623.5	10929.9	16.1
7 th plan	218729.6	12792.6	16589.9	13.4
8 th plan	485457.2	24895.7	31398.9	11.6
9 th plan	941041	37239	67875	11.2
10 th plan	152563.9	58933	103315	10.6

Source—Indian Agriculture under the Five-Year Plans, Booklet No. 539, Agricultural Situation in India: ASIS-10

The above figures show that percent of fund allocation in five years plans for agriculture sector is decreases and fund allocation for industry & other sector increases. The growth agriculture sector only 4% from last few years and contribution of agriculture sector in GDP is

decreases that's why need of separate agriculture budget for India

The Allocation of funds for agriculture sector in Annual budget Year 2010-11 to 2012-13 in India

Agriculture retained its high priority in the budget with a planned allocation for agriculture and allied sectors raised by 19 percent to INR 176.9 billion (\$3.5 billion). The budget provides additional funds to several ongoing programs for enhancing agricultural production, irrigation management, higher farm credit and improving post-harvest storage and processing infrastructure.

Table 2. India: Selected Agricultural and Food-Related Budget Items
Ministry of Agriculture, billion Indian rupees
(Table No.3)

	2010-2011 Actual	2011-2012 Budget	2011-2012 Revised	2012-2013 Budget
Crop Husbandry	98.13	78.91	74.31	90.34
Soil and Water Conservation	0.14	0.15	0.16	0.16
Animal Husbandry	7.15	9.50	7.50	10.63
Dairy Development	0.85	2.23	1.84	3.53
Fisheries	2.91	2.70	2.83	3.00
Forestry and Wildlife	9.29	7.85	7.82	9.07
Plantations	4.74	4.15	4.39	4.46
Food, Storage and Warehousing	5.02	6.44	6.34	7.87
Agricultural Research and Education	25.22	24.92	25.70	28.98
Co-operation	1.03	2.22	1.17	1.25

Other Agricultural Programs	2.68	8.36	16.48	17.64
Total	157.16	147.77	148.55	176.92

Source-GOI Budget 2012-13 - Agricultural Highlights

The above figures show that agriculture expenditure in annual budget is decreased year by year. This thing is responsible for slow growth rate for agriculture sector & less contribution in GDP of India.

Comparison of country regarding Subsidies to Agriculture (Table No.4)

Country	Subsidy per hectare	%subsidies	Population dependent on agriculture
EEC	\$82	37%	8%
USA	\$32	26%	5%
Japan	\$35	72%	4%
China	\$30	34%	24%
South Africa	\$24	60.67%	18%
India	\$14	2.33%	60%

Compilations from WTO reports

The above table shows agriculture subsidies is global phenomenon and it percent is more in developed country and less in developing country

Conclusion

India has very huge arable area and lot of investment in agriculture in last few years. But there is large number of decrement is shows in provision of fund towards agriculture sector in five years plan and annual budgets in term of agriculture subsidies. This thing is responsible for slow growth of agriculture in India and less contribution in GDP of country.

The agriculture subsidies are distributed by every country but it percent if very low and numbers of dependent is very large in India. The government of India takes serious measure for development of agriculture sector and agriculture subsidies are one of tool to help for growth of agriculture sector in India.

References

- [1] Capital investment in agriculture rises to 20% in India Infoline News Service / 08:37 , Apr 11, 2012
- [2] Dr.K.T.Chandy--Indian Agriculture Under the Five-Year Plans, Booklet No. 539, Agricultural Situation in India: ASIS-10

- [3] GOI Budget 2012-13 - Agricultural Highlights, USDA Foreign agriculture services, Global Agriculture Information Network. Date-12/03/2012 GAIN Report No.-IN2042 (Voluntary- Public)
- [4] Marshal A.Salunkhe, VOLUME NO. 2 (2012), ISSUE NO. 7 (JULY). "A Separate Agriculture Budget for India-Need of the hour" Referred International journal of Commerce, Economic & Management (ISSN No. 2231-4245) (online journal)
- [5] Steve Wiggins, 29-30 November 2010 "The Use of Input Subsidies in Developing Countries" published in Global Forum on agriculture Policies for Agricultural Development, Poverty Reduction and Food Security OECD Headquarters, Paris page 10
- [6] Report- Dope sheet page no.-4
www.ndtvmi.com/b4/dopesheets/rahul.pdf
- [7] Review of Five Year Plans Page no.-2
www.planning.rajasthan.gov.in/Eleventh%20Plan
- [8] Weilong Zhang, February 11, 2005 Case Study: Agricultural Subsidies and Development-The paradox of agricultural subsidies, MGMT 6350, International Business, Page no. 12

THE MEDICAL IMAGE COMPRESSION WITH EMBEDDED ZEROTREE WAVELET

ABDUL SATTAR

Assistant professor

Electronics & Telecommunication Engineering Department B. N. College Of Engineering PUSAD.
shaikhsattar@rediffmail.com

ABSTRACT

The rapid growth of digital imaging applications, including desktop publishing, multimedia, teleconferencing and high definition television, (HDTV) has increased the need of effective image processing. While processing any data, it requires large memory space for storage, which ultimately increases the transmission time. In order to save memory space and speed up the rate of transmission of data over networks, data compression is essential. Technically all image data Compressed into two groups as lossless and lossy. Some information is lost in the lossy compression, especially for radiological images. To minimize the effect of data loss on the diagnostic features of the images a new algorithm can be designed. Wavelet transform (WT) constitute a new compression technology that has been used in natural and medical images. In this study, the embedded zerotree wavelet algorithm (EZW) is used for image coding. It is designed to optimize the combination of zerotree coding and Huffman coding. It is shown that the multi-iteration algorithm and particularly the two iteration EZW for a given image quality produce lower bit rate. It is applied for medical images and here, the thorax radiology is chosen as a sample image and the good performance is codified.

This compression technique can be used for Office automation, Bio-medical, Remote Sensing, Criminology, Astronomy and space applications, Information technology and Military applications.

KEY WORDS – *Wavelet Transforms, DWT, EZW, Threshold, Huffman Coded*

1. INTRODUCTION

Uncompressed multimedia data (graphics, audio and video) requires considerable storage capacity and transmission bandwidth. Despite of rapid progress in mass storage density, processor Speeds, and digital communication system performance, demand for data storage capacity

and data-transmission bandwidth continues to outstrip the capabilities of available technologies. The recent growth of data intensive multimedia based applications have not only sustained the need for more efficient ways to encode signals and images but have made compression of such signals central to storage and communication technology. [1]

A major application domain of medical imaging technology is radiology where some of the imaging modalities include computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and positron emission tomography (PET), in the picture achieving and communication system environments [1]. It is well known that all image data compression schemes can be categorized into the lossless and lossy groups. Although lossless, one is especially preferred in medical images. It makes necessary the use of lossy schemes due to compression relatively low compression ratio is lossless method. This mustn't cause to have the less diagnostic features. Therefore, the new algorithms can be developed to minimize the effect of data loss on the diagnostic features of the image [2]. For still image compression, the JPEG [2] standard has been established. The JPEG compression encoding is based on Discrete Cosine Transform scheme [3]. First the image is divided into 8 x 8 block size and then DCT is applied. Due to this block based DCT scheme, the performance of these encoders generally degrades at low bit rates.

Over the past few years, a variety of powerful and sophisticated scheme for image compression with high compression ratio and good image quality have been developed and implemented. More recently, the wavelet transform has emerged as a cutting edge technology. Wavelet based coding provides substantial improvements in picture quality at higher compression ratios [4].

This paper introduces some basic concepts on image compression and the more popular wavelet based image-coding schemes.

2. WAVELET TRANSFORMS

A wavelet is a 'small wave' having the oscillating wave like characteristic and the ability to allow

simultaneous time and frequency analysis by the way of a time-frequency localization of the signal. Wavelet systems are generated by dilating and translating a single prototype function or wavelet $\psi(t)$.

A two-dimensional scaling function, $\phi(x, y)$, and three two-dimensional wavelets, $\psi^H(x, y)$, $\psi^V(x, y)$, and $\psi^D(x, y)$, are required. Each is the product of a one dimensional scaling function ϕ and corresponding wavelet ψ . Excluding products that produce one-dimensional results, like $\phi(x)$, $\psi(x)$, the four remaining products produce the separable scaling function [4].

$$\phi(x, y) = \phi(x) \phi(y) \quad (1)$$

and separable, "directionally sensitive" wavelets

$$\psi^H(x, y) = \psi(x) \phi(y) \quad (2)$$

$$\psi^D(x, y) = \phi(x) \psi(y) \quad (3)$$

$$\psi^D(x, y) = \psi(x) \psi(y) \quad (4)$$

These wavelets measure functional variations - intensity or gray level variation for images-along different directions. ψ^H measures variations along column's (horizontal edges), ψ^V respond to variations along rows (vertical edges), and ψ^D corresponds to variations along diagonals. The directional sensitivity is a natural consequence of the separability imposed by eqs. (1 to 4) and it does not increase the computational complexity of the two-dimensional transform.

3. THE ALGORITHM

The wavelet decomposition is an alternative representation of image data but the number of bits used to store it has not changed. To compress the image data, it must be decided which coefficients to send and how many bits to use to code them.

The Shapiro's EZW algorithm is based in the construction of **dominant and significant lists** for a given image, which is decorrelated with a wavelet transform. In the dominant list, the information about the significance of a coefficient is coded, while in the significant list only the values for the significant coefficients are kept up to a given degree of precision.

In Shapiro's scheme, the significance of a coefficient at a given iteration is determined based on its comparison with a threshold (T): If the value of the coefficient is greater than T, the coefficient is significant while, if it is smaller than T, it is considered insignificant.

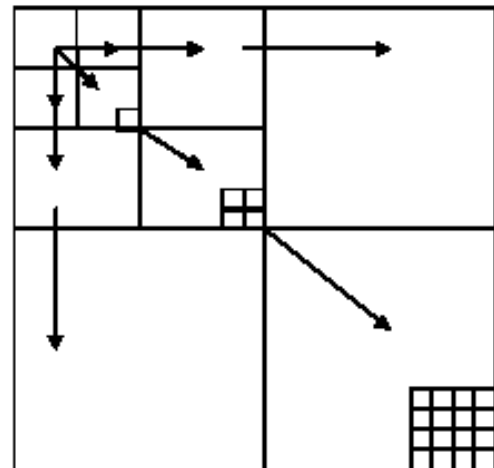


Figure 1. Parent-child dependencies of subbands.

In either case, two possibilities are considered and coded by a different symbol. When the coefficient is significant, its sign is coded: POS for positive values and NEG for negative values. When the coefficient value is below threshold, the values of the coefficient descendants, which are the corresponding coefficients in lower scales are analyzed. If all the descendants are insignificant, we have a ZTR and there is no need to code them. When some of the descendants are significant, however, we have an isolated zero (IZ), and the descendants have to be codified individually. Thus, 4 symbols (2 bits) are enough to code completely the dominant list. The same procedure is performed in all scales with a prefixed order until the dominant list is completed. The ordering procedure is described in Figure 2 for a 3-scale wavelet. When the dominant list is completed, the magnitudes of the significant coefficients are refined one additional bit of precision (coded by 0's or 1's). The same scheme is repeated iteratively alternating a dominant pass and a subordinate pass and then, reducing the threshold. In this way, the values of the coefficients are successively approximated at each iteration. As a final stage, the dominant list is Huffman coded to obtain further data compression [5].

Therefore, in the symbol distribution in the dominant list for several images, the idea is to code information about the coefficient value along with information about the value of its descendants, by diversifying the ZTR symbol into several other symbols.

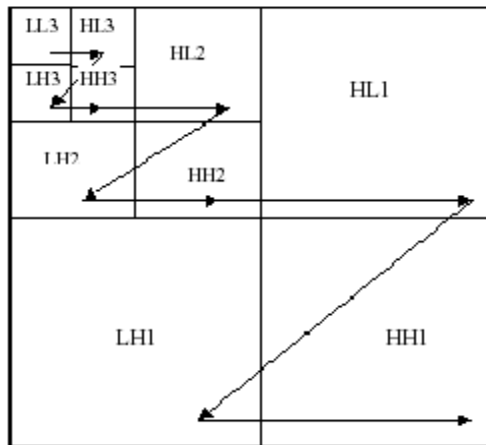


Figure 2. Scanning order of the subbands for encoding of a significant map.

In this way, here is the advantage of the data reduction achieved by ZTR symbol while, at the cost of introducing extra symbols, It is possible to convey more information about the coefficient value. We propose a method that combines two or more iterations of the original algorithm into one, comparing the coefficient values simultaneously to two different thresholds: T_1 and T_2 , with $T_1 > T_2$. Then, two alternatives have been considered depending on the number of symbols used to code the significance of a coefficient. In both cases, the symbols for the ZTR and IZ are still used to code those coefficients insignificant relative to T_2 . In the first case, the four symbols PIZ2, NIZ2, PZTR2 and NZTR2 code simultaneously the sign of coefficients in $[T_1, T_2]$ i.e. those whose value is significant relative to T_2 , but insignificant relative to T_1 , and also the significance of their descendants. Thus, PIZ2 and NIZ2 code respectively positive and negative coefficients with some significant descendants, while PZTR2 and NZTR2 code positive and negative coefficients whose descendants are insignificant. In this case, 8 symbols (3bits) are needed to code the significant list. In the second case, each of the symbols used to code coefficients significant relative to T_1 is also split into two new symbols to distinguish those significant coefficients whose descendants are significant relative to T_2 from those whose descendants are insignificant. Therefore, POS splits into PIZ1 and PZTR1, and NEG into NIZ1 and NZTR1. Thus, for this second alternative 10 symbols (4 bits) are needed to code the dominant list.

In summary, both alternatives need more bits (3 or 4 bits) than the original algorithm (2 bits) to code the dominant list but, as indicated in the Results, the total number of symbols is reduced as many of the old ZTRs are now coded with other symbols conveying more information in a single step.

4. RESULTS

A test image is chosen a 512x512 thorax radiography. Firstly, the image is transformed using a 6-scale biorthogonal wavelet [5] and then, coded with each of the algorithms described above. They are followed by adaptive Huffman coding which is one of the noiseless coding scheme. After an entropy analysis, it is found that the best performance is obtained when only two iterations are combined although higher compression ratio than original algorithm is obtained for three or more iterations but lower one is achieved for two iterations. Figure 3 illustrates the good performance of EZW algorithms for the thorax radiography codified at 0.5 bit Per pixel (bpp) with peak signal-to-noise ratio (PSNR) of 49 dB



Figure 3 (a) Thorax radiography: Original image



Figure3 (b) Thorax radiography: The image coded at 0.5 bpp.

It is chosen a compression ratio for which the images display good visual quality, similar to original, although with different PSNRs. It is found that, in general, the signal-to-noise ratio for the medical image needs to be higher by

approximately 6 dB than the natural image (for example Lena) to be visually acceptable (i.e. without blurry appearance or block-like artifacts), although the number of steps necessary to reach this level of visual quality is the same for the both kind of images. To reach the same PSNR with Shapiro's algorithm, 0.65 bpp are necessary for the radiography.

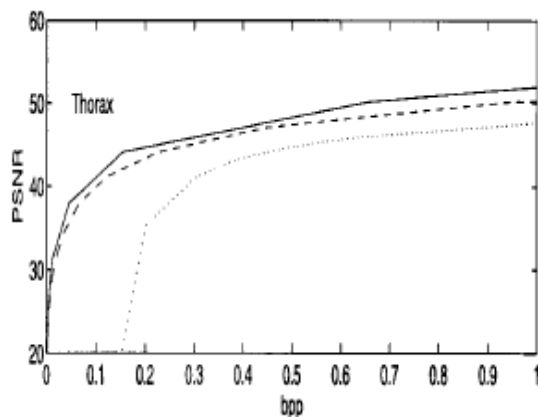


Figure 4. PSNR versus bpp for the thorax radiography.

To give a quantitative idea of the behaviour of the EZW algorithms at different bit rates, it is computed the PSNR and the bits per pixel necessary to code the image at each iteration, and plotted it in Figure 4 for Shapiro's (dashed line), the modified algorithm (solid line) and standard JPEG algorithm (dotted line). For a given PSNR, the compression ratio obtained with modified algorithm is always higher than the results obtained from the others. It is obviously seen that the performance of the JPEG is below both EZW algorithms. The difference in performance between the EZW algorithms and JPEG is larger at very low bit rates (0.1-0.3 bpp) for which JPEG produces images with very low PSNRs. In addition, images coded at low bit rates with JPEG are hardly recognizable, while those coded with either of the EZW algorithms show a better visual quality.

5. CONCLUSION

In this study, it is presented a modified version of the embedded zerotree wavelet basic algorithm introduced by Shapiro that can be applied to natural and medical images codec. The modified algorithm shows a clear advantage in the compression ratio achieved for a given SNR over

traditional EZW and it works at higher speed. It is concluded that for a given image quality the modified one produced lower bit rates than Shapiro's EZW. The new approach is more efficient for applications demanding high visual quality, which often happens in medical image compression rather than an embedded representation of the image. Then, the new technique can be adapted to provide a final image with a given visual quality by performing n -iterations combined in a single step. A 512x512 thorax radiograph image is chosen as a sample image. The results show that image quality is better than the one obtained by JPEG and EZW. Preliminary results in medical images show that the new algorithm gives better visual qualities than other lossy methods traditionally used. As a further research, the algorithm can be oriented to determine the advantages of it in an improved version of Shapiro's algorithm recently introduced by Said and Pearlman [10] and apply for the other wavelet transforms [10].

6. REFERENCES

- [1] Wong S., Zaremba L., Gooden D. and Huang H.K., "Radiologic Image compression-A Review", Proceedings of the IEEE vol. 83, no. 2, 1995.
- [2] Pennebaker W. B., Mitchell J. L. et al., *JPEG-Still Image Data Compression Standard*. New York: Van Nostrand Reinhold, 1993, pp.65-79
- [3] Daubechies I., "Orthonormal bases of compactly supported wavelets", Commun. Pure Appl. Math., vol. 41, pp. 909-996, 1988.
- [4] Shapiro J.M., "Embedded image coding using zerotrees of wavelet coefficients", IEEE Trans. Signal Processing, vol.41, no. 12, pp. 3445-3462, 1993.
- [5] Vetterli M. and Herley C., "Wavelets and filter banks:Theory and Design", IEEE Trans. Signal Processing, vol. 40, no. 9, pp. 2207-2232, 1992.
- [6] Lewis A.S. and Knowles G., "Image compression using the 2D wavelet transform", IEEE Trans. Image Processing, 1, pp. 244-250, 1992.
- [7] Mallat S., "Multifrequency channel decomposition of images and wavelet models", IEEE Trans. Pattern Anal. Mach. Intell., 11, pp. 674-693, 1989.
- [8] Said A. and Pearlman W.A., "A New, Fast and Efficient Image Codec Based on Set Partitioning in Hierarchical ITrees", IEEE Transactions on Circuits and Systems for Video Technology, Vol.6, pp. 243-249, 1996.
- [9] Adelson E.H, Simoncelli E. &Hingorani R., "Orthogonal pyramidal transforms for image coding", Proc. SPIE, vol.845, Cambridge, M A, pp. 50-58, 1987.

Classification of Faults on 400 KV Transmission Line

Dr.M.A.BEG¹ N.G.BUNDHE² S.R.PARASKAR³

¹Shri Sant Gajanan Maharaj College of engineering Shegaon

²Mauli college Of engineering and technology,Shegaon

Abstract: The Prime aim of Power System is to provide uninterrupted Power supply to consumers but the performance of Power system is frequently affected by transmission line faults. This fault may occur due to stormy weather, lightening strokes and overhead transmission line failure due to ageing of equipments etc which finally lead to disruption in power flow. In order to maintain the continuity of supply and to improve the efficiency of Power System the transmission line fault should be diagnosed and treated accurately. This paper describes the development of Wavelet-ANN method for classification of Faults on a HV network.

The disturbances characterized are events from an actual, simplified 400KV transmission system of Maharashtra State Electricity transmission company limited (MSETCL) with actual line parameters. The main purpose of the algorithm is to classify the fault, where the fault types that can be classified are single-line-to-earth fault (LG), double line fault (LL), double line to earth fault (LLG) and three phase fault (LLL).

Keywords: Discrete Wavelet Transform, Artificial Neural Network, Transmission Line Faults

I.Introduction

Among the power system components the transmission lines are mostly affected since they are exposed to environment. In order to ensure the quality performance of power system the proper classification of fault is essential. Different techniques have been proposed to classify the faults. Dash PK et al. [1] simulated the real power system model using PS block set of simulink (Matlab). Faults are conducted at different location, fault resistance and inception angle. The HS transform based time frequency analysis of current signals was performed and on the visual basis faults are classified. Classification of fault on visual basis is not reliable process. M. Jayabharata Reddy and D.K. Mohanta [2] presented DSP based frequency domain approach for classification of transmission line faults using a sample three phase power system simulated in MATLAB software. The line currents were processed using online wavelet transform algorithm to obtain wavelet MRA coefficient. The algorithm has used sixth

level detailed coefficient values of current for classification purpose. The suggested algorithm in this paper involves too much mathematical computation. P. S. Bhowmik et al. [3] used a portion of west Bengal state Electricity Board Power transmission system with actual line parameters as a source of study. The fault conditions were simulated using EMTP. DWT was used as a tool to process the fault voltage signal. Some meaningful features were extracted from the processed signal and fed to ANN for classification purpose. K.M.Silva et al. [4] proposed a novel method for fault detection and classification in transmission lines with the help of oscillographic record analysis. In module (1) i.e. detection of fault, the fault current and voltage sample were normalized and processed using DWT. In 2nd module once the fault is detected the samples related to fault clearing time were chosen and resampling of waveform was performed. Further with the help of windowing process, each window was analyzed through the ANN to classify the fault. Dalstein et al. [5] simulated the faults on a 380KV Transmission line with the help of simulation Program Netomac. Five consecutive sample points of normalized voltage and current of each line according to fault type are used as input to ANN. Therefore the 30 input nodes were build and ANN has to provide the 11 output nodes. One of these 11 output mapped to a value 0.9 and all the other valued mapped to 0.1. Hence this net is trained to learn that winner takes all problems.

G. Sudha and T. Basavaraju [6] suggested the study of three approaches that effectively classify all types of transmission line faults. The study is performed in MATLAB, since it provides interactive environment among toolboxes like wavelet transform, fuzzy interference system and simulink, making programming and transfer of data between program modules simpler.

This paper describes the development of Wavelet-ANN method for classification of Faults on a HV network. The disturbances characterized are events from an actual, simplified 400KV transmission system of Maharashtra State Electricity transmission company limited (MSETCL) with actual line parameters. The fault conditions are simulated in PSCAD software on the AKOLA-KORADI 250 km long transmission line .Fault signals in each case are extracted to several scales on the wavelet transforms, and then

certain selected features of the wavelet transformed signals are used as an input for a training the neural networks. The features which are provided as an input to ANN includes maximum and minimum level 3 and level 4 detailed coefficients of line voltage and energies of level 3 and level 4 detailed coefficients of current. The main purpose of the algorithm is to classify the fault.

II. WAVELET TRANSFORM

The transform of a signal is just another form of representing the signal. The Wavelet Transform provides a time-frequency representation of the signal and uses multi-resolution technique by which different frequencies are analyzed with different resolutions. The wavelet analysis described is known as the continuous wavelet transform or CWT. More formally it is written as:

$$Y(s, \tau) = \int f(t) \Psi^*_{s, \tau}(t) dt \quad \text{-----1}$$

Where * denotes complex conjugation.

This equation 1 shows how a function $f(t)$ is decomposed into a set of basis functions called the wavelets. The variables s and τ , scale and translation parameters respectively are the new dimensions after the wavelet transform. The Wavelet Series is just a sampled version of CWT and its computation may consume significant amount of time and resources, depending on the resolution required. The Discrete Wavelet Transform (DWT), which is based on sub-band coding, is found to yield a fast computation of Wavelet Transform. It is easy to implement and reduces the computation time and resources required.

$$\Psi_{j,k}(t) = \frac{1}{\sqrt{s_0^j}} \Psi(t - k s_0^j / s_0^j) \quad \text{-----2}$$

In equation (2) j and k are integers and $s_0 > 1$ is a fixed dilation step. The translation factor τ_0 depends on the dilation step. In the case of DWT, a time-scale representation of the digital signal is obtained using digital filtering techniques. The signal to be analyzed is passed through filters with different cut off frequencies at different scales. The DWT is computed by successive lowpass and highpass filtering of the discrete time-domain signal. The figure (1) shows the signal with sampling frequency of 200Khz denoted by the sequence $x[n]$, where n is an integer. This signal is decomposed upto level 4 and frequency bands contained in each level are represented in figure. The low pass filter is denoted by G_0 while the high pass filter is denoted by H_0 . At each level, the high pass filter produces detail information $d[n]$, while

the low pass filter associated with scaling function produces coarse approximations, $a[n]$.

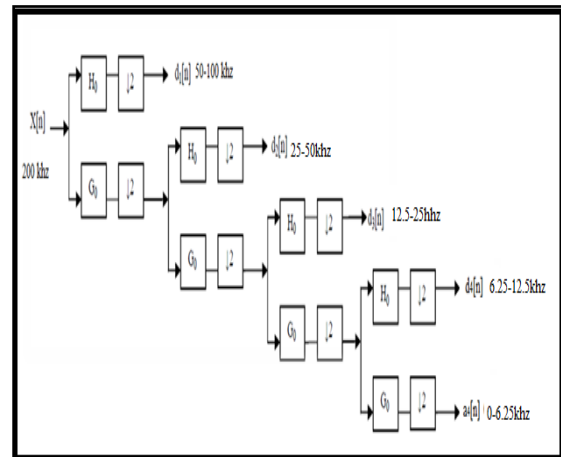


Fig 1. Wavelet decomposition tree

III. NEURAL NETWORKS

ANN is defined as a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs.

Neural networks are typically organized in layers made of a number of interconnected 'nodes' which contain 'activation function'. Patterns are presented to the network via the 'input layer', which communicates to one or more 'hidden layers' where the actual processing is done via a system of weighted 'connection'. The hidden layers then link to an 'output layer' as shown in the Fig 2

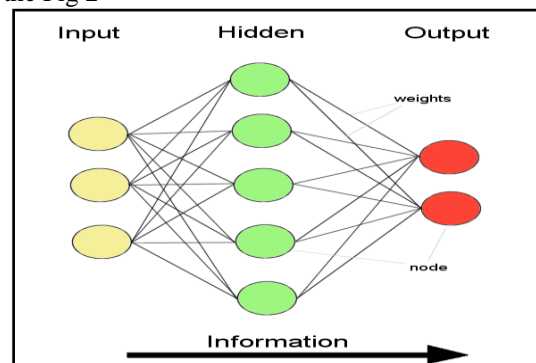


Fig.2 ANN architecture

An input is presented to the neural network and a corresponding desired target response is set at the output. An error is composed from the difference between the desired response and the system output. This error information is fed back to the system and adjusts the system parameters in a systematic fashion (the learning rule). The process is repeated until the performance is acceptable. The performance of ANN hinges heavily on the data. If one does not have data that

cover a significant portion of the operating conditions or the data is noisy, then neural network technology is probably not the right solution. On the other hand, if there is plenty of data and the problem is poorly understood to derive an approximate model, then neural network technology is a good choice.

IV. SIMULATED SYSTEM

MSETCL 400KV network shown in Fig (3) consists of total 28 buses out of which 20 are the intrastate buses and 8 are the interstate buses. This network also includes 55 Transmission Lines, Four generating buses and 16 LOAD buses. Additional power require to fulfill the demand is imported from inter-state generator namely Bhilai, Khandwa, Sardarsarovar, Boisar, Bhadravati, Tarapur, Satpura, and Mapusa.

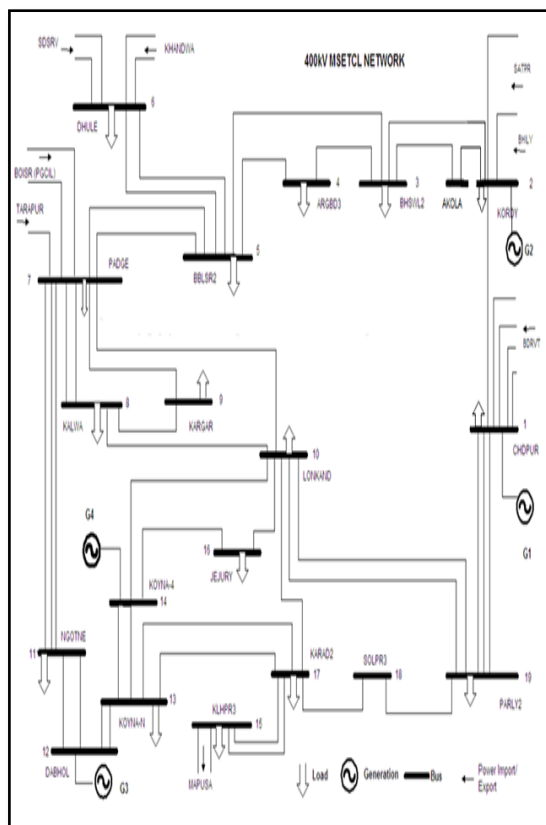


Fig 3: MSETCL 400KV network

In this Paper 400KV MSETCL network is simulated in PSCAD software with a sampling frequency of 200 KHZ. Different types of fault LG, LL, LLG and LLL are created at different locations on the AKOLA-KORADI 250 km long transmission line at an interval of 20 km including the different inception angle 0, 45, and 90 degrees. So in all 13 fault locations, three inception fault

angles and four different types of faults ($13 \times 3 \times 4 = 156$) constitute 156 cases. The data from the single end from AKOLA bus is used for the classification of faults.

V. Feature extraction:

The line voltages and phase current signals of simulated system are recorded for a time period of 2cycles.i.e.1 prefault cycle and 1 during fault cycle. To extract some selected feature these line voltages and phase current signals are decomposed up to fourth detail level using Daubechies-3 (db3) as a mother wavelet. DWT is used since it is one of the best tools to analyses non stationary signal. Daubechies-3 (db3) wavelet is employed since it has been demonstrated to perform well.

The features extracted by processing the wavelet coefficient are maximum and minimum d3 and d4 level detailed coefficients of line voltages and energies of d3 and level d4 level detailed coefficients of phase currents . This analysis is performed on the Akola bus. The features obtained by processing the wavelet coefficient are provided as an input to ANN for the classification purpose. The analysis in case of LG fault is shown in fig.5,6,7

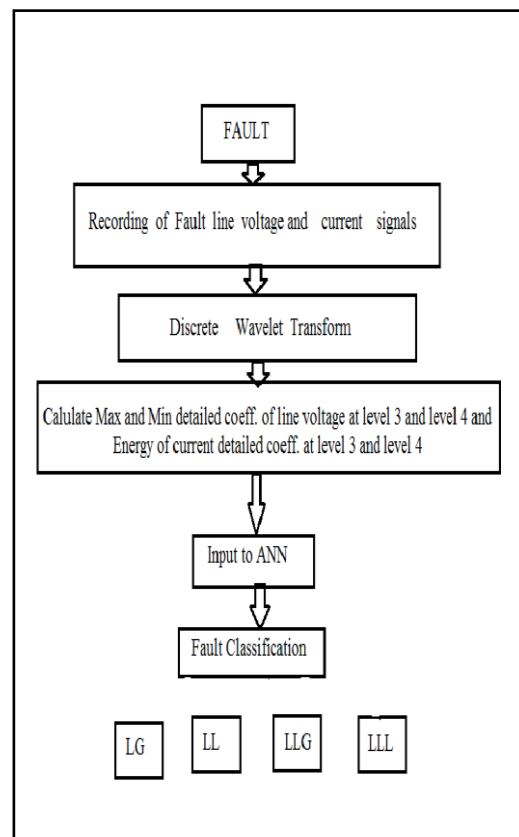


Fig 4. The proposed methodology of fault classification

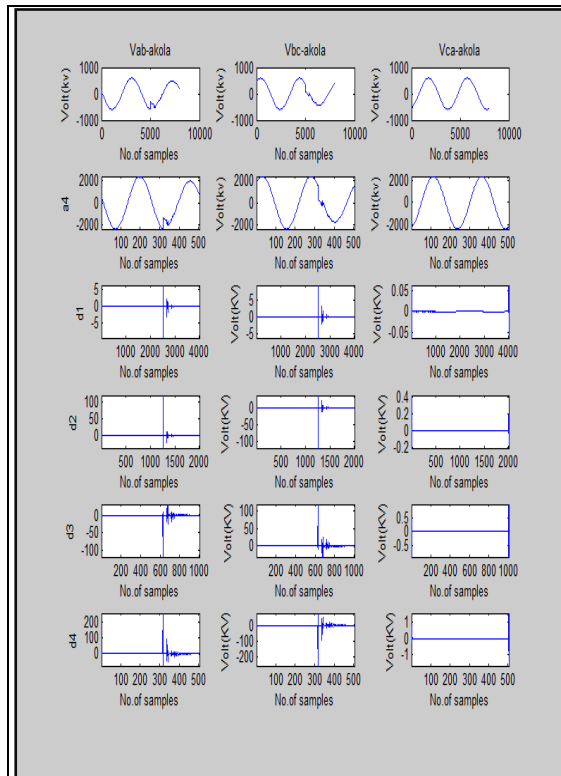


Fig5. Wavelet decomposition of line voltage signal in case of LG fault

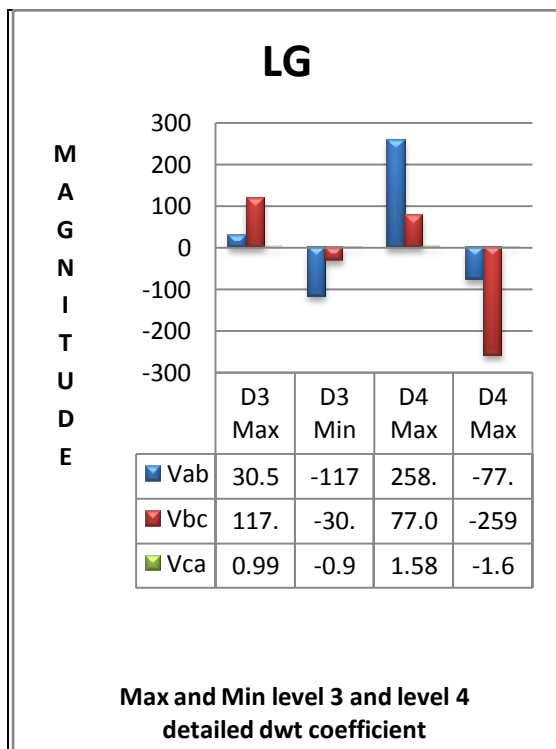


Fig6. Maximum and minimum d3 and d4 level dwt coefficient in case of LG fault

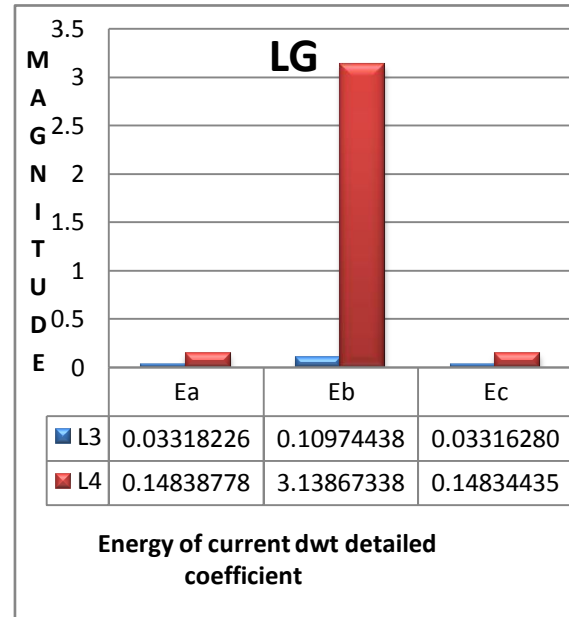


Fig7. Energy of d3 and d4 level dwt coefficient in case of LG fault

VI. Result and Discussion

The Frequency-Dependent Line Model is selected for simulation of 400 KV system because it is the most accurate and it represents all frequency dependent effects of a transmission line. The faults cannot be distinguished merely by observing the simulated system waveform hence processing of signal is necessary. The phase current and line voltage signals are processed for pre-fault and during fault cycle using dwt. However the discrimination of fault is not possible just with the help of dwt transformed signals. Finally some distinguishing features were derived from the dwt transformed signal. The features include the maximum and minimum d3 and d4 level dwt coefficient of line voltages along with the energy of d3 and d4 level dwt coefficient of phase currents. The energy of signal is given as $E = \sum_{i=1}^n x^2(i)$ where $x(i)$ is the discrete sequence representing maximum and minimum d3 and d4 level dwt coefficient of phase currents. These distinguishing features are provided as an input to ANN.

Some previous studies offer guidelines for selecting the architecture of ANN. Various training methods were used for ANN. In this paper Multilayer perceptron (MLP) neural network is used with combination of momentum learning rule and tanhaxon axon is chosen as node activation function. The choice of 1 hidden layer with 10 processing element (PE) provides the 100% correct fault classification.

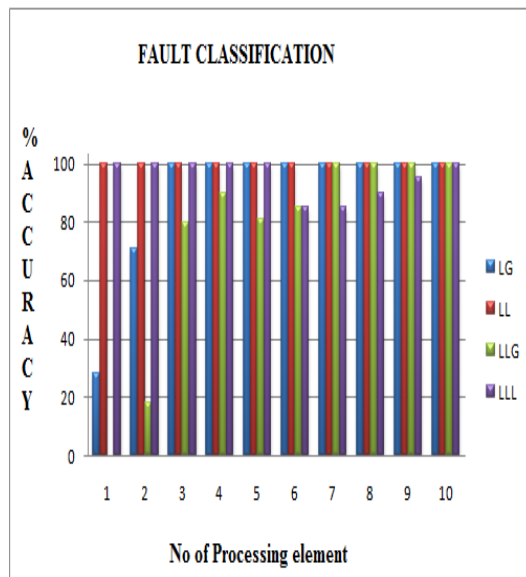


Fig8. No. Of processing element Vs classification accuracy

VII. Conclusion

A new generalised algorithm to classify the faults occurring on High Voltage transmission line is developed in the paper. In the present work a 400KV MSETCL system is simulated in PSCAD with actual line parameters. DWT with its inherent time frequency localization property is employed to extract discriminating features from the phase currents and line voltages. A back propagation neural network classifier is then used for identification of fault type. Faults with various types, conditions and location have been tested and hundred percent accurate classifications are obtained.

The results obtained with the use of DWT-ANN based algorithm are promising and suggest that this approach could lead to useful application in an actual power system.

REFERENCES

- [1] Dash PK and Samantaray SR “ A novel distance protection scheme using time–frequency analysis and pattern recognition approach”. Int J Elect Power Energy system 2006
- [2] M. Jayabharata Reddy and D.K. Mohanta “ A DSP based frequency domain approach for classification of transmission line faults “Science Direct Digital Signal Processing 18 (2008) pp. 751–761
- [3] P. S. Bhowmik, P. Purkait Member and K. Bhattacharya “ A Novel Wavelet Assisted Neural Network for Transmission Line Fault Analysis” Electrical Power and Energy Systems 31 (2009) pp.213–219
- [4] K.M.Silva B.A.Souza and N.S.D.Brito “Fault Detection and Classification in Transmission Lines Based on Wavelet Transform & ANN” IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 21, NO. 4, OCTOBER 2006 pp.2058-2063

- [5] Dalstein and B. Kulicke, “Neural network approach to fault classification for high speed protective relaying”, IEEE Trans. Power Del., vol.10, pp. 1002-1009, 1995.
- [6] G. Sudha , T. Basavaraju B.I.T, V.T.U, Bangalore, India “A comparison between different approaches for fault classification in transmission line” IET-UK International Conference on Information and Communication Technology in Electrical Sciences (ICTES 2007) Dr. M.G.R. University, Chennai, Tamil Nadu, India. Dec. 20-22- 2007. pp.398-403.

Investigation of Human Resource Management Practices (HRM) in Hospitals of Jalgaon District

Saroj B. Patil; Dr. P.T.Choudhari***

*Research Scholar, North Maharashtra University, Jalgaon, India.

** Head, Department of Commerce, M.J. College, Jalgaon, India

Email: *Sarojpatil74@rediff.com

ABSTRACT

This study is aimed to investigate, identify and compare Human Resource Management (HRM) practices in government and private hospitals of Jalgaon District. Self developed questionnaire; based on literature reviews are an instrument used for data collection. The findings of this study are important for understanding the needs of human resource management practices in hospitals, contributions of different factors towards quality care of patients and work culture among the staff.

Keywords: *HRM, Hospital*

INTRODUCTION

Human behavior means, how the people react to situation, what motivate the people and how organization create an environment for people to feel comfort and work independently. Human resource management not only deals with individuals but with team work. Work together to give best output management task is for ensuring a success and motivated workforce and deal with work place environment.

Human resource management in health sector seeks to improve the quality of services and patients satisfaction. Health care quality is generally defined in two ways: technical quality and socio-cultural quality. Technical refers to the impact that the health services available can have on the health condition population. Socio-cultural quality measures the degree of acceptability of services and the ability to satisfy patient expectations. Better use of the spectrum of health care providers and better co-ordination of patient services through inter disciplinary team work have been required as a part of human resource management. Since all health care is ultimately delivered by people, effective human resource management will play a vital role in the success of health policies in any nation.

Fisher (1991) and Spreitzer (1998) suggest that trust in management and perceptions that downsizing was handled in a justifiable manner can lead to reduced threat and greater cooperation from staff. Spector (1997) said that "job

satisfaction is the most frequently studied variable in organizational behavior research". He discussed the reason why we should be concerned with job satisfaction. He concluded that, "job satisfaction is to some extent a reflection of good treatment" and "it can lead to behavior by employees that affect organizational functioning".

Objectives of the study are -

1. To identify the HRM practices in hospitals
2. To compare HRM policy and practices in government and private hospitals.
3. To propose workable suggestions to improve HRM in hospitals.

METHODOLOGY

HRM practices were analyzed to identify the influence of these practices on job satisfaction level of nurses through defined questionnaire for doctors i.e. hospital administrators. By using the Chi-square value, p-value, count value, cross tabulations and sample percentage value interpretations were developed. All statistical data is also represented by suitable charts in presentable manners for better understanding. Further, all the variables were tested by using Chi-Square test to test the hypothesis that made an adequate and satisfactory determination.

ANALYSIS AND FINDINGS

The researcher used a questionnaire for collecting the data. The data is analyzed and results are graphically presented as below:

A. Human Resource planning development

i. Vision and mission displayed

In government hospitals the mission and vision are promulgated by the ministry of health and welfare. They are mandatorily displayed. The nurses are more aware about them and there is an equality of private hospitals also to do so for their professional reasons. The result is that 66.67% of the doctors in government hospitals and 63.0% of the private hospital doctors agreed that vision and mission of

hospital is displayed. There is no significant relationship exist with reference to the parameter 'mission and vision of hospitals' and type of hospitals was reported.

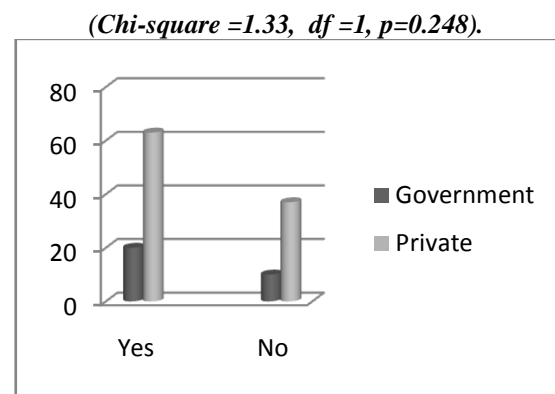


Fig. No. 1: vision and mission displayed

ii Nursing staff is encouraged

The government hospitals have systematic procedure of employee unions. The 63.34% of the doctors in government hospitals and 35.0% of the private hospital doctors agreed that hospital is encouraging nursing staff to participate in human resource planning. The doctors of government hospital felt that they have encourage nurses to participate in HR planning while the private hospitals not to do so. There is significant relationship exists with reference to the parameter 'participation of nurses in HR planning' and type of hospitals was reported.

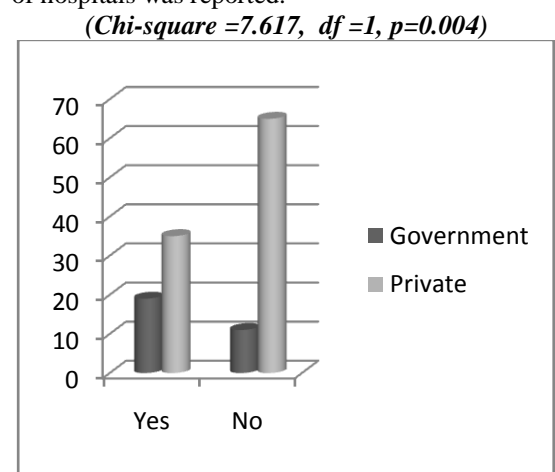


Fig. No. 2: Graph for nursing staff is encouraged

B.RECRUITMENT AND SELECTION

i. Recruitment process defined well

In all government sectors the recruitment procedure is quite well defined. Hospitals are no exception. There are norms for selection

procedures for private sectors also. But there is some flexibility in the norms itself and certain degree of autonomy is given to private sector for staff selection. This is obviously being reflected in the response of doctors given herein regarding selection process. It is observed that 90% of the doctors in government hospitals and 70.0% of the private hospital doctors agreed that recruitment process defined well in their hospital. There is significant relationship exist with reference to the parameter 'recruitment process of nurses' and type of hospitals was reported.

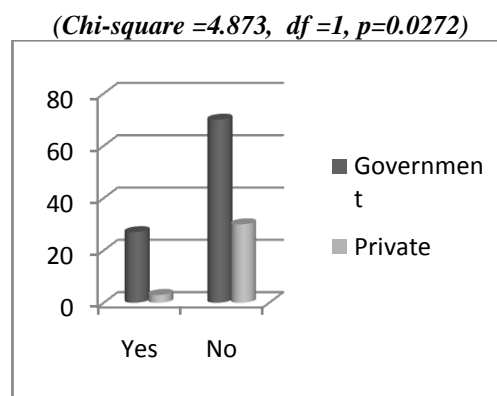


Fig.No. 3: Recruitment process defined well

ii. Staff Selection is fair & clearly set out the criteria of selection in their hospital.

When the procedures are not followed stringently, the confidence level falls down. It is observed that 80.36% of the doctors in government hospitals and 65.0% of the private hospital doctors agreed that the staff selection is fair and clearly set out the criteria of selection in their hospital. There is significant relationship exist with reference to the parameter 'fair staff selection processes' and type of hospitals was reported.

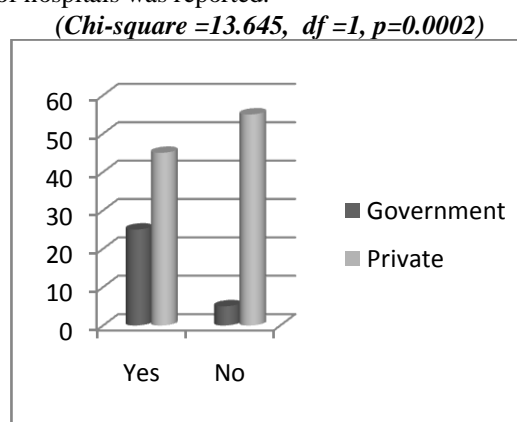


Fig. No., 4: Staff Selection is fair & clearly set out the criteria of selection in their hospital

C. PERSONAL POLICIES

i. Career development scheme exists in their hospital.

The ministry of health and welfare of central and state governments have initiated several schemes for the welfare of nursing staff. Government hospitals are at top position for implementing the development scheme and their nursing staff is getting benefit of these schemes. But private hospitals are lagging behind to take the benefit of such schemes. It is observed that 63.36% of the doctors in government hospitals and 38.0% of the private hospital doctors agreed that career development scheme exists in their hospital. There is significant relationship exist with reference to the parameter 'career development scheme exists' and type of hospitals was reported.

(*Chi-square =6.015, df =1, p=0.0141*)

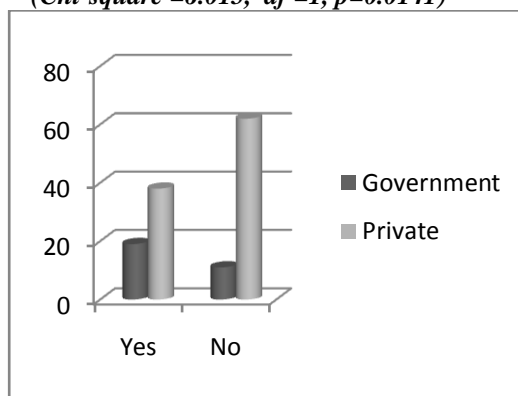


Fig. No.5: Career development scheme exists in their hospital

ii. Hospital handles staff needs and demands properly.

It is a very positive observation that both the category of doctors has reported that the needs of staff are handled properly. This proportion is even higher in the private hospitals. This may be because the fact that they have a personal attention to the staff and they are concerned with the output quality. It is observed that 86.66% of the doctors in government hospitals and 98% of the private hospital doctors agree that hospital handles staff needs and demands properly. There is significant relationship exist with reference to the parameter 'staff needs and demands' and type of hospitals were reported.

(*Chi-square =6.733, df =1, p=0.009*).

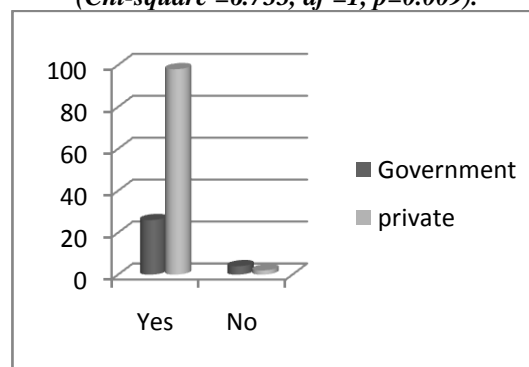


Fig. No. 6: Hospital handles staff needs and demands properly

D.PRACTICES FOR EMPLOYEE BENEFITS

i. Group/individual insurance policy is exist in their hospital.

Insurance policies are the most helping hands to the employees those are working in government hospitals and private hospital. These insurance policies minimize the future risk and financial needs when big sort of problem arises. Government hospitals are always following their norms for group insurance policy or individual insurance policy. Government hospitals have clear-cut mechanism for insurance of nursing staff. In this regard there are government directives for private hospitals also. But the insurance policies are not well implemented in the private hospitals. Such practices need to be practiced in private hospitals too. It has been found that 66.66% of the doctors in government hospitals and 15% of the private hospital doctors agreed that group/individual insurance policy is exist in their hospital. There is significant relationship exist with reference to the parameter 'an insurance policy of nurses' and type of hospitals was reported.

(*Chi-square =31.311, df =1, p=2.19831E-08*)

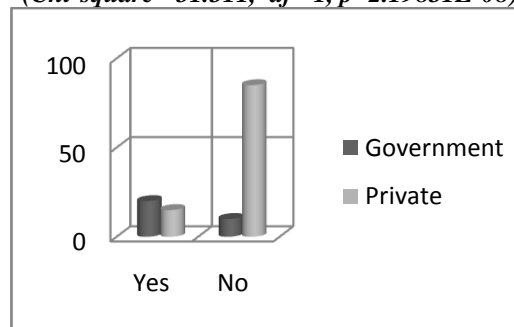


Fig No. : 7: Group/individual insurance policy is exist in their hospital.

ii. Reimbursing for skill development activities.

Hospital management arranges variety of the training programme and workshops for skill development. It has been observed that 70.0% of the doctors in government hospitals and 55.0% of the private hospital doctors are agreed that their hospitals are reimbursing for skill development activities. There is no significant relationship exist with reference to the parameter 'Nurses reimbursed for skill development activities' and type of hospitals was reported.

(*Chi-square* =2.138, *df* =1, *p*=0.143)

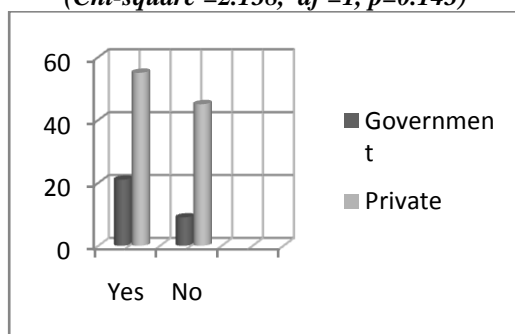


Fig. No. 8: Reimbursing for skill development activities.

E. WORKPLACE MANAGEMENT

i. Clerical duties are performed by clerical staff in their hospital

It is clear that the private hospital nurses are being overloaded. In addition to their regular work, they are additionally being loaded with the clerical work. This situation must be changed. Private hospitals must involve adequate number of clerical staff for such duties. It is observed that 96.67% of the doctors in government hospitals and 65.0% of the private hospital doctors agreed that clerical duties are performed by clerical staff in their hospital. There is significant relationship exists with reference to the parameter 'job responsibility other than nursing staff' and type of hospitals was reported.

(*Chi-square* =11.557, *df* =1, *p*=0.0006)

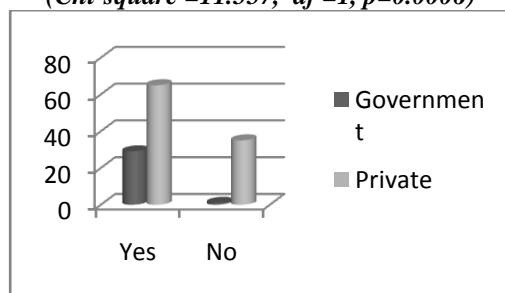


Fig. No. 9: Clerical duties are performed by clerical staff in their hospital

ii. Hygiene and safety are emphasized in their hospital.

It is very pleasant to see that doctors from both the sectors felt that hygiene and safety is being practiced properly in the hospitals. It is observed that 96.67% of the doctors in government hospitals and 85.0% of the private hospital doctors agreed that hygiene and safety are emphasized in their hospital. There is no significant relationship exist with reference to the parameter 'Hygiene and safety at work places' and type of hospitals was reported.

(*Chi-square* =2.910, *df* =1, *p*=0.0880)

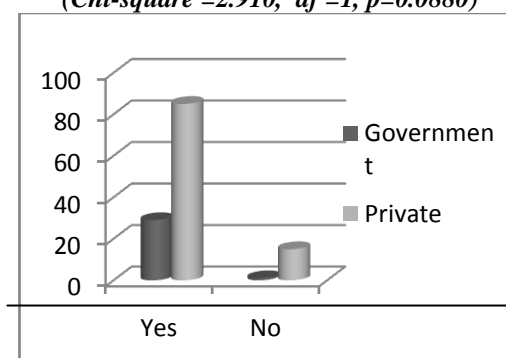


Fig. No. 10: Hygiene and safety are emphasized in their hospital.

F. EMPLOYEE RELATION AND COMMUNICATION

i. Hospital promote corporative interdisciplinary relationships

It is quite positive to see that in government hospitals there is a flexibility to promote corporative interdisciplinary relations. In private hospitals this proportion is very low. This is a matter of concern. Hospitals authorities must seriously investigate the causes for this and must do required changes to promote corporative interdisciplinary relationship. It is observed that 96.66% of the doctors in government hospitals and 30% of the private hospital doctors agreed that their hospital promote corporative interdisciplinary relationships. There is significant relationship exist with reference to the parameter 'promotion of co-operative inter disciplinary relationship' and type of hospitals was reported.

(*Chi-square* =41.378, *df* =1, *p*=1.25461E-10)

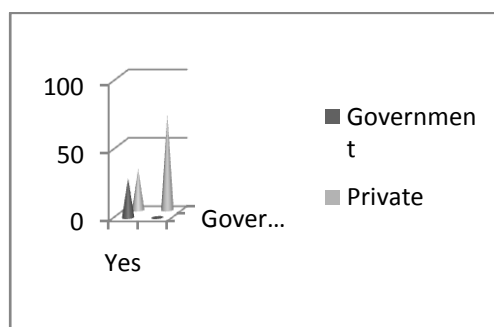


Fig. No. 11: Hospital promote corporate interdisciplinary relationships

ii. Nurses participated in hospital management practices.

In the present era of liberalization and globalization, employees have instinct urge to participate in management up to certain limit. The observation is that 16.67% of the doctors in government hospitals and 1% of the private hospital doctors agreed that nurses participated in hospital management practices. There is significant relationship exists with reference to the parameter 'Nurses participate in hospital management' and type of hospitals was reported.

(*Chi-square =12.866, df =1, p=0.0003*)

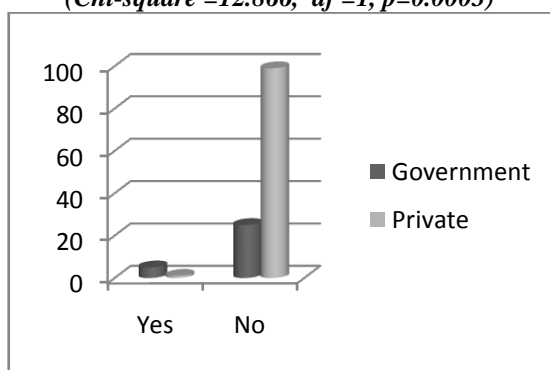


Fig. No. 12: Nurses participated in hospital management practices.

G. TRAINING AND DEVELOPMENT

i. Opportunities for continuing education are available in their hospital.

Education is the process to achieve excellence and hospital and 95.0% of the private doctors agreed that opportunities for continuing education are available in their hospital. There is no significant relationship exist with reference to the parameter 'Opportunities for continuing education are available' and type of hospitals was reported.

(*Chi-square =3.250, df =1, p=0.071423*)

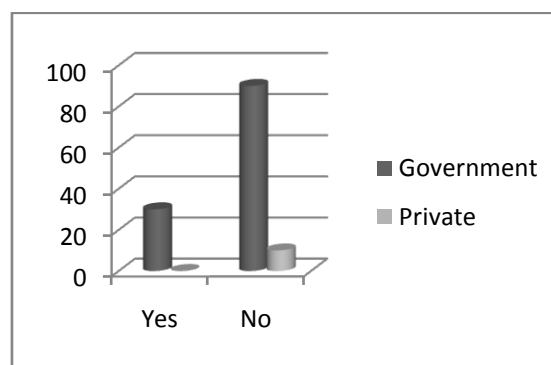


Fig. No. 13: Opportunities for continuing education are available in their hospital

H. EMPLOYEE WELFARE AND COMPENSATION

i. Excellence in human resource management practices.

It is observe that 96.67% of the doctors in government hospital and 0% of the private doctors agreed that fringe benefits (PF, Gratuity, Uniform, Recreation. etc) are given in their hospital. It is serious concern for private hospitals administrators to achieve the excellence in human resource management practices. There is significant relationship exist with reference to the parameter 'fringe benefits' and type of hospitals was reported.

(*Chi-square =124.422, df =1, p=6.81043E-29*)

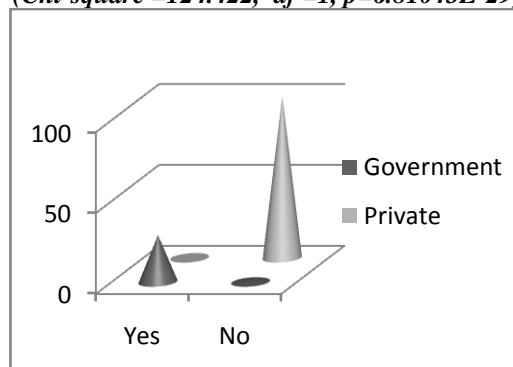


Fig. No. : 14: Excellence in human resource management practices

ii. Post retirement benefit program

develop the creative and innovative sights in human being. It is therefor

It is observed that 100.0% of the doctors in government hospitals and none of the private hospital doctor agreed that the post retirement benefit program is existing in their hospital. It must be improved in private hospitals. There is significant relationship exist with reference to the parameter 'post retirement benefits' and type of hospitals was reported.

(*Chi-square =185, df =1, p=392462E-42*)

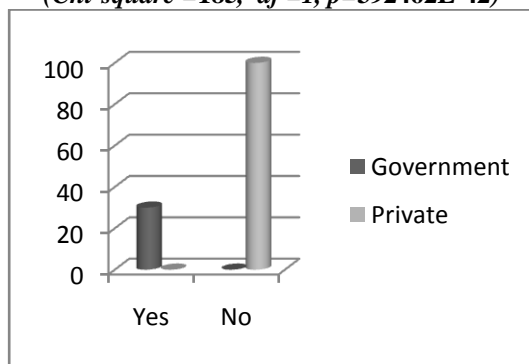


Fig. No 15. : Post retirement benefit program

CONCLUSION

The present study leads to the conclusion that HRM practices are very skill fully applied by private hospitals. They have applied all superficial practices in higher proportion as compared to the government hospitals. However the core practices are applied only in Government hospitals. In fact these practices are dictated by the service norms of government employees and are reflected in other professions too.

It is very interesting to note that the private hospitals are more skilled in customer oriented training of their staff. In government hospitals, there is a routine practice of senior officials taking meeting of staff and taking feedback and report from staff regarding target compliances. In fact targets are the specific tasks given to staff in government hospital that is in conjunction with the mission and vision. In private hospitals, nurses do not have such “targets” and field jobs are limited to the clinical cares only. Thus about the mission and vision there awareness is less. These are a positive indication that more than 80% of staff in private hospitals well as government hospitals have accepted that their organizational goals are for

good causes. An unsatisfied employee would have less faith in the genuineness of organizational goals. It is very positive sign that the working procedures are well known to the very large proportion of employees. Further the percentage is higher for government hospitals. These are because government hospitals have many well established procedures as compared to the private hospitals. The administrative approaches of the government hospitals as compared to the private hospitals are more flexible. It is hoped that the present study will form a suitable data base for hospitals to retrospect their HRM practices and to enhance them for better HRM outcome.

REFERENCES

- [1] Kavya Sharma, Sanjay Zope, “Health and Hospital Management Education in India”. ISSN 2229-337X, Vol-2, Issue 1. Jan – 2011.
- [2] Nahid Dehghan Nayeri Ali Akbar Nazari, “Iranian staff nurses view of their productivity and human resources factor improving and impeding it::a quality study”.
- [3] Linda McGillis hall, “ Nursing intellectual capital: a theoretical approach for analyzing nursing productivity”, Jan-2003
- [4] Thomay A-Slay, Thesis entitled as , “Intrinsic and extrinsic factor affecting job satisfaction of nursing assistants in two long term care.”
- [5] Aswathappa K., “ Human Resource Management- Text & Cases”, Tata McGraw Hill, 6th edition,2010
- [6] Menon P.K.S., “Human Resource Management and Organizational Behavior”, Himalaya Publishing House, 2005
- [7] Manoria C.B., Gankar S.V., “ A Textbook of Human Resource Management”, Himalaya Publishing House, 2010
- [8] Wayne R., “Human Resource Management”, SPHR, 10th edition, Pearson Publications.2010, ISBN 978 – 81 -317 -2568 -9
- [9] Mutsuddi Indranil, “ Essentials of Human Resource Management”, New Age international Publishers, 2010, ISBN 978 – 81 – 224 -2815 -5

Role of Constitutional Ruling System

Sakina Husain¹, Dr M Husain² and Dr K S Wani³

1. Formerly Lecturer, Dr Jakir Husain Academy, College of Science, Arts and Commerce, Burhanpur, MP.
2. Professor, Civil Engineering, SSBT's College of Engineering and Technology, Bambhori, Jalgaon, MS.
3. Principal, SSBT's College of Engineering and Technology, Bambhori, Jalgaon, MS.

Abstract: Indian philosophy believes that since the ancient times, the universe was auto-regulated. It was absolutely self-governed without existence of formal external governance. It was later the conscious beings started violating the universal laws and the inception of an external governing system became inevitable. In the modern era, every nation has its own governing system. In the present era one cannot imagine a nation without a governing system. Apart from a central governing system at top there exists are a multilayered governing system. Indian philosophy considers the beginning of governing system since the time of Ramayan. Crowning of Lord Ram symbolizes the beginning of good governance that protects the rights of weaker and ensures non-violation of inherent laws of universe. It laid certain morals and values for ideal governance.

Is the constitution of modern India founded on those ideals? What is the role of constitutional governing system in modern society? This paper discusses these issues with a retrospective perspective into ancient Indian mythology and spirituality. It does a vis-à-vis comparison of the role model of governance presented by ancient Indian epic Ramayan and modern India's constitution.

Key words: *Constitution, Mythology, Spirituality, Ramayan (The ancient Indian epic).*

Introduction:

GOD is the ultimate ruler of universe. It is a fundamental idea of human psychology and is reflected in all spiritual and mythological thoughts too. The word God has many synonyms in Indian philosophy. One of the synonyms is "Vidhi"- the rule or law or procedure. It is important to be seen that in the word "vidhi" God is not referred as a noun; rather as a verb. God is the creator of "Vidhi", the Vidhata. Still the Indian philosophy does not consider him to be over and above the vidhi. The creator of universal laws (Vidhi) himself (herself) is abided of his own universal laws. He, the almighty as referred in most of the spiritual philosophies is not an autocratic random players of universal laws. It means that the creator

of laws himself is not considered to be a monarch. This represents the supremacy of universal laws. The universal laws owe equally highest degree of respectability as the creator of these laws. Even the incarnations (Avtar) also abide themselves with these universal laws (Maryada). The character of Lord Ram is an excellent example of this and is rightly referred as "Marayada Purushottam" -the great human who respected all the laws.

All activities in the universe are governed by these supreme and pious laws. All materialistic creatures strictly follow these universal laws. Yet the conscious beings, the living creatures are given a "freedom of selection" within the universal laws. This freedom in true sense is the wisdom of conscious beings. The universal functioning is going on since the infinite time according to these laws. Yet, if a conscious being attempts to violate the universal laws, what are the inherent provisions within the laws to prohibit such violation? What if a mighty conscious being attempts to suppress a weaker one? How the rights of a weaker one are safe-guarded? The Constitutional governing system is a provision to check such violations. In true sense, this is the role of constitutional governing system.

The ancient Indian mythological epic Ramayan describes that the incarnation of Ram was for the purpose of prohibiting the violation of pious universal laws and to establish their supremacy. It was to basically protect the right of weaker. Ramayan is the Constitution of Indian philosophy. Today, the ruling system in India is defined by the Constitution of India. The scope of discussion of this paper is to analyze to what extent does this constitution of modern India meets the ideals defined by ancient Indian philosophy.

The Mythological Reference:

Once upon a time, in the farmyards (Ashram) of Sage Valmiki a couple birds were indulged in play. Here play symbolically represents the prevalence of an inherent peace and satisfaction. It shows that the universal functioning was smoothly following the course; auto-regulated and self governed. There came a hunter. He killed one of the birds. The other bird fell in sorrow. Sage being in meditation saw all this. The incident

nailed him deep in his heart. He cursed the hunter in following words:

*“Ma nishad pratishtham twang amah shaswatih samah,
Yat Kroch mithunadikam vadhih kam mohitam.”*

Meaning: O hunter you have killed the playing birds. You will never and nowhere get a peace [1; 2].

Later the sage realized that the words of curse are in the form of a “Shloka”, a well versed couplet according to the grammar of Sanskrit language. Then the sage evolved a vision. He wrote the great epic of Ramayan. Ramayan starts with the words that Valmiki used to curse the hunter. Ramayan is considered to be the first literature created by civilization. Ramayan presents a hypothesis of Ramrajya, the ruling of Ram. An ideal governing system. A governing system in which the rights of weaker are not suppressed by the stronger. The rights of weaker are protected by the governance. It assures a kingdom which is free from fear. According to Indian philosophy this is the role of constitutional ruling system. In Ramayan, the capital of Ram’s Kingdom is Ayadhya- a place where no yudhha (war) takes place. Another name of Ayodhya is Avadh- a place where no vadh (killing) takes place. These are the ideals laid down for a governing system according to Indian mythology. This paper endeavors to identify these ideals in the constitution of modern India.

Ruling Patterns in Modern World:

In modern world there are varieties of ruling patterns. They include right from pure monarchy, military rule, communist rule, pure democracy etc. broadly they may be categorized into two- autocracy and democracy. The word democracy is derived from the Latin word democratine [3]. It means people to rule. Democracy is generally considered to be a system evolved later with civilization hence is a modern system. It is evolved as a people beneficiary ruling system. Still there are so many examples of so called failed democracies and successful autocracies also. Yet there is a fundamental difference between the two. Autocracy in itself has no room for the opposite thought, while democracy is based upon the ideology of coexistence and consensus. It gives recognition to the opposite thoughts too. It is not just a ruling system but is a life style in broad sense. Suppression of opposite thought is violence. Democracy is a non-violence based system.

The constitution of India:

Modern India opted democracy as a ruling pattern. The constitution of India is the world’s largest written constitution which is created refereeing all the constitutions of the world. It has declared India to be a sovereign, socialist and secular democratic republic [4]. It has given right of equality to all. It is based upon the theory of no discrimination on the basis of caste, religion, language, race, gender, color etc.. In abstract it is based upon the theory of right is might not might is right. It defines a ruling pattern, a governance that safe-guards the interest of the weakest.

An important fundamental feature of Indian constitution is a secular governing system. In fact Indian democracy in many ways is a role model for the world. There are many countries which got independence with or after India. They preferred to opt democracy as ruling system. Yet they could not sustain long their democracy. Some of them fell into autocracy. The Indian democracy has sustained itself amidst all the critical situations. This is owing to the fact that democracy is the basis of Indian spiritual life style. In Indian spirituality there is a room for opposite thoughts too. Coexistence with opposite thoughts and consensus amongst diversified thoughts are deeply rooted in the Indian spirituality. The spiritual philosophy of “syadvad^{an}” gives allowance multiple opinions about truth; while that of “anekantvad^{bn}” seeks conformity and consistency amongst diversified thoughts. Thus the ideology of suppressing the opposite thought does not arise; rather there is a natural ideological rise of coexistence. Thus the democracy persists.

One more thing is important here. Democracy and secularism go hand in hand [5]. A ruling system based upon specific religion cannot protect its democratic character, as it is against the fundamental requirement of democracy that is coexistence [6]. The world history has shown that the nations who opted religion specific ruling system could not protect their democracy for long time.

Conclusions:

“Ramrajya” is a role model of an ideal governing system. In modern context the ideals and values of Ramrajya is can be achieved in a well functioning democracy. The constitution of India is truly influenced with the ideology of Ramrajya. Secularism is an important pillar of this system. It is very important in Indian context or in general in the context of all eastern democracies of the globe [7]. Once Swami Vivekananda said- “In east one cannot talk of politics without referring to religion,

while in west one cannot talk of religion without referring to the politics.” Consequently religion is of supreme importance in the life style of east. Yet our governing system is not religion specific. Our life style is based upon consensus and coexistence. Thus our ruling system is based upon secularism. Hence is our democracy prevalent and persistent. Under its umbrella the ideals of Ramrajya have scope to groom up. This finally leads to a people beneficiary ruling system; an absolutely fearless kingdom in which right is the might. Only a truly civilized society can evolve such a system. Conversely, a truly civilized system flourishes under such a ruling system.

^aSyadvad: according to Indian spirituality “syadvad” is a theory which believes that no one can be perfectly sure about reality. Or, the reality cannot be described beyond doubt. It all depends upon the observer’s capacity to analyze about the reality.

^bAnekanekantvad: according to Indian spirituality “anekantekantvad” is a theory which believes that all different opinions about reality differ merely at the surface; in the depth they all describe the same reality.

References:

- [1] Shri Ramcharitmanas, Gita Press, Gorakhpur.
- [2] Wikipedia of Ramcharitmanas.
- [3] Wikipedia of political science.
- [4] Pylee M V (1997) Indian Constitution, S Chand and Co. Publication.
- [5] Holyake G J (1896) The original nature of secularism, Watts and Co. Publication, London.
- [6] Wikipedia of secularism.
- [7] Kosmin Barry A (2007) Contemporary Secularity and Secularism, Publication of Institute for the study of secularism in society and culture, Hartford.

Response Spectrum Analysis of Asymmetrical Building

Pravin Ashok Shirule¹, Bharti V. Mahajan²

¹ Associate professor, Civil Engineering Department, SSBT's COET, Bambhori, Jalgaon, (MS) – 425001.

² Asst. Professor, Civil Engineering Department, Rajarshi Shahu College of Engineering, Pune.

ABSTRACT

In this project a parametric study on Reinforced Concrete structural walls and moment resisting frames building representative of structural types using response spectrum method is carried out. Here, the design spectra recommended by Indian Standard Code IS 1893-2002 (part I) and two other codes (Uniform Building Code, Euro Code 8) are considered for comparison. The objective of this study is to investigate the differences caused by the use of different codes in the dynamic analysis of multistoried RC building. To evaluate the seismic response of the buildings, elastic analysis was performed by using response spectrum method using the computer program SAP2000. It is observed from the comparative study that the base shear using IS code is higher in all the three buildings, when compared to that of with other codes which leads to overestimate of overturning moments in the building and hence heavier structural members. To experimentally verify the applicability of the proposed semi active control system to torsionally coupled responses of an asymmetric building, use of computer software was conducted using in a G+13 storey building model with asymmetric column distribution.

KEYWORDS

Response spectrum analysis, Elastic design spectra, RC building, IS code.

INTRODUCTION

Earthquake codes are periodically revised and updated depending on the improvements in the representation of ground motions, soils and structures. Moreover, these revisions have been made more frequently in recent years. The Indian Standard Code (IS 1893-2002 (Part-I)) was also revised in 2001 and has been in effect since 2002. This improvement was done followed to destructive earthquake occurred in Bhuj (Gujarat State, India) on 26th January, 2001 which resulted in more than 19,000 recorded death and 1,66,000 injuries. Preliminary indications are that 600,000 people were left homeless, with 48,000 houses destroyed and an additional 844,000 damaged. The

Indian State Department estimates that the earthquake affected, directly or indirectly, 15.9 million people, nearly 50% of the population of Gujarat. More than 20,000 cattle were reported killed. Government estimates place direct economic losses at \$1.3 billion, although more recent estimates indicate losses may exceed \$5 billion. A number of separate teams from different bodies conducted damage surveys and reported some conclusions as briefly summarized below. Early reports stressed that quality of construction were poor and that there were many structural mistakes and deficiencies due to the non-compliance with the earthquake code. It was concluded that the nature of the strong-motion was also a major contribution factor to the level of damage. Under the light of observations and lessons from the 2001 earthquake and past earthquakes, many studies concerning to IS 1893-2002 have been carried out up to now and number of improvements are made. The influence of local ground conditions on the seismic action is considered depending on the ground types described in the various codes considered in the present study. That is why the emphasis has been given on the differences caused by the use of spectra given in IS Code and other well known codes such as UBC and Euro code in the seismic analysis of sample buildings.

Response Spectra

Response spectrum of any building gives us a plot of peak or steady state response (Displacement, Velocity or Acceleration) of a series of oscillators of a varying natural frequency, that are forced into motion by the same base vibration or shock. The resulting plot can then be used to pick off the response of any linear system, given its natural frequency of oscillation. Response spectrum analysis requires that isolator units be modeled using amplitude- dependent values of effective stiffness. The effective damping of the isolated modes of response is limited to 30 percent of critical. Higher modes of response are usually assumed to have five percent damping a value of damping appropriate for the superstructure, which remains essentially elastic. As previously noted, maximum and minimum values of effective stiffness are typically used to individually capture

maximum displacement of the isolation system and maximum forces in the superstructure. Horizontal loads are applied in the two orthogonal directions, and peak response of the isolation system and other structural elements is determined using the 100 percent plus 30 percent combination method. The basic mode superposition method, which is restricted to linearly elastic analysis, produces the complete time history response of joint displacements and member forces. In the past there have been two major disadvantages in the use of this approach. First, the method produces a large amount of output information that can require a significant amount of computational effort to conduct all possible design checks as a function of time. Second, the analysis must be repeated for several different earthquake motions in order to assure that all frequencies are excited, since a response spectrum for one earthquake in a specified direction is not a smooth function there are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each mode using smooth design spectra that are the average of several earthquake motions.

MATERIALS AND METHODS

Nonsymmetric Buildings Plan of G+13:-

The plan view of non-symmetric buildings is shown in Figure 2. The structural system is selected as concrete frames with identical columns of 50/50 cm in size, and beams of dimension 40/70 cm. Each floor slab has 15 cm thickness and the story height is 3 m. The critical damping ratio of superstructure is taken as 2% for isolated cases.

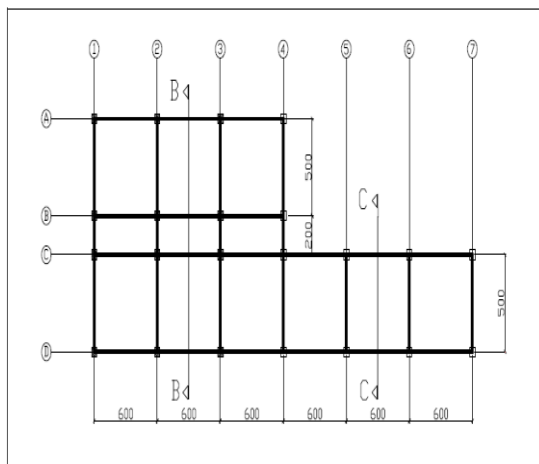


Figure No 1: Plan view of nonsymmetric building

MODES OF FAILURE

After the analysis of above plan using SAP2000 we got some result and mode of failure. Following diagrams are nothing but the different modes in which building gets buckled, bitter or collapse. These 4 diagrams are nothing but the mode of failure of the building. While analysis this asymmetrical building by using computer software SAP2000, it was observed that this building is failed in first mode only. It means building is not safe in seismic area and it could not stand at the time of earthquake. So it is a need to provide a shear wall to the building then only the chances of failure of the structure can be minimised. There is also a one figure of the building which is with provided shear wall.

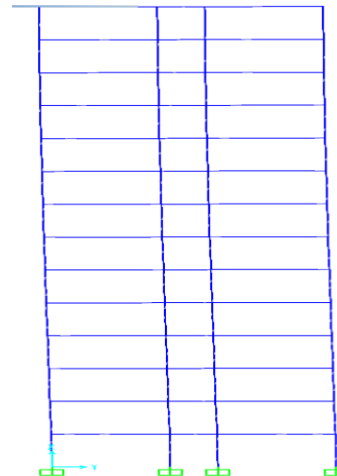


Figure No 2 Mode: 1

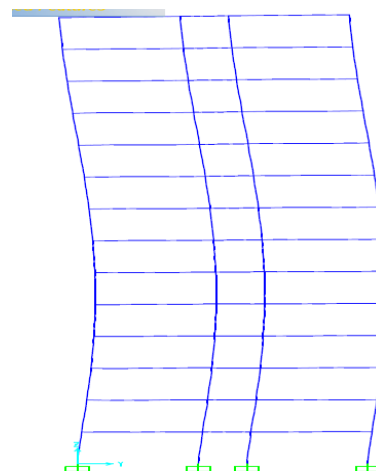


Figure No 3 Mode: 2

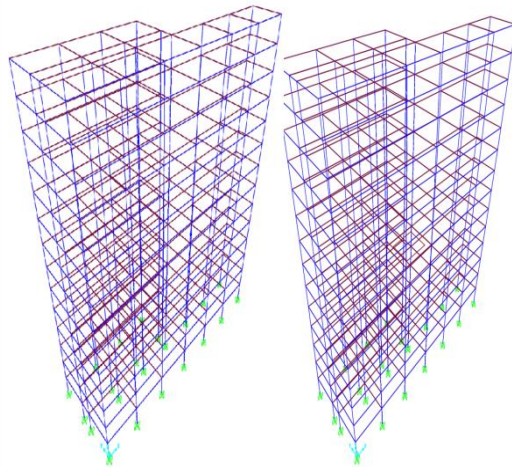


Figure No 4 Mode 3

Figure No 5 Mode 4

RESULT AND DISCUSSION

Comparisons between building with Shear Wall and without Shear wall

We have obtain the graph of base shear, deflection and storey drift after providing the shear wall in x-x direction and y-y direction which have been shown in above. Now combining the graph of x-x direction and y-y direction for both the structure i.e. for asymmetrical building with shear wall and without shear wall. Comparing both the graph we will get the respected result.

Following graphs are combined graph of base shear, deflection and story drift for the both building i.e. with shear wall and without shear wall.

	Base Shear in X-X Direction		
Code	TYPE 1	TYPE 2	TYPE 3
IS Code	580.565	759.925	915.808
EURO Code	549.395	549.395	549.395
UBC 94 Code	628.026	899.68	1367.461

Table 1 A: Base Shear for a building without Shear wall

	Base Shear in Y-Y Direction		
Code	TYPE 1	TYPE 2	TYPE 3
IS Code	1566.82 5	2031.21 1	2415.168
EURO Code	1530.38 7	1530.38 7	1530.387
UBC 94 Code	1699.75 4	2396.01 7	3560.291

Table 1 B: Base Shear for a building without Shear wall

	Base Shear in X-X Direction		
Code	TYPE 1	TYPE 2	TYPE 3
IS Code	1149.197	1149.197	1149.197
EURO Code	1149.197	1149.197	1149.197
UBC 94 Code	1149.197	1149.197	1536.481

Table 2 A: Base Shear for a building with Shear wall

	Base Shear in Y – Y Direction		
Code	TYPE 1	TYPE 2	TYPE 3
IS Code	38927.51	38927.51	38927.51
EURO Code	38927.51	38927.51	38927.51
UBC 94 Code	38927.51	38927.51	38927.51

Table 2 A: Base Shear for a building with Shear wall

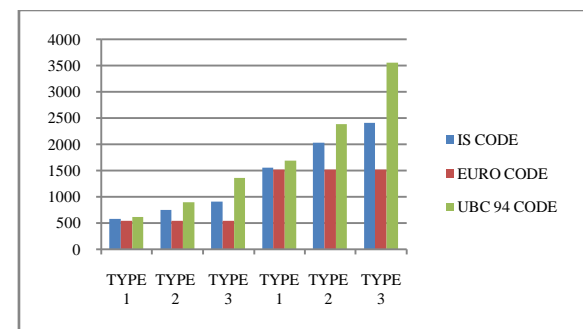


Figure No 6: Base Shear for a building without Shear wall

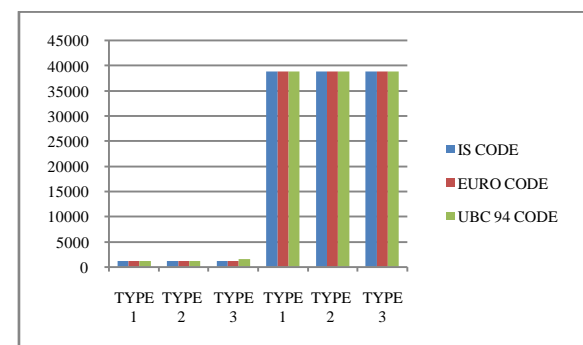


Figure No 7: Base Shear for a building with Shear wall

From the figure 6 & 7, it is observed that the base shear is reduces in X direction than that in Y direction which is about 35%.

From the comparison it can be concluded that response spectra analysis according to UBC 94 code gives satisfied result and most accurate for design than rest of the two codes. Also soil type 3 is good for design than other two types.

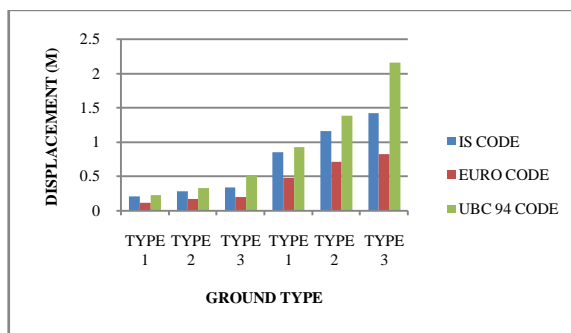


Figure No. 8 Deflection without Shear wall Building

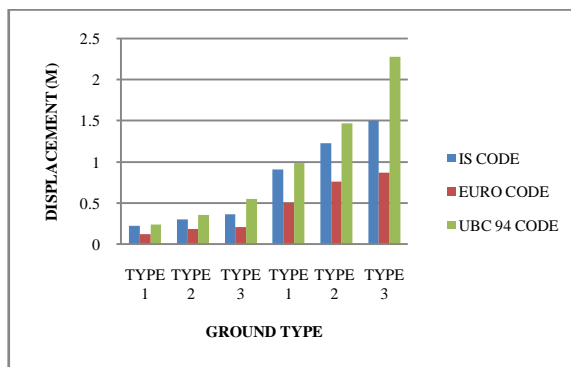


Figure No. 9 Deflection with Shear wall Building

From the figure 9 & 10 it is observed that deflection is reduces in X direction than that in Y direction which is about 15%.

From the comparison it can be concluded that response spectra analysis according to UBC 94 code gives satisfied result and it is most accurate for design than rest of the two codes. Also soil type 3 is good for design than other two types.

CONCLUSION

- After the all analysis of the asymmetrical building, from the result we concluded that it is better to provide shear wall to the asymmetrical building. It helps in prevention of the building from damage and collapse, increases the strength of the building. And also decreases the displacement and storey drift of the building.
- From the parametric study on Reinforced Concrete buildings the following conclusions are drawn as:-
- IS code depict the higher values of base shear for similar ground types defined in the other codes which may lead to overestimate the

overturning moment and could results in heavier structural members in the building.

- For the buildings, UBC code gives the maximum and IS gives the minimum displacement values.

Acknowledgement

The author gratefully acknowledges the support in all the way from management, SSBT's College of Engineering And Technology, Jalgaon, Maharashtra, India for publishing this research work.

REFERENCES:-

- [1] Ambraseys N, Simpson K. Bommer J. 1996 "Prediction of horizontal response spectra in European Earthquake". Engineering Structural Dynamics, 25, Page no.371-400.
- [2] Bommer J.J. Acevedo A.B. 2004 "The use of real earthquake accelerograms as input to dynamic analysis". Journal of Earthquake Engineering, 8, Page no.43-91.
- [3] Bommer, J. J. Elnashai, A. S. Weir, A.G. 2000 "Compatible acceleration and displacement spectra for seismic design codes". Proceeding of 12th World Conf. on Earthq. Engg. Auckland, Paper no.207.
- [4] EC 8. 2004. Eurocode 8: Design of structures for earthquake resistance Part 1: general rules, seismic actions and rules for buildings, European Norm. European Committee for Standardization, European Committee for Standardization Central Secretariat, rue de Stassart 36, B-1050 Brussels.
- [5] IS1893 (Part-1)-2002. Criteria for earthquake resistant design of structures-general provisions and buildings (fifth revision), Bureau of Indian Standards, India.
- [6] Liang, J. and Hao, H.. "Characterization of representative site profiles in PMA through ambient vibration measurement". Proceedings, Australian Earthquake Engineering Society Conference, Ballarant, Victoria, Australia. 2008
- [7] SAP2000. Integrated Software for Structural Analysis and Design: Computers and Struct. Inc. Berkeley, California.
- [8] UBC, 1994. Uniform Building Code, International Conference of Building Officials. Whittier, California, USA.
- [9] Mario Pazz (Structural dynamics)
- [10] Azlan A.Tan chee. W,tan Beng C . "An Evaluation of High-Rise Building Performances under Low Intensity earthquake effect". The International conference on disaster management Lankawi. (2001).

Spherical Electrical Machines

Bhagat Singh Tomar,

Assistant Professor, Electrical Engg. Department,
Laxmi Devi Institute Of Technology, Alwar
(Rajasthan), bhagatstomar@yahoo.co.in.

Apeksha Narendra Rajput,

Sr. Lecturer, Indraprastha Engineering College,
Electrical Engg. Deptt. Ghaziabad (U.P),
apeksha_rajput@hotmail.com

Abstract- This paper contains a summary of the work with spherical electrical machines found in the specialized literature. Spherical actuators allow several degrees of freedom (DOF), which is particularly interesting in robotics. The research into multidegree-of-freedom actuators has been ongoing for decades, the first designs dating from the 1950's. However, competitive performance has not been achieved until power electronics and digital signal processors were incorporated in the controls.

Index Terms- spherical electrical machines, degrees of freedom (DOF), asynchronous motors, induction motors.

I. INTRODUCTION

The latest contributions on spherical machines are pointing towards asynchronous motors rather than permanent magnets. However, these concepts are already at a very early design stage, mainly focusing on simulations and how to achieve the movement of the rotor, while practical implementation and accurate controls are not yet reported.

The purpose of this report is to provide an insight view of the different topologies found in the specialized literature regarding two and three degrees of freedom actuators suitable for robot applications.

Advances in robotics, office automation and intelligent flexible manufacturing and assembly systems have necessitated the development of precision actuation systems with multiple degrees of freedom (DOF). In general, however, motion with several DOF is currently realized almost exclusively by using a separate motor/actuator for each axis, which results in complicated transmission systems and relatively heavy structures. This inevitably compromises the dynamic performance, owing to the effects of inertia, backlash, nonlinear friction and elastic deformation of gears.

Actuators which are capable of controlled motion in two or more degrees of freedom can alleviate these problems, while being lighter and more efficient. A particular interesting

configuration to perform these tasks is the spherical machine.

II. PERMANENT MAGNET MACHINES

The principle of the spherical machine is shown in Figure 1. The diameter of the inner sphere is 275 mm and the height of the pole shoes is 50 mm. The specified torque is 40 Nm in all positions. The rated speed is 12 rad/s. The gap between stator and rotor is approximately 40 micrometers. A high manufacturing accuracy is needed to build the elements of the inner and outer sphere. Oil inside the stator housing is used for the hydrostatic bearing and also for cooling purposes. The stator yoke is made of a soft magnetic powder composite with a relative permeability of 500, and it serves to reduce eddy current losses. In parked position or in case of a failure of the bearing system an additional mechanical brake is activated.

The rotor consists of a sphere with 112 NdFeB permanent magnets, arranged in seven rows each having 16 magnets with alternating north and south orientation. The outer stator core casing has 96 stator poles and windings. The rotor is supported by hydrostatic bearings built into the outer stator case. The working area is only limited by the opening angle of the case ($\pm 60^\circ$). The control hardware consists of three digital signal processor (DSP) boards, which offer 480 MFLOP computing power, memory for storing force characteristics, and a high number of input/output channels.

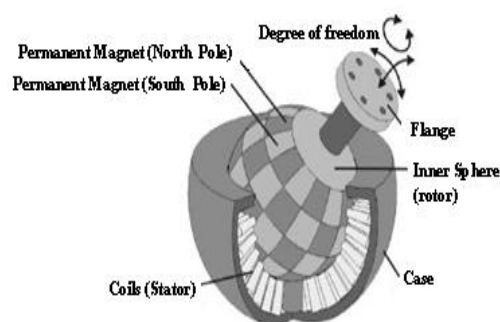


Figure 1 Principle of design

The main applications of Halbach magnetised machines are:

- High-speed motors/generators. For example in flywheel energy storage systems. This is due to their low iron loss.
- Servomotors. For example computer disks and electric power assisted steering. This is due to the low cogging torque and torque ripple.
- Linear machines. Such as material handling and semiconductor wafer stepping. Due to the low inertia and high air gap field and force capabilities, linear Halbach motors can achieve very high acceleration.
- Passive magnetic bearings/magnetic coupling. Actually Halbach machines are extensively been used for these applications.
- Spherical motors. In particular it is interesting the fact that no rotor back-iron is needed, which would alleviate the actual weight problems in spherical machines. Their lower torque ripple would also be an advantage for position control. With adequate magnetization techniques they could be more easily manufactured than conventional surface permanent magnet spherical machines.

In general, all the actuators analyzed so far have an aperture in the stator to allow access to the rotor so as to attach the external payload, and the effect of this aperture has been analyzed in [5]. The aperture modifies the magnetic field distribution, which in turn may degrade the performance of the actuator in three respects, since it may result in the following:

- an asymmetrical flux density distribution, which would affect the excitation torque versus rotor angular displacement characteristics.
- a reluctance torque component, due to the interaction of the permanent-magnet field and the asymmetrical stator iron geometry.
- asymmetry in the radial force distribution, and hence an “unbalanced magnetic pull”, which could impose a significant additional load on the bearing system.

III. INDUCTION MACHINES

Traditionally, induction (asynchronous) spherical machines have not attracted commercial interests, probably due to the relatively complex stator core and winding arrangement and the inherently poor servo characteristics of induction motors. The first topology has been presented in [7], and it is shown in Figure 2. The external surface of the rotor can be slotted (left picture) or smooth (right picture). In

case of a smooth rotor, the winding is a thin, conducting layer of copper or other diamagnetic material. Rods made of diamagnetic, conducting materials, create a winding in case of slotted rotor.

The rotor may be situated in the centre of the stator in such a way that distances between the rotor's surface and the stator are constant in the polar directions, or the rotor could even roll on the internal surface of the armature. The armature should have diametrically opposite pairs of coils. They are connected in series, so that when one of them acts as a North pole, the other acts as a South pole. To cause rotation of the rotor around one of its polar axis, an armature should have additional elements, which can produce migration and rotation of the field around the polar axis. These elements can be additional armatures or modular magnetic circuits with double slot-tooth structure. The presented three-phase spherical induction motor has four symmetric situated modular exciters, with six slots each. The air gap radius is 50 mm and the outer stator radius 80 mm. The air gap is 0.4 mm. An interesting idea has been cited in [8] about filling the gap of spherical machines with ferrofluids.

A numerical model testing this idea is presented in [9]. The main purpose of ferrofluids in terms of electric effects is to fill air gaps in magnetic circuits in order to increase the permeability in the gap to reduce the magnetic resistance in the circuit. This leads to a decrease of the magnetizing current and an increase of the efficiency. First 10 results from theoretical studies show that the magnetic resistance using a ferrofluid is reduced by about 10%, if the solid magnetic materials are taken into account. However, no experimental results have been reported.

Analytical and finite element modeling proved that massive rotor's performances are much worse comparing to the rotor with an internal layer composed of iron and an external layer created of copper. However, for the rotor with teeth, not only the electromechanical conversion is better, but also the maximal torque produced is higher, around 20% more than option b) and 40% more than option).

The distribution of the teeth in the rotor has to be as regular as possible in order to ensure torque isotropy. The most uniform distribution on a sphere is defined by the vertices of a regular icosahedrons, i.e. formed of identical equilateral triangles, inscribed in this sphere. Additional vertices and face number were created by tessellation, which consists in adding new vertices in the center of each face of the considered solid.

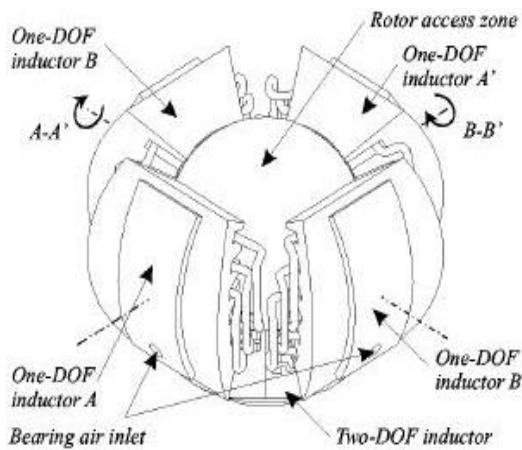


Figure 2 Spherical induction motor

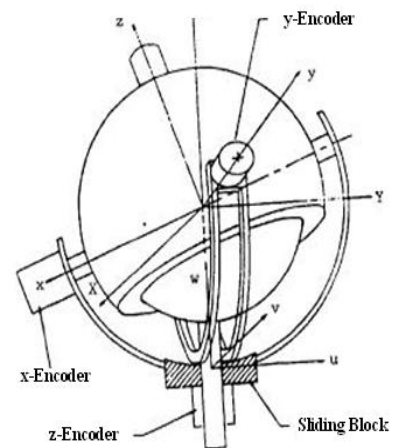


Figure 3 Basic structure of the VR spherical motor

IV. RELUCTANCE MACHINES

The 3-DOF spherical motor presented in [13] operates on the principle of variable - reluctance (VR). The machine consists of two spheres as shown in Figure 3. These two spheres are concentric and are supported one on the other by bearing rollers in the gap. The stator poles are wound by coils and each coil can be energized individually. The ferromagnetic poles are strategically distributed on the stator surface.

The rotor poles which have no coil are distributed on the rotor surface. Both the stator poles and the rotor poles are of circular shape. The measurement mechanism of the rotor orientation consists of two circular sliding guides one sliding block, and three encoders. For simplicity in motion control, it is desired that the poles are evenly spaced on the stator and on the rotor following the pattern of regular polyhedrons.

Each vertex of the polyhedron corresponds to the location of one pole. The regular polyhedrons are tetrahedron (4), octahedron (6), cube (8), icosahedrons (12), and dodecahedron (20). The choice on the particular pattern influences the range of inclination. To provide 3-DOF motion, at least two independent torques which are not collinear acting on the rotor are required. Thus, it is necessary to have more stator poles than rotor poles. The mismatch is also necessary to avoid electro-magnetic singularities, when all the stator and rotor poles are fully overlapped.

The kinematic analysis of the spherical wrist actuator and an exact relationship of the overlapping area in three dimensional spaces is derived analytically. In general, a VR motor has a relatively large range of motion, possesses isotropic properties in motion, and is relatively simple and compact in design. The trade-off however, is that a sophisticated control scheme is required. An air bearing for this kind of machine was analyzed in [14]. The air bearing is essentially a regulator that tends to maintain the rotor at its equilibrium position.

It is clean and has a cooling effect on interacting components, and does not interfere with the actuator electromagnetic system. The air bearing is characterized by three distinct flow regions; namely the restrictor, air pocket, and the annulus. Air enters the bearing from a pressure source, passes through the restrictor, flows through the annulus and then exhausts to the atmosphere. To maintain the rotor in equilibrium at the stator center, the air bearings are designed to direct their forces at the vertices of polyhedrons towards the stator center. Thus, once the bearing locations are specified, the directions of the bearing forces are considered known. Theoretically, the minimum number of simple point bearings required to achieve bi-directional position control of the spherical rotor in a three-dimensional space is four.

Another attractive approach to the air bearing concept, is to design a compound unit so that pressurized air passes through the center of the electromagnetic pole enabling it to also serve as a bearing.

The advantages of a compound unit are twofold:

- The air-jet will provide cooling effect to the electromagnetic pole coil windings.
- The design will optimize the stator surface by maximizing the size of each bearing, thereby enhancing load-bearing capacity. The results indicate that the magnetic disturbance is adequately compensated by the air-bearing system since the force has little impact on the air bearing. Another attractive approach to the air bearing concept, is to design a compound unit so that pressurized air passes through the center of the electromagnetic pole enabling it to also serve as a bearing.

The advantages of a compound unit are twofold:

- The air-jet will provide cooling effect to the electromagnetic pole coil windings.
- The design will optimize the stator surface by maximizing the size of each bearing, thereby enhancing load-bearing capacity. The detailed kinematics of air bearings are analytically described in the paper, and evaluated by simulation. The results indicate that the magnetic disturbance is adequately compensated by the air-bearing system since the force has little impact on the air bearing.

V. OTHER 2-DOF TOPOLOGIES

Some other topologies have been found for 2-DOF actuators that are worth including in the survey. The spherical direct drive actuator consists on a constant magnet rotor fastened in gimbals and located between two pairs of crossed solenoids. The windings of each pair of solenoids are located in alignment and are connected in phase for a mechanical moment magnification enclosed on a magnet rotor. Such disposition of the windings allows, in the first approximation, to neglect their mutual influence and mutual induction. Position is measured by means of four Hall sensors, and a control system is used to excite the adequate coils depending on the position error.

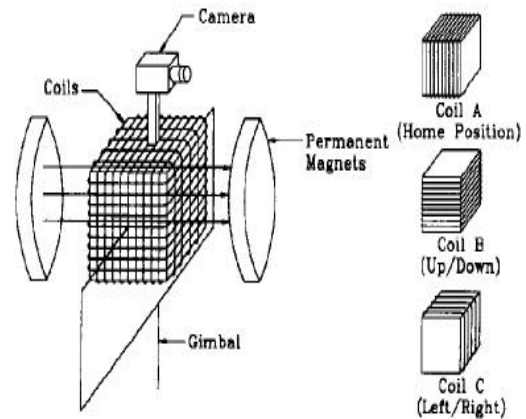


Figure 4 Picture of Bederson's pointing motor principle.

The motor consists of three orthogonal motor windings in a permanent magnetic field, configured to move a small camera mounted on a gimbals, see Figure 4. It is an absolute positioning device and is run open-loop. The basic principle is to orient a permanent magnet to the magnetic field induced by three orthogonal motor windings by applying the appropriate ratio of currents to the three coils. Coils A and B control the tilting, while coils A and C control the panning.

The position of the rotor can be calculated given the currents applied to the three coils. However, due to manufacturing tolerances, the calculated currents give only an approximation to the actual position of the motor. Therefore the motor had to be calibrated to associate motor positions with the related set of currents that move the motor to these positions. An open-loop controller was implemented successfully, but for higher performance a velocity or position sensor could be added to run the motor with a closed-loop control strategy.

The prototype is 4x5x6 cm, weights 160 gram and is capable of actuating a 15 gram load. Its total workspace is approximately 60°. The position of the motor could be achieved in steps no smaller than 0.011°.

VI. CONCLUSION

Advances in robotics, office automation and intelligent flexible manufacturing and assembly systems have necessitated the development of precision actuation systems with multiple degrees of freedom (DOF). In general, however, motion with several DOF is currently realized almost exclusively by using a separate motor/actuator for each axis, which results in complicated transmission systems and relatively heavy structures. This inevitably compromises the dynamic performance, owing to the effects of inertia, backlash, nonlinear friction and elastic deformation of gears, for example. Actuators which are capable of controlled motion in two or more degrees of freedom can alleviate these problems, while being lighter and more efficient. A particular interesting configuration to perform these tasks is the spherical machine.

REFERENCES

- [1] K. Kahlen, I. Voss, C. Priebe and R.W. De Doncker, "Torque control of a spherical machine with variable pole pitch", IEEE Trans. Power Electron., Vol. 19, No. 6, pp. 1628-1634, 2004.
- [2] K. Kahlen and R.W. De Doncker, "Current regulators for multi-phase permanent magnet spherical machines", IEEE Industry Applications Conf. Rec., 2000, Vol. 3, pp. 2011-2016.
- [3] W. Wang, J. Wang, G.W. Jewell and D. Howe, "Design and control of a novel spherical permanent magnet actuator with three degrees of freedom", IEEE Trans. Mechatronics., Vol. 8, No. 4, pp. 457-468, 2003.
- [4] J. Wang, G.W. Jewell and D. Howe, "Analysis, design and control of a novel spherical permanent -magnet actuator", IEE Proc.- Electr. Power Appl., Vol. 145, No. 1, pp. 61-71, 1998.
- [5] J. K. Mitchell, G. W. Jewell, J. Wang, C.M. Bingham and D. Howe, "Influence of an aperture on the performance of a two-degree-of freedom iron-cored spherical permanent-magnet actuator", IEEE Trans. Magnetics. Vol. 38, No. 6, pp. 3650- 3653, 2002.
- [6] Z.Q. Zhu and D. Howe, "Halbach permanent magnet machines and applications: a review", IEE Proc. - Electr. Power Appl., Vol. 148, No. 4, pp. 299-308, 2001.
- [7] G. Kaminski and A. Smak, "Induction motors with spherical rotor", ICEM'04 Conf.Proc., Sept. 2004, Cracow, Poland, 4 pp.
- [8] D. Spalek and K. Waleczek, "Spherical induction motor with ferrofluids in gap", ICEM'04 Conf. Proc., Sept. 2004, Cracow, Poland, 6 pp.
- [9] A. Nethe, T. Scholz, H.D. Stahlmann and M. Filtz, "Ferro fluids in electric motors –A numerical process model", IEEE Trans. Magnetics. Vol. 38, No. 2, pp. 1177-1180, 2002.
- [10] G. Galary, B. Dehez and D. Grenier, "Finite element modeling of a two-degree of freedom spherical actuator", ICEM'04 Conf. Proc., Sept. 2004, Cracow, Poland, 6 pp.
- [11] S.M. Sokolov, O.V. Trifonov and V.S. Yaroshevsky, "Research of spherical direct drive actuators control systems", IEEE Int. Conf. on Robotics & Automation, May 2001, Seoul, Korea, 6 pp.
- [12] B.B. Bederson, R.S. Wallace and E.L. Schwartz, "A miniature pan-tilt actuator: the spherical pointing motor", IEEE Trans. Robotics & Automation, Vol. 10, No. 3, pp. 298-308, 1994.
- [13] K.M. Lee and J. Pei, "Kinematic analysis of a three degree-of-freedom spherical wrist actuator", Fifth Int. Conf. On Advanced Robotics, Atlanta, USA pp. 72-77, 1991.
- [14] D.E. Ezenekwe and K.M. Lee, "Design of air bearing system for fine motion application of multi-DOF spherical actuators", IEEE Int. Conf. on Advanced Intelligent Mechatronics, Sept. 1999, Atlanta, USA, 7 pp.



**PRATIBHA : INTERNATIONAL JOURNAL OF SCIENCE,
SPIRITUALITY, BUSINESS & TECHNOLOGY (IJSSBT)**

Vol.1, No.2, February 2013

ISSN (Print) : 2277-7261

ISSN (on-line) : 2278-3857

[http : www.ijssbt.org](http://www.ijssbt.org)



SHRAM SADHANA BOMBAY TRUST's
**COLLEGE OF ENGINEERING & TECHNOLOGY,
BAMBHORI, JALGAON (INDIA)**



ISSN 2277-7261