

# NETWORK PARAMETERS PERFORMANCE EVALUATION & SIMULATION FOR NOC ARCHITECTURE

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## ABSTRACT

*Network on Chip (NoC) architecture attempts to address different component level architectures with specific interconnection network topologies and routing techniques, some of the topologies are CLICHE, Folded Torus, BFT. Only one distance vector routing used for different topologies. The work has not done with one routing for (CLICHE, Folded Torus and BFT) topologies. In this project we proposed link state routing and compares (CLICHE, Folded Torus, BFT) NoC architectures to evaluate their performance using a simulating tool NS-2. Simulation provides relationship among latency, throughput and packet drop probability for NoC architectures. Best one topology can be identifying by comparing various parameters.*

**Keywords-*Network on Chip, Different Topologies and topology parameter.***

## I. INTRODUCTION

Network on Chip (NoC) is one solution for designing communication among components in the SoC circuits with several billion transistors that will reach the market in approximately 5-10 years from now. Different topologies having various advantages according to their applications. This paper present brief idea about topologies depending on parameter. solutions to overcome performance limitations in NoCs are yet to be presented. Many topologies with different capabilities have been proposed for NoCs including Mesh [8], Torus [3], Octagon [4], SPIN [4], and BFT [7].Some of the topologies for NoC are Mesh ,Folded Torus, and Butterfly Fat Tree (BFT), which are discussed below.

The following are the list of popular NoC architectures: (i)CLICHE architecture, (ii)Folded torus architecture, (iii)Butterfly fat tree architecture.

**CLICHE:** All switches are connected to the four closest switches and the target resource block, except those on the edge of the layout. The simplicity of such a mesh architectural layout allows for the division of the chip into processing or resource regions.

**Folded Torus:** In torus architecture the long wrap around connection may result in excessive delay & this problem can be avoided by folding the torus.

BFT (Butterfly fat tree): The layout is modeled in the form of a tree. Each node in the tree is represented by a set of coordinates (level, position) where level is the level in the tree and position is the spot in right-to left-ordering. Each switch is allocated two parent ports, and four child ports, or connections.

In this project we compare the performance parameters of topology networks and evaluation of these parameters using NS2 simulator.

## II. NoC TOPOLOGIES

Network topology refers to the shape of the network. The different nodes in a network are connected to each other and how they communicate are determined by the network's topology.

Mesh topology are of two types. They are full mesh and partial mesh. Full mesh, that a node is connected to every other node in the network; this is a very costly method and mostly used to connect buses. Partial mesh means that a node doesn't have to be directly connected to all other nodes. This type of mesh is not as costly as full mesh, but the disadvantage is less redundancy.

Torus is a topology, which is similar to the 2D-array in which nodes form a regular cyclic 2- dimensional grid. Here all routers have four connections since a torus basically is a mesh with wrap-around on the edges.

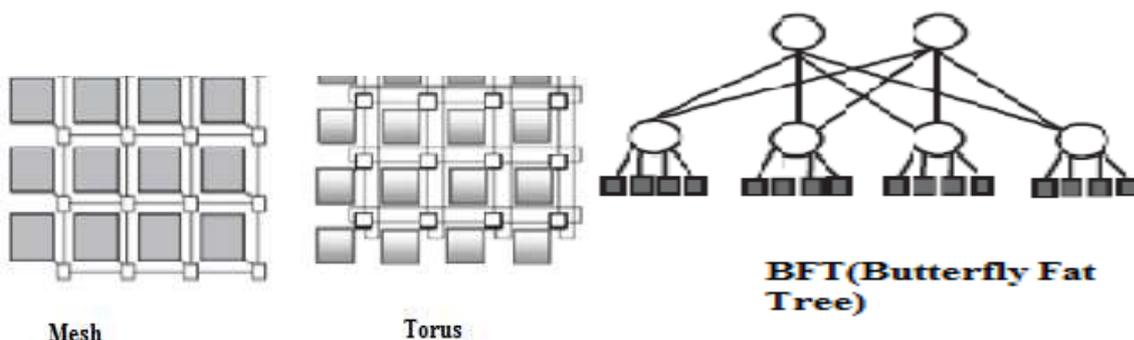
Star topology uses a central hub to which all resources are connected. All communication between resources is then passed through the central hub. Ring topology when the resources are connected to each other in a ring.

Every resource is then connected to its two neighbors communication with other resources then has to pass through the neighbors'. Bus topology means that several resources use the same communication channel.

Octagon Topology is one of the type of ring topology. It consists of several eight paths so it is called as octagon.

Binary Tree Topology(BFT) has a central root node that is connected to one or more nodes of a lower hierarchy.

In a symmetrical hierarchy, each node in the network has a specific fixed number of nodes connected to those at a lower level. Scalable, Programmable, Integrated Network (SPIN) architecture. This architecture implements the topology similar to Butterfly Fat Tree Topology with some changes. In this topology router in each level consists of same number of parent ports and child ports. This type of topological structure provides higher throughput compared with Butterfly Fat Tree Topology.



### III. LITERATURE REVIEW

Wang Zhang, Ligang Hou, Lei Zuo, Zhenyu Peng, Wuchen Wu. have described the performance of architecture is evaluated based on metrics of latency and throughput per channel under Constant Bit Rate (CBR) and Bursty traffic.

The proposed architecture is 2 dimensional mesh topology and designed with Odd-Even (OE) routing algorithm. The simulation result is that the proposed architecture achieves balanced performance of latency and throughput under CBR and Bursty traffic. [1]

Saad Mubeen<sup>1,2</sup> and Shashi Kumar<sup>1</sup> have discussed two routing algorithms (Source routing and distributed routing) are used for 2 dimensional mesh topology. Evaluation results show that source routing gives higher latency and throughput performance as compared to corresponding distributed routing. [2]

Minghua Tang<sup>1</sup>, Chunhui have described a methodology based on divide conquer strategy to design routing algorithms for mesh NoC. they obtain 266 routings which outperform OE routing in transpose traffic. The plentiful routings increase the available research material of routing objects. The new routing algorithm can decrease the average packet delay up to 54.5% than the Odd-Even turn model. [3]

Lalit Kishore Arora, Rajkumar have analyze the packet loss during the link down in mesh interconnection network topology with source routing using simulation. They have analyzed 2D Mesh performance on the one down link for one second, and they have changed two parameters packet size and time interval and found that the ratio of packet loss on CBR traffic generator over UDP agent is constant in both cases. [4]

Pratiksha Gehlot, Shailesh Singh Chouhan have compared five different topologies using distance vector routing algorithm. The SPIN and Octagon providing higher throughput and lower latency but it also has much higher drop probability which gives trade-off between low latency, high throughput and drop probability. BFT has lowest drop probability but also has lowest throughput.

In CLICHÉ (mesh) and Folded Torus has moderate value all parameters so here again a trade-off between latency, throughput and drop probability. [5]

Jie Cen and Cheng Li, Paul Gillared have described a simulation framework for mesh interconnection network has been designed, where the packet loss during the link down has been analyzed. Analysis and evaluation has been done on mesh interconnection networks on different traffic patterns using simulation on NS2. [6]

### IV. NS-2 NETWORK SIMULATOR

NS-2 is an object-oriented, discrete event driven network simulator developed at UC Berkely and written in C++ and OTcl. NS-2 is a very common tool used for simulating local and wide area networks. It implements network protocols such as TCP and UDP; traffic source behavior such as FTP, Telnet, Web, CBR and VBR; router queue management mechanism such as Drop Tail, RED and CBQ; routing algorithms such as Dijkstra, and a lot more.

NS-2 also implements multicasting and some of the MAC layer protocols for LAN simulations. The simulator is open source, hence, allowing anyone and everyone to make changes to the existing code, besides adding new protocols and functionalities to it. This makes it very popular among the networking community which can

easily evaluate the functionality of their new proposed and novel designs for network research. The simulator is developed in two languages: C++ and OTcl1. C++ is used for detailed implementations of protocols like TCP or any customized ones.

TCL scripting, on the other hand, is the front-end interpreter for NS-2 used for constructing commands and configuration interfaces. For example, if you want to develop a new routing protocol, you have to write it in C++ and add it into the NS-2 library. In order to check the functionality of this protocol, you use TCL scripting through which you can create the required topology, define parameters for links and nodes, and perform simulations to realize your own protocol in action. Besides above-mentioned functionality of NS-2, a Network AniMator (NAM) is also provided with NS-2 in order to visualize and interact with the system at run-time. Finally, graphs can be created from the produced results to evaluate and analyze the performance of the system.

Following evaluation parameters has been selected for performance evaluation of Network on Chip architectures

**4.1. Throughput:** It is the rate at which a network sends or receives data or amount of data that is transferred over a period of time. It is measure of the channel capacity of a communications link, and connections .

(Number of IP) x (Total Time) TP  $\square \square$  (Total messages completed) x (Message Length) Where total messages completed refers to the number of whole messages that successfully arrive at their destination

IPs, Message length is measured in flits, Number of IP blocks is the total number of IP blocks present in the system, Total

time is the time (in clock cycles) that elapses between the occurrence of the first message generation and the last message reception.

**4.2. Latency:** In a network latency is a synonym fort time delay along a path. It define as how much time it takes for a packet

of data to get from source to destination and say that latency measures the amount of time between the start of an action and its completion . Latency can be affected by interconnecting devices. it is fundamental measures of network performance.

**4.3. Drop probability:** Drop Probability is the probability of number of packets dropped. A Drop Probability has 0 value means that a packet will never be dropped, and value 100 signifies that all packets will be dropped . The drop probability is very sensitive to communication load. As the communication load increases the drop probability or say number of dropped packet is also increases.

## V. OBJECTIVES

To evaluate performance of link state routing algorithm. To reduce the packet drop probability, we use encryption decryption method.

To evaluate the performance the parameters like maximum throughput, minimum latency, maximum packet delivery and minimum packet drop probability of NOC architecture.

To identify the best topology comparing three topologies with parameters latency, throughput and packet drop probability.

We will observe the effects of topological design choices on performance evaluation. We have Proposed encryption decryption method to reduce the packet drop probability (Due to noise or attack of the packet , more packets loss).We will Compare the following parameter of topologies (CLICHÉ, Folded Torus, BFT)

- 1) Latency
- 2) Throughput
- 3) Packet drop probability

The simulation will be done using Network Simulator NS-2, which is an open source simulation tool that runs on Linux or windows. We have proposed the link state routing algorithm & encryption decryption method which improve the performance. Our proposed work is to comparative study of various topologies in terms of average network delay. And comparing all the topologies according to the delay parameter.

## VI. CONCLUSION

In the previous work they were using various topologies such as mesh, torus, BFT etc. and compare with different parameters such as delay, area, throughput. Investigation of performance of CLICHE, Folded Torus, BFT topologies for various figure of merits (latency, throughput and packet drop probability) has been summarized. This comparison give interesting performance of parameters with trade offs. The BFT has lowest drop probability but also has lowest throughput. CLICHÉ and Folded Torus has moderate value of all parameters. So here again a trade-off between latency, throughput and drop probability. If higher throughput and lower latency is a criterion, it is proposed to evaluate performance by using link state routing algorithm for all topologies(CLICH, Folded Torus, BFT).

## REFERENCES

- [1] Wang Zhang, Ligang Hou, Lei Zuo, Zhenyu Peng,” A Network on Chip Architecture and Performance Evaluation” Wuchen Wu.2010 Second International Conference on Networks Security, Wireless Communications and Trusted Computing
- [2] Saad Mubeen<sup>1,2</sup> and Shashi Kumar,” Designing Efficient Source Routing for Mesh Topology Network on Chip Platforms“2010 13th Euromicro Conference on Digital System Design: Architectures, Methods and Tools
- [3] Minghua Tang<sup>1</sup>, Chunhui, “A New Method of Designing NoC Routing Algorithm”2012 IEEE
- [4] Lalit Kishore Arora, Rajkumar, “Simulation and Analysis of Packet loss in Mesh Interconnection Networks” National Conference on Development of Reliable Information Systems, Techniques and Related Issues (DRISTI) 2012 Proceedings published in International Journal of Computer Applications® (IJCA)
- [5] Pratiksha Gehlot,Shailesh singh Chouhan, “Performance evaluation of network on chip architecture” ‘2009 International Conference on Emerging Trends in Electronic and photonic devices & Systems(ELECTRO-2009)

- [6] Simulation and Analysis of Packet loss in Mesh Interconnection Network with Source Routing, International Journal of Advanced Research in Computer Science and Software Engineering Volume 2, Issue 6, June 2012 .
- [7] A Comparative Study of Different Topologies for Network-On-Chip Architecture International Journal of Computer Applications (0975 – 8887) “Recent Trends in Engineering Technology-2013
- [8], Partha Pratim Pande, Cristian Grecu, Michael Jones, Andre’ Ivanov, and Resve Saleh, “Performance Evaluation and Design Trade-Offs for Network-on-Chip Interconnect Architectures” IEEE2005
- [9] A Delay-Aware Topology-based Design for Network-on-chip Applications By Haytham Elmiligi, Ahmed A. Morgan, M. Watheq El-Kharashi, Fayez Gebali. IEEE transaction, 2009.
- [10] M. Mirza-Aghatabar<sup>+</sup>, S. Koochi<sup>+</sup>, S. Hessabi<sup>\*</sup>, M. Pedram<sup>†</sup>,” An Empirical Investigation of Mesh and Torus NoC Topologies Under Different Routing Algorithms and Traffic Models”, IEEE International Conference on Digital System DSD 2007.
- [11] L. Benini and D. Micheli, Networks on Chips: A New SoC Paradigm, IEEE Computer, 35 p.70 (2002).
- [12] B. H. Meyer, J.J. Pieper, J.M. Paul, J.E. Nelson, S. M. Pieper and A.G. Rowe, “Power-performance simulation and design strategies for single-chip heterogeneous multiprocessors,” IEEE transactions on Computers, vol.54, no. 6, pp.684-697, Jun 2005.
- [13] M. Palesi, R. Holsmark, S. Kumar, and V. Catania, “ Application specific routing algorithms for network on chip,” IEEE Transactions on Parallel and Distributed Systems, vol. 20, no3 pp. 316-339, 2009.
- [14] Khalid Latif, Tiberiu Seceleanu, Hannu Tenhunen, Power and Area Efficient Design of Network-on-Chip Router Through Utilization of Idle Buffers.
- [15] M. Nickray, M. Dehyadgari, and A. Afzali-kusha, “Power and Delay optimization for network on chip,” in Proceedings of the 2005 European Conference on Circuit Theory and Designs, Cork, Ireland, Aug-28-2 Sept. 2005, pp. 273-276.
- [16] T. Bjerregaard and K. Mahadevan, “ A survey of research and practices of network-on-chip,” ACM Computing Surveys, vol. 38

# A MULTICRITERIA APPROACH TO EVALUATE OFFSHORE WIND FARMS IN TAMILNADU COASTAL REGION

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## ABSTRACT

Wind energy offers significant potential for greenhouse gas emissions reductions. Most applications have been developed onshore but the planning and siting conflicts with other land uses have created considerable interest and motivated research to offshore wind energy establishments. As per Lawrence Berkeley National Laboratory & WISE (World Institute of Science & Environment) reports, the offshore potential in India is estimated more than 100 GW. The coastal regions along Tamil Nadu is having very high potential in wind energy with net Capacity Utilization factor (CUF) of over 40% and wind power density of over 700 w/m<sup>2</sup> at many locations. In this study, a systematic process is carried out in order to investigate the most feasible region among 21 islands in Gulf of Mannar for implementing the offshore wind farms. This can be achieved, by considering 4 criteria's like wind velocity, distance from shore, ship route distance and depth of the sea by using relative importance method.

**Keywords:** Capacity Utilization Factor, World Institute of Sustainable Energy

## 1. INTRODUCTION

Worldwide, wind energy is accepted as one of the most developed, cost-effective and proven renewable energy to meet increasing electricity demands in a sustainable manner. While onshore wind energy technologies have reached to a stage of mass deployment and have become competitive with fossil fuel based electricity generation with supportive policy regimes across the world, exploitation of offshore wind energy is yet to reach a comparable scale.

About 5 GW offshore wind capacity has already been installed around the world and approximately an equal capacity is under construction. There are a large number of offshore wind farms in Belgium, Denmark, Finland, Germany, Ireland, Netherlands, Norway, Sweden, and United Kingdom. The European Union has established aggressive targets to install 40 GW of offshore wind by 2020 and 150 GW by 2030. It is estimated that by 2030, the installed capacity could reach 191 GW globally. Developing countries have more than 1/3<sup>rd</sup> global wind power capacity. In India - onshore wind energy deployment has crossed 19600 MW - attracted \$16.5 billion of

investment in 2012, created 179,000 'green collar' jobs in manufacturing, project development, installation, operation, maintenance, consulting etc., saving 131 million tons CO<sub>2</sub>/year. Centre for Wind Energy Technology (CWET) has reassessed India's onshore wind power potential as 102,778 MW (at 80 meters height and 2% land availability).

Technology for offshore turbines same as that of onshore turbines and their operational life also same (~ 20 years). The rated capacity of turbines higher than that of onshore - in range of 3 MW-5 MW. Off shore wind farms in water depths from 0.8 to 220m with monopole, jacket, tripod and floating technologies. At different depths, turbine installations require different type of bases for stability. Mono pile base is used for water up to 30 m depth, whereas turbines installed on tripod or steel jacket base for 20-80 m depths.

## II. GLOBAL SCENARIO OF OFFSHORE WIND TURBINES

### 2.1 Introduction on Offshore and Onshore Structures

2.1.1 Offshore structure: The structures and facilities installed in a marine environment for the production and transmission of electricity, oil, gas & other resources

2.1.2 Offshore wind turbine: Refers to the construction of wind farm in bodies of water to generate electricity from wind. Better wind speeds are available in offshore compared to on shore, so offshore wind power's contribution in terms of electricity supplied is higher.

2.1.3. Onshore structure: The structure & facilities install from the sea towards the land.

2.1.4. Onshore wind turbine: It refers to wind turbines located on land to generate electricity.

2.1.5. Advantages of offshore wind farm over onshore wind farm:

- Wind velocity in offshore is more than 20m/s and can reach as much as 50m/s where as in onshore limited (11 to 15m/s).
- Availability of free area for the installation of wind farm.
- Offshore wind velocity is higher & steadier in deep waters.
- Continuous availability of wind in offshore and extraction of energy is more efficient.
- Low Noise Pollution and Visual Intrusion.
- Most of the potential onshore sites already utilized.

2. 1.6. Evolution of offshore wind projects:

First Offshore Wind Turbine – Sweden (1990)

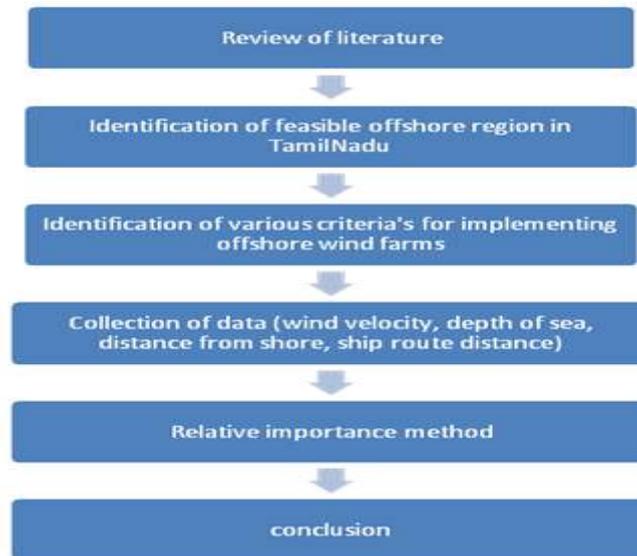
- 220 kW – Single, 250m from the coast@ 7m Water Depth Supported on Tripod

First Offshore Wind Farm – Denmark (1991)

- 450 kW – 11 Turbines, 1.5 – 3 km from coast@ 2-6 m Water Depth Gravity Foundation.
- Global Installed Capacity - 5.5 GW
- India is blessed with coastline of about 7600 Km. There are 3 zones located in Indian coastal lines. They are EEZ, pollution prevention zone, continuous zone & territorial zone. The EEZ lies 200 nautical miles from the base line of the shore, territorial zone lies 12 nautical miles from the base line of the shore and continuous zone lies 12 nautical miles from the base line of the territorial zone.



### III. EXPERIMENTAL WORK



**Fig.4. Methodology**

The 4 criteria's are consider for implementing the offshore wind farm are studied from the review of literature, the criteria's as follows.

**Table.1. Four Criteria Selection**

Criteria's	Types	Description
Average wind velocity (m/s)	Quantitative	Average wind velocity
Depth of sea (m)	Quantitative	Average depth
Distance from shore(km)	Quantitative	Average islands distance from the shore
Distance to ship route (km)	Qualitative	Average distance of the ship route from the shore

### IV IDENTIFICATION OF FEASIBLE OFFSHORE REGION IN TAMIL NADU

The Gulf of Mannar is the region among the Tamil Nadu coastal regions and is chosen for feasibility study implementation of offshore wind farm.

The Gulf of Mannar lies between India and Sri Lanka. It encompasses the territorial waters of the southeast coast of India, from Dhanushkodi in the north to Kanyakumari in the south. It has a chain of 21 islands, with each island having an area of 0.5 ha minimum and 129 ha maximum.

Islands are located 2 to 10 km from the mainland along the 140 km stretch between Tuticorin and Rameswaram (Lat $8^{\circ}55'-9^{\circ}15'N$  and Long  $78^{\circ}0'-79^{\circ}16'E$ ). The Gulf of Mannar Marine Biosphere Reserve came into existence on 18th February 1989 by a joint declaration of Government of India and Government of Tamil Nadu. The purpose of the marine park is to create awareness on Conservation and management of the marine resources in a scientific manner so that there will be proper socioeconomic development in the region.

The aim of the park is to promote judicious and optimal utilization of the resources for research, education and recreational purposes following appropriate ecological principles. The depth of the Gulf of Mannar beyond the island chain ranges from 3.5 to 15 m with a sudden fall after that giving oceanic condition. There are 21 islands located in Gulf of Mannar region that fall under 4 groups (mandapam group, vember group, keezhakari group and tuticorin group).



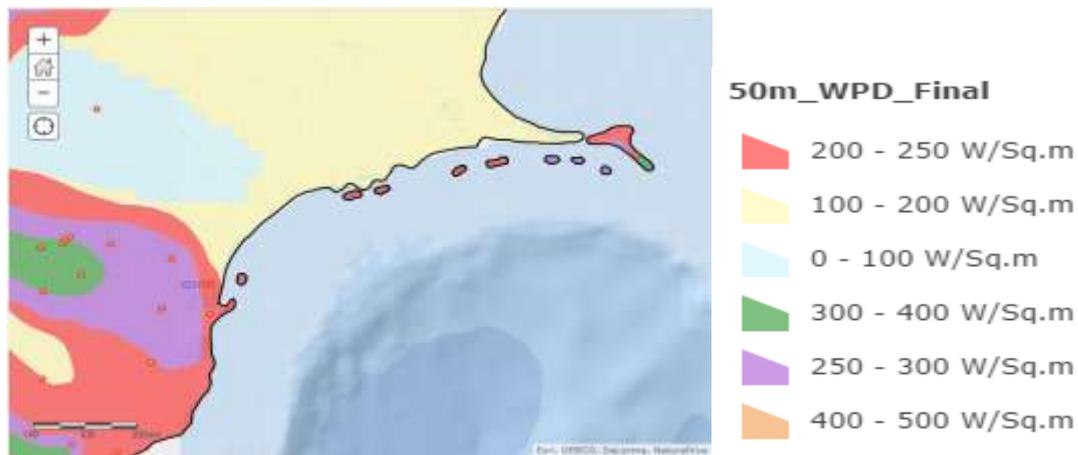
Fig.4. Location of Gulf of Mannar Region in Indian Map



Fig.5. Islands in Gulf of Mannar

## V IDENTIFICATION OF VARIOUS CRITERIAS FOR IMPLEMENTING OFFSHORE WIND FARMS:

### 5.1 Wind Velocity



**Fig 6. Wind velocity on 30.9.14**

Source: National Institute of Wind Energy

The wind power density (WPD) is represented in different color pattern in Tamil Nadu southern coastal map. The highest wind power density is found both in onshore and offshore. The onshore wind power generation reached the enormous growth rate in power generation and hence the wind source found in the offshore are not utilized for power generation despite of initial high cost but output efficiency will be comparatively more when compared to onshore wind power generation. From the fig.3.4 highest offshore wind energy range 250-300 W/sq.m is generated in mandapam group region among four groups.

**5.2 Ship route:** There is no ship passage in-between the 21 islands; hence the region is having shallow depth (3.5m-15m).

### 5.3. Distance of island from shore

**TABLE.2.Distance from shore**

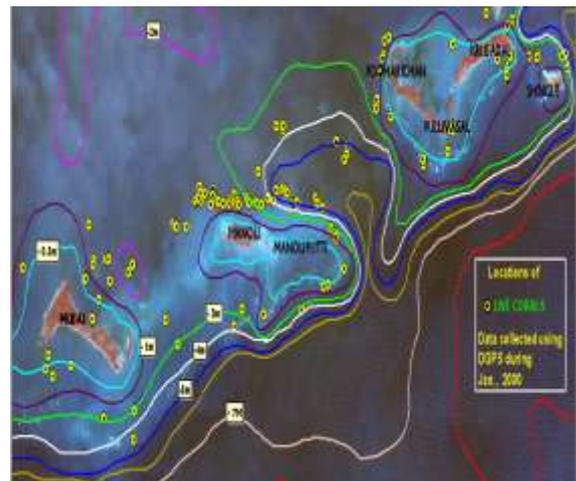
Island	area(ha)	Distance from shore(km)
<b>Mandapam group island</b>		
1. Shingle	12.69	4
2. Krusadai	65.80	3.5
3. Pullivasal	9.95	3

4. Poomarichan	16.58	3
5. Manoli	25.90	5
6. Manoliputti	02.34	5
7. Musal	129.04	7
<b>Keezhakarai Group island</b>		
8. Mulli	10.20	10
9. Valai	10.15	9
10. Talairi	75.15	9
11. Appa	28.63	8
12. Poovarasampatti	0.25	8
13. Valimunai	6.72	8
14. Anaipar	11.00	9
<b>Vembar Group island</b>		
15. Nallathanni	110.0	10
16. Pulivinichalli	6.12	8
17. Upputhanni	29.94	8
<b>Tuticorin group Island</b>		
18. Karaichalli	16.46	15
19.- Vilanguchalli	0.95	15
20. Kasuwar	9.50	7
21. Van	6.0	6

The islands in Gulf of Mannar regions are kept as reference point for the study of implementing offshore wind farm. so the distance of the islands are measured from shore. From the above data it has been observed that the mandapam group islands is having shortest distance from the shore when compared with other groups.

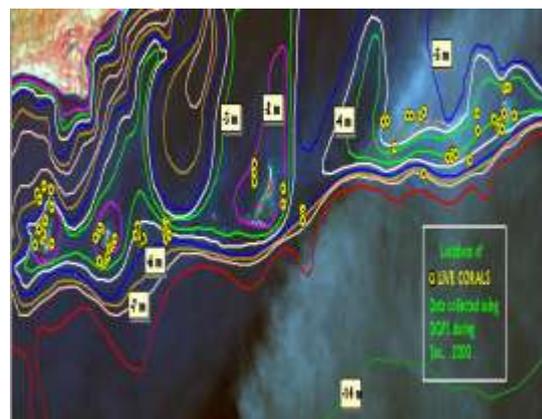
#### **5.4 Depth of Gulf of Mannar regions(From shore to Island )**

The depths of Gulf of Mannar regions are measured from the shore to the islands. The depth of the 4 groups of islands is shown in fig as below.



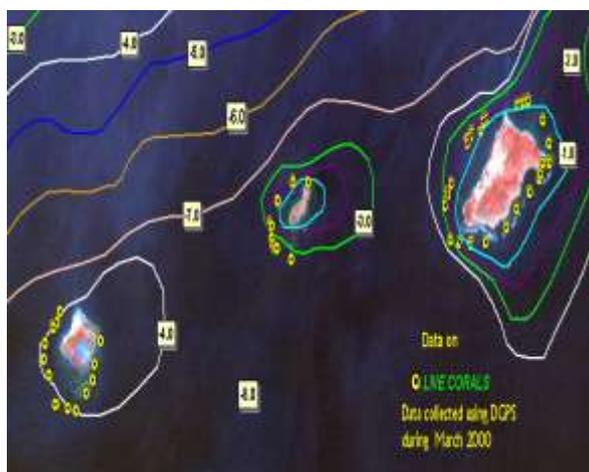
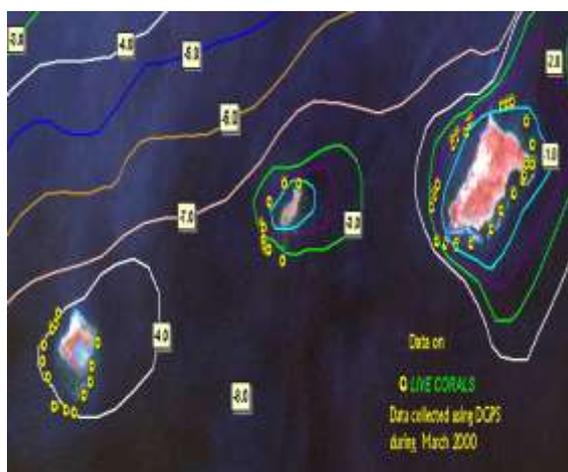
**Fig.7.**Islands in mandapam group    **Fig.8.**contour map indicating the depth of mandapam group islands

Source: *Integrated Coastal and Marine Area Management (ICMAM)*



**Fig.9.**keezhakarai group islands    **Fig.10.** contour map indicating the depth of keezhakarai group islands.

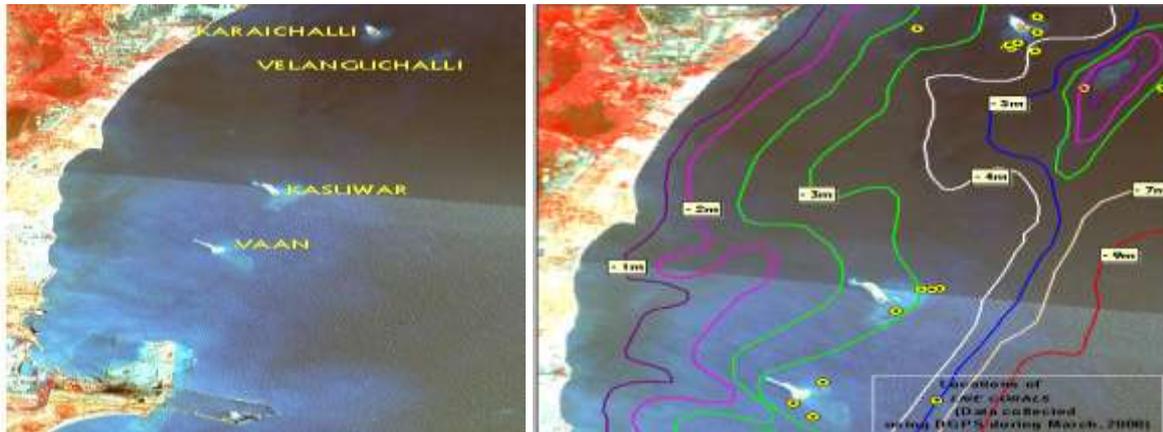
Source: *Integrated Coastal and Marine Area Management (ICMAM)*



**Fig.11.**Vember Group Islands.

**Fig.12.** Contour Map Indicating The Depth Of Vember Group Islands.

Source: Integrated Coastal and Marine Area Management (ICMAM)



**Fig.13.Tuticorin Group Islands Fig.14. Contour Map Indicating the Depth of Tuticorin Group Islands.**

Source: Integrated Coastal and Marine Area Management (ICMAM)

#### VI MULTI CRITERIA RELATIVE IMPORTANCE METHOD:

**TABLE.3.Comparison method for 4 groups by considering 4 criteria's**

Island group	Average wind power density (WPD)	Average distance from shore(KM)	Average depth (m)	Ship route
<b>Mandapam group</b>	<b>250-300</b>	<b>04.35</b>	<b>3.21</b>	<b>No</b>
Keezhakari group	200-250	08.71	5.85	No
Vember group	200-250	08.66	4.30	No
Tuticorin group	200-250	10.75	4.42	No

#### VII CONCLUSION

- The data's of factors were collected and analyzed using comparative method
- The factors influencing on implementation of wind farms in the Gulf of mannar region were identified.
- The mandapam group satisfies all the criteria's (**max wind power density, shortest shore distance, average depth and no ship route**) when compared with other 3 groups and it results in the best region for implementing the offshore wind farm.

- The 7 mandapam group islands are having highest wind power density than the other groups of islands in Gulf of Mannar regions. The average depth of mandapam group regions (3.21m) lesser than the other group

## REFERENCE

- [1] Bilal A. Akash(1998) "Multi-criteria selection of electric power plants using analytical hierarchy process" *Electric Power Systems Research* 52 (1999) 29–35.
- [2] BinduSulochanan, and K.Muniyandi(2005) "Hydro graphic parameters off Gulf of Mannar and Palk Bay during an year of abnormal rainfall" *J.Ma Biol. Ass. India*, 47 (2): 198 – 200 December 2005.
- [3]D.G. Vagona(2012) "A multicriteria approach to evaluate offshore wind farms sitting in Greece" *Global NEST Journal*, Vol 14, No 2, pp 235-243, 2012.
- [4]R. Gowthaman1 and V. Sanil Kumar(2013) "Waves in Gulf of Mannar and Palk Bay around Dhanushkodi, Tamil Nadu, India" *current science*, vol. 104, no. 10, 25 may2013.
- [5] J.k. patterson Edward andG. Mathews(2008)"Status of Coral Reefs of the Gulf of Mannar, South-eastern India".

# LIFETIME MAXIMIZATION STRATEGIES IN WIRELESS SENSOR NETWORK

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## ABSTRACT

Wireless sensor networks consist of small nodes with sensing, computation, and wireless communications capabilities. Goal of the network is to sense the environment and report what occurs in the region it is deployed in. Wireless sensor networks can be used for various applications like Environmental Applications health applications, military applications, Home Applications. Each node has a limited energy supply and in many applications it is not easy to replace the batteries or sometimes not even recharge the batteries. Therefore how to optimize the network lifetime becomes an important problem. According to the research fruit many researchers have contributed. In the paper we give out the survey lifetime maximization strategies in wireless sensor network. In this article we also points out the open research concerns and intends to inspiration innovative interests and developments in this field.

**Keywords:** *Wireless Sensor Networks, Network Lifetime, Energy efficient routing, MAC Protocols, Sleep scheduling, Aggregation, Topology control.*

## I INTRODUCTION

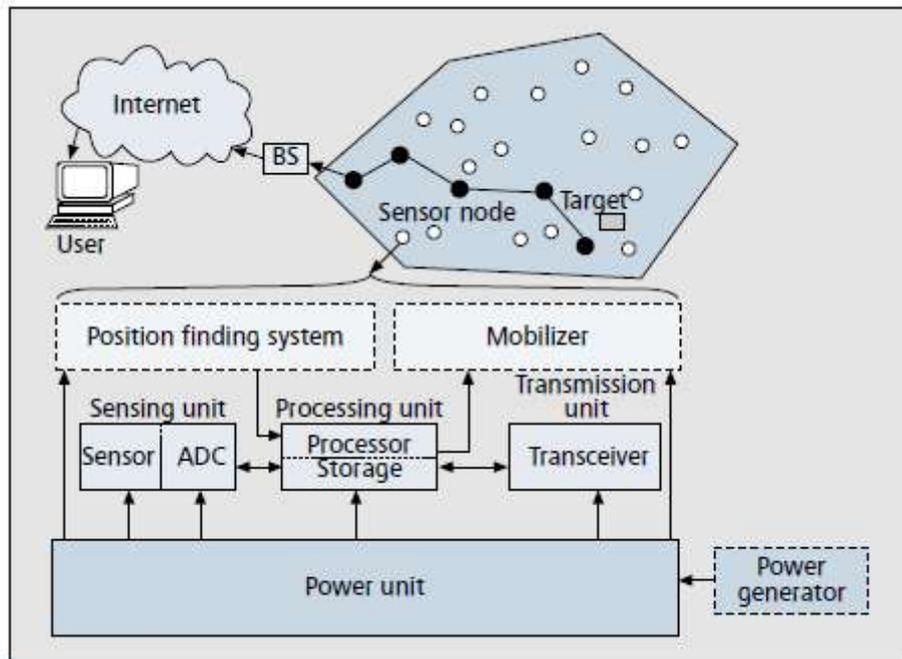
A Wireless Sensor Networks (WSNs) contains hundreds or thousands of sensor nodes. These sensors have the ability to communicate either among each other or directly to an external

Base-station (BS). A greater number of sensors allows for sensing over larger geographical regions with greater accuracy. Sensor nodes coordinate among themselves to produce high-

quality information about the physical environment. Each sensor node bases its decisions on its mission, the information it currently has, and its knowledge of its computing, communication, and energy resources. Each of these scattered sensor nodes has the capability to collect and route data either to other sensors or back to an external base station(s)[1]. Traditionally sensor networks have been employed for monitoring environmental conditions such as temperature, pressure, moisture contents etc. But with technological advances sophisticated sensor nodes are being produced capable of transmitting real-time data (video/images) and critical data (outages/leaks).

A base station may be a fixed node or a mobile node capable of connecting the sensor network to an existing communications infrastructure or to the Internet where a user can have access to the reported data. Figure 1 shows a schematic diagram of sensor node components. Basically, each sensor node comprises sensing,

processing, transmission, mobilizer, position finding system, and power units (some of these components are optional, like the mobilizer). The same figure shows the communication architecture of a WSN. Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed. Sensor nodes coordinate among themselves to produce high-quality information about the physical environment.



■ **Figure 1.** *The components of a sensor node.*

The applications of sensor networks in various fields vary from environment monitoring, military applications to monitoring patients in hospitals [2]. Basically nodes are driven by batteries and in many applications it is not easy to replace the batteries or sometimes not even recharge the batteries so each node has a limited energy supply. Lifetime is very important factor in wireless sensor network.

Definitions of network Lifetime of wireless sensor network can be defined as:

- Definition 1: the period to the first node failure due to battery outage;
- Definition 2: the period to the unapproachability of application functionality.
- Definition 3: the period to the first network partitioning. As soon as the network is no longer connected, vital information can no longer be transferred to its destination.

Due to the energy constrained nature of wireless nodes requires the use of energy efficient strategies to maximize network lifetime. We can classify these strategies in following categories:

- 1) Energy efficient routing
- 2) MAC Protocols with Low Duty Cycle
- 3) Sleep scheduling
- 4) Mobility based schemes
- 5) Reducing the amount of information
- 6) Topology control

This paper is organized as follows. In Section II, we focus on energy efficient routing. In Section III, we present MAC Protocols with low duty cycle. In Section IV, we present solutions allowing nodes to sleep while maintaining network connectivity. In Section V, we present mobility based schemes. In Section VI, we present different strategies whose common goal is to reduce the amount of information transferred. Section VII present topology control scheme that allowing nodes to decrease their transmission power as long as the network remains connected. Section VIII presents the conclusion of the paper.

## II. ENERGY EFFICIENT ROUTING

With the help of energy efficient routing we can minimize the energy consumed by the end-to-end transmission of a packet, to avoid nodes with a low residual energy and reduce the number of unsuccessful transmissions.

### 2.1 Multipath routing

In [3], a multipath routing, energy aware, is proposed to maximize network lifetime. It is a reactive routing protocol triggered by the data sink. It consists in finding all paths between source and destination according to a metric which takes into account 1) the energy consumed by the transmission and reception of the packet and 2) the residual energy of nodes. Paths that have a cost higher than a given threshold are discarded.

### 2.2 Hop-By-Hop Routing Protocols

The second category of energy efficient routing protocols corresponds to adaptive hop-by-hop routing protocols. We can distinguish the families of energy efficient routing protocols:

- the protocols selecting the path consuming the minimum energy. The advantage is that each transmission of a packet from its source to its destination minimizes the energy consumed. We can cite for example [4] and a more sophisticated protocol [5]. This routing protocol computes the additional energy dissipated by one flow when routed on a given path, taking into account the SINR and the energy lost by radio interferences. Then, it uses the Dijkstra algorithm to find the path which minimizes this additional energy.
- the protocols selecting the path visiting the nodes with the highest residual energy. In the paper [6] use the concept of potential in physics to design an energy efficient routing protocol in WSN. They use virtual potential field in terms of depth, energy density, and residual energy and residual energy and develop a scheme that forces packets towards sink through the dense energy area. This helps in conservation of energy of low residual energy nodes.

## III MAC PROTOCOLS WITH LOW DUTY CYLCLE

In the following discussion we will focus mainly on power management issues rather than on channel access methods. Most of them implement a low duty cycle scheme for power management.

### 3.1 TDMA (Time Division Multiple Access)

These schemes naturally enable a duty cycle on sensor nodes as channel access is done on a slot-by-slot basis. As nodes need to turn on their radio only during their own slots, the energy consumption is ideally reduced to the minimum required for transmitting/receiving data. In TDMA-based MAC protocols [7], [8] time is divided in (periodic) frames and each frame consists of a certain number of time slots. Every node is assigned to one or more slots per frame, according to a certain scheduling algorithm, and uses such slots for transmitting/receiving packets to/from other nodes.

### 3.2 Contention-based protocols

They achieve duty cycling by tightly integrating channel access functionalities with a sleep/wakeup scheme. The only difference is that in this case the sleep/wakeup algorithm is not a protocol independent of the MAC protocol, but is tightly coupled with it. One of the most popular contention-based MAC protocols is B-MAC (Berkeley MAC) [9], a low complexity and low power MAC protocol which is shipped with the TinyOS operating system. The goal of B-MAC is to provide a few core functionalities and an energy efficient mechanism for channel access. A well-known MAC protocol for multi-hop sensor networks is S-MAC (Sensor-MAC) [10], which adopts a scheduled rendezvous communication scheme. Nodes exchange sync packets to coordinate their sleep/wakeup periods.

### 3.3 Hybrid Protocols

They behave as a contention-based protocol when the level of contention is low, and switch to a TDMA scheme when the level of contention is high. In wireless sensor networks, one of the most interesting hybrid protocols is Z-MAC [11]. In order to define the main transmission control scheme, Z-MAC starts a preliminary setup phase. By means of the neighbor discovery process each node builds a list of two-hop neighbors. Then a distributed slot assignment algorithm is applied to ensure that any two nodes in the two-hop neighborhood are not assigned to the same slot. As a result, it is guaranteed that no transmission from a node to any of its one-hop neighbor interferes with any transmission from its two-hop neighbors. The local frame exchange is aimed at deciding the time frame procedure.

## IV. SLEEP SCHEDULING

They allow nodes to sleep in order to spare energy, provided that the network and application functionalities are still ensured, A wireless node's radio can be in one of the following states:

- Transmit: node is transmitting a frame with transmission power  $P_{\text{transmit}}$ ;
- Receive: node is receiving a frame with reception power  $P_{\text{receive}}$ .
- Idle (listening): even when no messages are being transmitted over the medium, the nodes stay idle and keep listening the medium with power  $P_{\text{idle}}$ ;
- Sleep: when the radio is turned off and the node is not capable of detecting radio signals: no communication is possible.

As it is wasteful to send a message to a sleeping receiver, it is then needed to coordinate neighbour nodes states. Moreover, sleeping nodes must not inhibit the application functionalities. That is why scheduling node activity is required.

#### **4.1 On-demand**

The basic idea is that a node should wakeup only when another node wants to communicate with it. STEM (Sparse Topology and Energy Management) [12] uses two different radios for wakeup signal and data packet transmissions, respectively. To achieve a tradeoff between energy saving and wakeup latency, [13] proposes a Pipelined Tone Wakeup (PTW) scheme. Like STEM, PTW relies on two different channels for transmitting wakeup signals and packet data, and uses a wakeup tone to awake neighboring nodes. Hence, any node in the neighborhood of the source node will be awakened.

#### **4.2 Scheduled Rendezvous**

The basic idea behind scheduled rendezvous schemes is that each node should wake up at the same time as its neighbors. Typically, nodes wake up according to a wakeup schedule, and remain active for a short time interval to communicate with their neighbors. Then, they go to sleep until the next rendezvous time. The simplest way is using a Fully Synchronized Pattern [14]. In this case all nodes in the network wake up at the same time according to a periodic pattern. More precisely, all nodes wake up periodically every  $T_{wakeup}$ , and remain active for a fixed time  $T_{active}$ . Then, they return to sleep until the next wakeup instant.

#### **4.3 Asynchronous Schemes**

Asynchronous schemes allow each node to wake up independently of the others by guaranteeing that neighbors always have overlapped active periods within a specified number of cycles. Asynchronous wakeup was first introduced with reference to IEEE 802.11 ad hoc networks. Zheng et al. [15] took a systematic approach to design asynchronous wakeup mechanisms for ad hoc networks. Their scheme applies to wireless sensor networks, as well.

### **V. MOBILITY BASED SCHEMES**

#### **5.1 Mobile-Sink-based Approaches**

Many approaches proposed in the literature about sensor networks with mobile sinks (MSs) which is exploited in order to optimize parameters such the network lifetime and so on. For example, in [16] the authors propose a model consisting of a MS which can move to a limited number of locations (sink sites) to visit a given sensor and communicate with it (sensors are supposed to be arranged in a square grid within the sensing area. Two-Tier Data Dissemination (TTDD) [17] is a low-power protocol for efficient data delivery to multiple MSs. Instead of passively waiting for queries coming from sinks, sensor nodes can proactively build a structure to set up forwarding.

## 5.2 Mobile-Relay-based Approaches

One of the most well-known approaches is given by the message ferrying scheme [18]. Message ferries are special mobile nodes which are introduced into a sparse network to offer the service of message relaying. Message ferries move around in the network area and collect data from source nodes. They carry stored data and forward them towards the destination node. Thus, message ferries can be seen as a moving communication infrastructure which accommodates data transfer in sparse wireless networks.

## VI. REDUCE THE AMOUNT OF INFORMATION TRANSFERRED

This energy efficient strategy consists in aggregating information by reducing wasteful transmissions or tuning the refreshment period of control messages (e.g.; neighbourhood discovery, topology dissemination, data gathering tree structure).

### 6.1 Information aggregation

Information aggregation is frequently used in data gathering applications, where it enables high benefits. It can use clustering. 1) With clustering: LEACH (Low-Energy Adaptive Clustering Hierarchy) [19] organizes nodes into clusters with one acting as cluster head which is used as router to the base station. Hence, all members of cluster transmit their data to the cluster head. Then the cluster head aggregates and compresses all the data received and sent it to the base station. The energy consumption of nodes is balanced by means of a randomized rotation of the cluster heads over time. Performance evaluation results show that LEACH reduces communication energy by as much as 8 times compared to direct transmission. Another improved and very popular energy-efficient protocol is HEED (Hybrid Energy- Efficient Distributed Clustering [20]). HEED is a hierarchical, distributed, clustering scheme in which a single-hop communication pattern is retained within each cluster, whereas multi-hop communication is allowed among CHs and the BS. The CH nodes are chosen based on two basic parameters, residual energy and intra cluster communication cost. Residual energy of each node is used to probabilistically choose the initial set of CHs. On the other hand, intra cluster communication cost reflects the node degree or node's proximity to the neighbor and is used by the nodes in deciding to join a cluster or not.

### 6.2 Without clustering

In [21], the MLDA (Maximum Life- time Data Aggregation) problem is to find a data gathering schedule with a maximum lifetime (duration after which a node has exhausted its energy) for the sensor network which allows data aggregation. In each round, an aggregation tree is created, whose root is the data sink. This tree specifies how data will be collected, aggregated and transmitted to the base station (i.e.; the data sink). To resolve this problem, an integer program is presented with a linear relaxation. This centralized protocol improves network lifetime.

## VII. TOPOLOGY CONTROL

These strategies find the optimum node transmission power that minimizes energy consumption, while keeping network connectivity, power, and each node adjusts its power transmission. Thus, energy dissipated in transmission is reduced and a new network topology is created. In [22], the idea is to reduce the transmission range  $d$  of every node to minimize the energy dissipated in transmission,  $E(d) = da + c$ , where  $a$  and  $c$  are physical parameters, while keeping a connected topology. It is shown that there exists an optimal transmission range which minimizes energy consumption. In [23], the TCH (Topology Control with Hitch-hiking) problem is addressed. Hitch-hiking takes advantage of a physical layer that allows combining partial messages containing the same information to decode a complete message. The goal of TCH is to obtain a strongly connected topology minimizing the energy dissipated in transmission. An Adaptive Transmission Power Control (ATPC) is proposed in [24]. The goal of ATPC is to achieve energy efficiency and guarantee link quality between neighbors. ATPC allows each node to know the optimal transmission power level to use for each neighbor while maintaining a good link quality. This power is adjusted adapting to spatial and temporal factors by collecting the link quality history.

## VII. CONCLUSION

In this paper we have surveyed the main approaches to enhance lifetime in wireless sensor networks. Clearly, the highest benefits will be obtained by a solution combining these strategies. Along with the current research projects, we encourage more insight into the problems and intend to motivate a search for solutions to the open research issues described in this article.

## REFERENCES

- [1] I.F. Akyildiz, W. Su, Y.Sankarasubramaniam, and E. Cayirci, "Wireless Sensor Networks: A Survey," IEEE Trans on Computer Networks, vol.38, no. 4, pp. 393-422, 2002.
- [2] J. N. AL-Karaki and A. E. Kamal, "Routing Techniques in Wireless Sensor Networks: A Survey", IEEE Trans on Wireless Communications, vol. 11, no. 6, pp.6-28, Dec. 2004.
- [3] R.C. Shah, J.M. Rabaey, Energy Aware Routing for Low Energy Ad Hoc Sensor Networks, IEEE WCNC, Volume 1, pp. 17-21, March 2002.
- [4] S.-M. Senouci, G. Pujolle, Energy efficient routing in wireless ad hoc networks, IEEE International Conference on Communications (ICC 2004), volume 7, pp. 4057-4061, June 2004.
- [5] S. Kwon, Ness B. Shroff, Energy-Efficient Interference-Based Routing for Multi-hop Wireless Networks, IEEE INFOCOM'2006, Barcelona, Spain, April 2006.
- [6] Fengyuan Ren; Jiao Zhang; Tao He; Chuang Lin; Ren, S.K.D. "EBRP: Energy-Balanced Routing Protocol for Data Gathering in Wireless Sensor Networks" Parallel and Distributed Systems, IEEE Transactions on Vol.22,2011.
- [7] K. Arisha, M. Youssef, M. Younis "Energy-aware TDMA-based MAC for Sensor Networks", Proc. IEEE Workshop on Integrated Management of Power Aware Communications, Computing and Networking (IMPACCT 2002), New York City (USA), May 2002.

- [8] J. Li, G. Lazarou, "A Bit-map-assisted energy-efficient MAC Scheme for Wireless Sensor Networks", Proc. International Symposium on Information Processing in Sensor Networks (IPSN 2004), pp. 56-60, Berkeley (USA), April 2004.
- [9] J. Polastre, J. Hill and D. Culler, "Versatile Low Power Media Access for Sensor Networks", Proc. of the Second ACM Conference on Embedded Networked Sensor Systems, November 3-5, 2004.
- [10] W. Ye, J. Heidemann and D. Estrin, "Medium Access Control With Coordinated Adaptive Sleeping for Wireless Sensor Networks", IEEE/ACM Transactions on Networking, Volume: 12, Issue: 3, Pages: 493-506, June 2004.
- [11] I. Rhee, A. Warrier, M. Aia, J. Min, "Z-MAC: a Hybrid MAC for Wireless Sensor Networks", Proc. ACM SenSys 2005, S Diego (USA), November 2005.
- [12] C. Schurgers, V. Tsiatsis, M. B. Srivastava, "STEM: Topology Management for Energy Efficient Sensor Networks", IEEE Aerospace Conference '02, Big Sky, MT, March 10-15, 2002.
- [13] X. Yang, N. Vaidya, "A Wakeup Scheme for Sensor Networks : Achieving Balance between Energy Saving and End-to-end Delay", Proc. of the IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS 2004), pp. 19-26, 2004.
- [14] A. Keshavarzian, H. Lee, L. Venkatraman, "Wakeup Scheduling in Wireless Sensor Networks", Proc. ACM MobiHoc 2006, pp. 322-333, Florence (Italy), May 2006.
- [15] R. Zheng, J. Hou, L. Sha, "Asynchronous Wakeup for Ad Hoc Networks", Proc. ACM MobiHoc 2003, pp. 35-45, Annapolis (USA), June 1-3, 2003.
- [16] Z. M. Wang, S. Basagni, E. Melachrinoudis, C. Petrioli, "Exploiting Sink Mobility for Maximizing Sensor Networks Lifetime", Proc. of the 38th Annual Hawaii International Conference on System Sciences (HICSS '05), Hawaii, 03-06 Jan. 2005.
- [17] H. Luo, F. Ye, J. Cheng, S. Lu, L. Zhang, "TTDD: Two-Tier Data Dissemination in Large-Scale Wireless Sensor Networks", Elsevier/ACM Wireless Networks, Vol. 11, No. 1-2, pp. 161-175, January 2005.
- [18] H. Jun, W. Zhao, M. Ammar, E. Zegura, and C. Lee, "Trading Latency for Energy in Wireless Ad Hoc Networks using Message Ferrying", Proc. IEEE PerCom Workshops, International Workshop on Pervasive Wireless Networking (PWN 2005), March 2005.
- [19] W. Heinzelman, A. Chandrakasan, H. Balakrishnan, Energy-efficient communication protocol for wireless microsensor networks, HICSS'00, Maui, Hawaii, USA, vol. 2, pp. 3005-3014, January 2000.
- [20] O. Younis and S. Fahmy, HEED: A hybrid, energy-efficient, distributed clustering approach for Ad Hoc sensor networks, IEEE Transactions on Mobile Computing, 3(4), 366-379, 2004.
- [21] K. Kalpakis, K. Dasgupta, P. Namjoshi, Maximum Lifetime Data Gathering and Aggregation in Wireless Sensor Networks, IEEE Networks'02, Munich, Germany, August 2002.
- [22] F. Ingelrest, D. Simplot-Ryl, I. Stojmenovic, Optimal Transmission Radius for Energy Efficient Broadcasting Protocols in Ad Hoc Networks, IEEE Transactions on Parallel and Distributed Systems, June 2006.
- [23] M. Cardei, J. Wu, S. Yang, Topology Control in Ad hoc Wireless Networks with Hitch-hiking, First IEEE SECON04, October 2004.
- [24] S. Lin, J. Zhang, G. Zhou, L. Gu, T. He, J. A. Stankovic, ATPC: Adaptive Transmission Power Control for Wireless Sensor Networks, SenSys'06, Colorado, November 2006.

# D-STATCOM FOR VOLTAGE SAG, VOLTAGE SWELL MITIGATION USING MATLAB SIMULINK

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## ABSTRACT

*This paper deals with control strategies for DSTATCOM (Distribution Static Compensator) for power quality improvement for a three-phase, three-wire distribution system. A three-leg voltage source inverter (VSI) configuration with a dc bus capacitor is employed as DSTATCOM. The PWM current controllers are designed analyzed and compare for PI controller. The capability of the DSTATCOM is demonstrated through results obtained using Simulink MATLAB. The performance of the DSTATCOM acting as a shunt compensator is found satisfactory under varied load perturbations.*

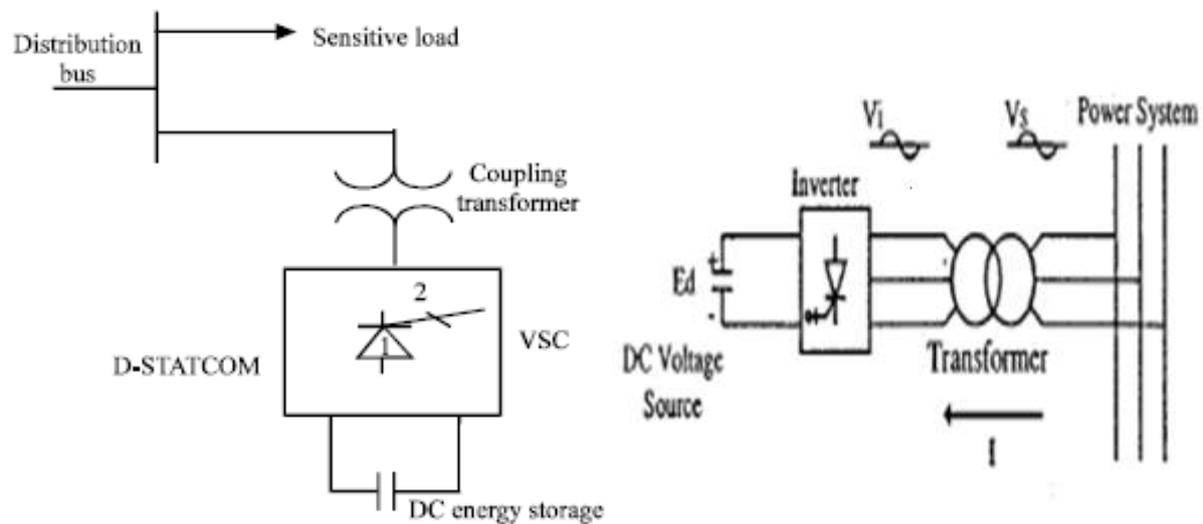
**Keywords:** FACTS, Shunt Compensation, Static Synchronous Compensator (STATCOM), Voltage dip, VSC.

## I INTRODUCTION

Power system is a complex network & it's made of thousands of buses and hundreds of generators. Available power generation does not situated near a growing of load center, to meet the demand, utilities have an interest in better utilization of available power system capacities, existing generation and existing power transmission network, instead of building new transmission lines and expanding substations. On the other hand, power flows in some of the transmission lines are overloaded, which has as an overall effect of deteriorating voltage profiles and decreasing system stability and security. Series capacitor, shunt capacitor, and phase shifter are different approaches to increase the power system transmission lines load ability, all these devices were controlled and switched mechanically and therefore, relatively slow. The best equipment to solve this problem at distribution systems at minimum cost is by using Custom Power family of D-STATCOM [1].

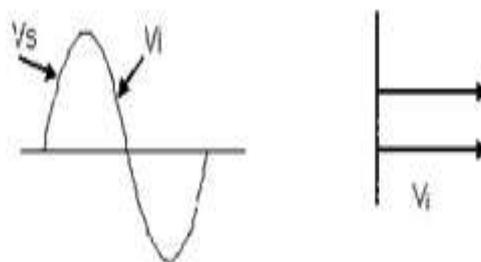
## II CONFIGURATION OF D-STATCOM

The basic electronic block of the D-STATCOM is the voltage source inverter that converts an input dc voltage into a three-phase output voltage at fundamental frequency. These voltages are in phase and coupled with the ac system through the reactance of the coupling transformer. Suitable adjustment of the phase and magnitude of the D-STATCOM output voltages allows effective control of active and reactive power exchanges between the DSTATCOM and the ac system. Fig 1 shows the schematic of D-STATCOM. The D-STACOM employs an inverter to convert the DC link voltage  $V_{dc}$  on the capacitor to a voltage source of adjustable magnitude and phase. Therefore the DSTATCOM can be treated as a voltage-controlled source. Fig.2 shows a single phase equivalent of the Statcom[2]. A voltage source inverter produces a set of three phase voltages,  $V_i$ , that are in phase with the system voltage,  $V_s$ . small reactance,  $X_c$ , is used to link the compensator voltage to the power system. When.  $V_i > V_s$ , a reactive current,  $i_c$ , is produced that leads  $V_s$  and when  $V_i < V_s$ , the current lags  $V_s$ .

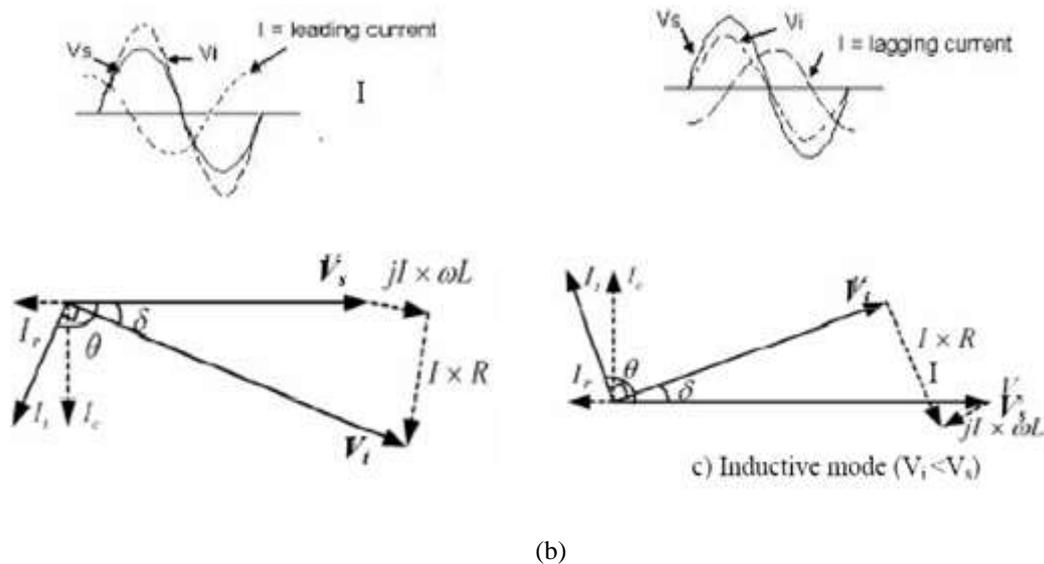


**Fig. 1 STATCOM based on voltage-sourced converter. Fig. 2. Single line equivalent model of dstatcom**

Fig. 2 shows the inductance  $L$  and resistance  $R$  which represent the equivalent circuit elements of the step-down transformer and the inverter will be the main component of the D-STATCOM. The voltage  $V_i$  is the effective output voltage of the D-STATCOM and  $\delta$  is the power angle. The reactive power output of the D-STATCOM inductive or capacitive depending can be either on the operation mode of the D-STATCOM. Referring to figure 1, the controller of the D-STATCOM is used to operate the inverter in such a way that the phase angle between the inverter voltage and the line voltage is dynamically adjusted so that the D-STATCOM generates or absorbs the desired VAR at the point of connection. The phase of the output voltage of the thyristor-based inverter,  $V_i$ , is controlled in the same way as the distribution system voltage,  $V_s$ . Figure 3 shows the three basic operation modes of the DSTATCOM output current,  $I$ , which varies depending upon  $V_i$ . If  $V_i$  is equal to  $V_s$ , the reactive power is zero and the D-STATCOM does not generate or absorb reactive power. When  $V_i$  is greater than  $V_s$ , the DSTATCOM shows an inductive reactance connected at its terminal. The current,  $I$ , flows through the transformer reactance from the D-STATCOM to the ac system, and the device generates capacitive reactive power. If  $V_s$  is greater than  $V_i$ , the D-STATCOM shows the system as a capacitive reactance. Then the current flows from the ac system to the D-STATCOM, resulting in the device absorbing inductive reactive power[3].

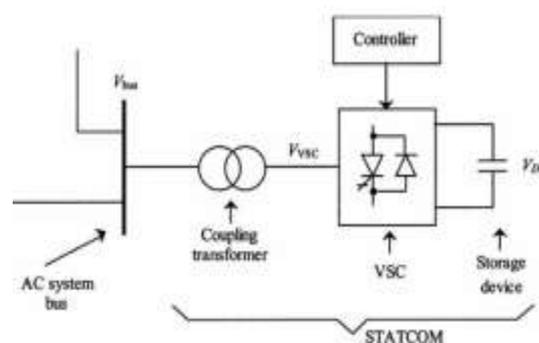


(a)



**Fig.3 Operation mode of DSTATCOM a) No Load, b) Capacitive mode, c) Inductive mode**  
**III OPERATING PRINCIPLE OF THE DSTATCOM**

The DSTATCOM system is comprised of three main parts: a VSC, a set of coupling reactors and a controller. The basic principle of a DSTATCOM installed in a power system is the generation of a controllable ac voltage source by a voltage source inverter (VSI) connected to a dc capacitor (energy storage device). The ac voltage source, in general, appears behind a transformer leakage reactance. The active and reactive power transfer between the power system and the DSTATCOM is caused by the voltage difference across this reactance. The DSTATCOM is connected to the power networks at a PCC, where the voltage-quality problem is a concern[4]. All required voltages and currents are measured and are fed into the controller to be compared with the commands. The controller then performs feedback control and outputs a set of switching signals to drive the main semiconductor switches MOSFET's, which are used at the distribution level) of the power converter accordingly. The basic diagram of the DSTATCOM is illustrated in Fig.4.



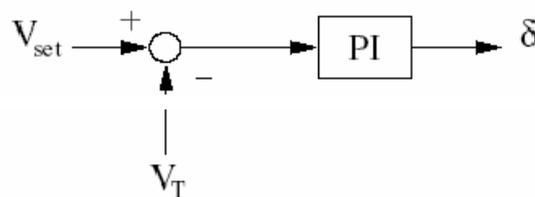
**Fig.4 Block Diagram of the voltage source converter based DSTATCOM.**

The ac voltage control is achieved by firing angle control. Ideally the output voltage of the VSI is in phase with the bus (where the DSTATCOM is connected) voltage. In steady state, the dc side capacitance is maintained at a fixed voltage and there is no real power exchange, except for losses[5]. The DSTATCOM differs from other

reactive power generating devices (such as shunt Capacitors, Static VAR Compensators etc.) in the sense that the ability for energy storage is not a rigid necessity but is only required for system unbalance or harmonic absorption. There are two control objectives implemented in the DSTATCOM. One is the ac voltage regulation of the power system at the bus where the DSTATCOM is connected and the other is dc voltage control across the capacitor inside the DSTATCOM[6]. It is widely known that shunt reactive power injection can be used to control the bus voltage. In conventional control scheme, there are two voltage regulators designed for these purposes: ac voltage regulator for bus voltage control and dc voltage regulator for capacitor voltage control. In the simplest strategy, both the regulators are proportional integral (PI) type controller[7]s. Thus, the shunt current is split into d-axis and q-axis components. The reference values for these currents are obtained by separate PI regulators from dc voltage and ac-bus voltage errors, respectively. Then, subsequently, these reference currents are regulated by another set of PI regulators whose outputs are the d-axis and q-axis control voltages for the DSTATCOM [8].

#### IV CONTROLLER

The aim of the control scheme is to maintain constant voltage magnitude at the point where a sensitive load is connected, under system disturbances. The control system only measures the r.m.s voltage at the load point, i.e., no reactive power measurements are required. The VSC switching strategy is based on a sinusoidal PWM technique which offers simplicity and good response. Since custom power is a relatively low-power application, PWM methods offer a more flexible option than the Fundamental Frequency Switching (FFS) methods favored in FACTS applications. Besides, high switching frequencies can be used to improve on the efficiency of the converter, without incurring significant switching losses. The controller input is an error signal obtained from the reference voltage and the value rms of the terminal voltage measured. Such error is processed by a PI controller the output is the angle  $\delta$ , which is provided to the PWM signal generator. It is important to note that in this case, indirectly controlled converter, there is active and reactive power exchange with the network simultaneously: an error signal is obtained by comparing the reference voltage with the rms voltage measured at the load point. The PI controller process the error signal generates the required angle to drive the error to zero, i.e., the load rms voltage is brought back to the reference voltage.



**Fig.5 PI controller**

#### V METHODOLOGY

To enhance the performance of distribution system, D-STATCOM was connected to the distribution system. D-STATCOM was designed using MATLAB simulink version R2012.

#### VI SIMULINK MODEL FOR THE TEST SYSTEM

### 6.1 Short Circuit Fault

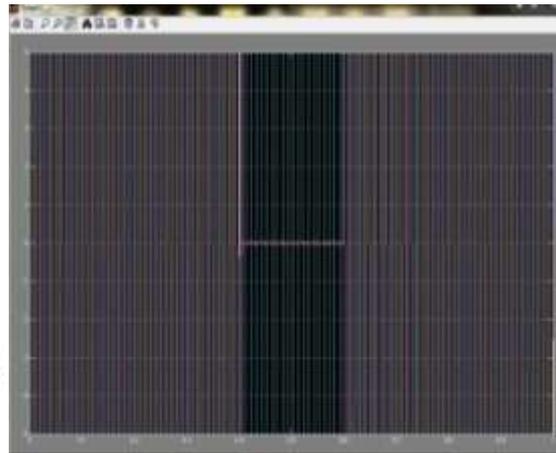
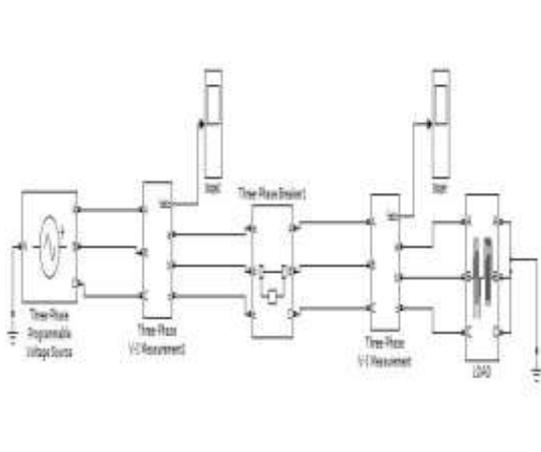


Fig.6 short circuit fault without D-Statcom Fig.7 Waveforms of Short Circuit Fault without D-Statcom

### 6.2 Swell Fault

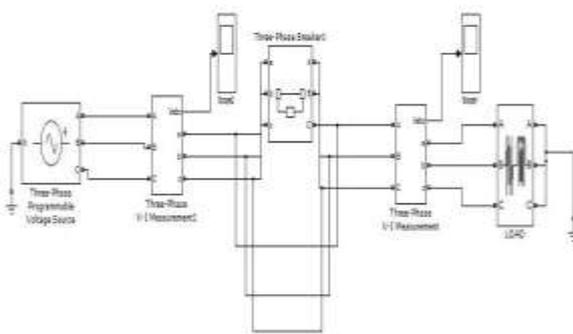


Fig.8 Circuit without D-Statcom Fig.9 Waveforms of Swell Fault without D-Statcom

### 6.3 Sag Fault

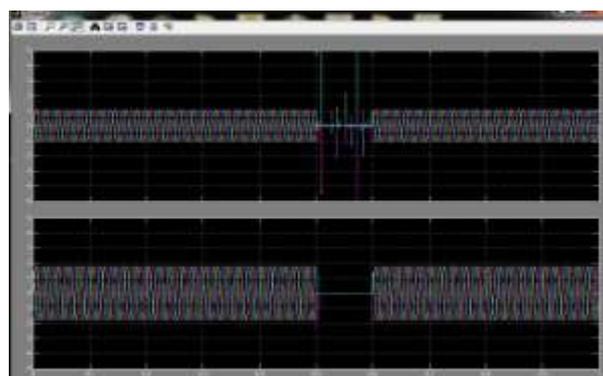
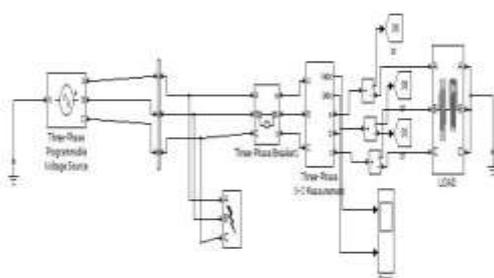
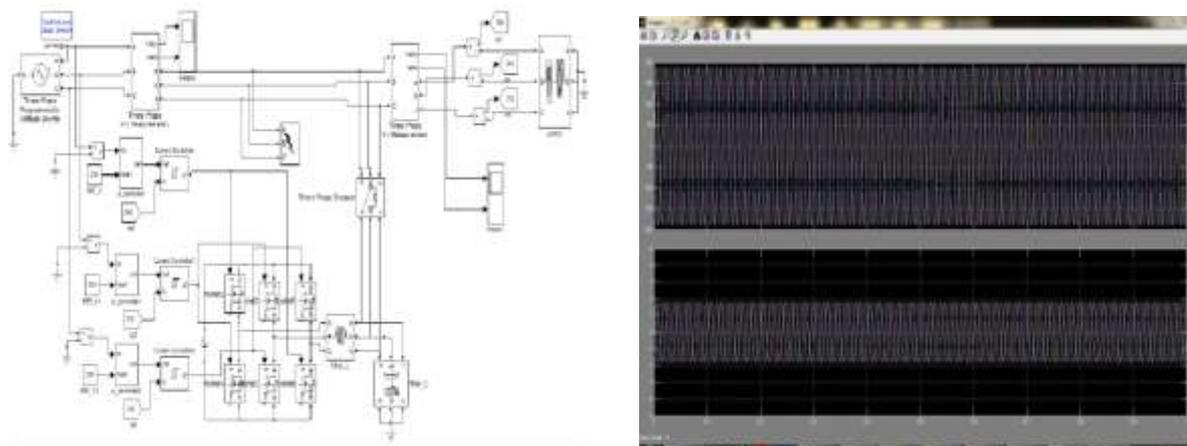


Fig.10 Circuit without D-Statcom Fig.11 Waveforms of Sag Fault without D-Statcom

#### 6.4 Simulink Model for the Test System



**Fig.12 Wave forms of Controlled Output using D-Statcom**

#### VII CONCLUSION

The power quality problems such as voltage dips, swells and interruptions, consequences, and mitigation techniques of custom power electronic devices D-STATCOM. The design and applications of D-STATCOM for voltage sags, interruptions and swells, and comprehensive results are presented. The simulations carried out showed that the DSTATCOM provides relatively better voltage regulation capabilities. It was also observed that the capacity for power compensation and voltage regulation of DSTATCOM depends on the rating of the dc storage device.

#### REFERENCES

- [1] N.Usha, Simulation results of eight bus system using push-pull inverter based +STATCOM, *Journal of Theoretical and Applied Information Technology*.
- [2] Cai Rong, Analysis of STATCOM for Voltage Dip Mitigation. Sweden ISSN 1401-6184 M.Sc. No. IEEE, December 2004
- [3] Wahidah AbdulHalim, Aida Fazliana Abdul Kadir, Jurifa Mat Lazi, Steady State Performance of Static Synchronous Compensator (STATCOM)
- [4] Bhim Singh, Senior Member, IEEE, Alka Adya, A.P.Mittal, Member, IEEE, and J.R.P. Gupt, Modeling, Design and Analysis of Different Controllers for DSTATCOM. 978-1-4244-1762-9/08/\$25.00 C2008 IEEE.
- [5] Cunping Wang, Xianggen Yin, Minghao Wen, Jian Liu, Qing Xiong, and Bin Zhang, 2010 Structure and Parameters Design of Output LC Filter in D-STATCOM. 978-1-4244-5940-7/10/\$26.00©2010 IEE
- [6] Hendri Masdi, Norman Mariun1 Senior MIEEEE, S.M.Bashi MIEEEE, A. Mohamed Senior MIEEEE, Sallehuddin Yusuf MIEEEE, Design of a prototype D-STATCOM for volstage sag mitigation.

[7] K R Padiyar and A M Kulkarni, Flexible AC transmission systems: A status review

[8] G.Sundar, Digital simulation of dstatcom for voltage fluctuation et. al. / International

# IDENTIFYING LOCATION OF MAXIMUM INTERFACE PRESSURE IN BEDRIDDEN PATIENT –A COMPARATIVE STUDY

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## ABSTRACT

*Bedridden patients are more likely to develop Pressure Ulcers. Major contributing factor includes interface pressure (IP) developed over bony prominences. To alleviate the IP, special purpose mattresses are used and to check the efficacy of these mattresses maximum IP is best evaluation measure. The work is an attempt towards identifying location of maximum IP first by hospital survey. Secondly by reaction board method and CONFORMat<sup>®</sup> pressure mapping system. The significance between the location of center of mass and location of maximum IP were tested by t-test. Total 40 subjects were considered for study. It is noted that location of center of mass by reaction board and maximum IP on subjects were located approximately at same location. Center of mass and corresponding IP for female subjects were at 53% of subject's height where as for male subject it is at 57 % when subject is lying on board in supine posture.*

**Keywords :** *Interface Pressure, Pressure Ulcer (Pus), Support Surface, Supine Posture.*

## I INTRODUCTION

Prolonged sleeping posture is one of the most fundamental activities of daily living for the disabled, aged and paraplegic patients. For these people, who have limited mobility and impaired sensation, prolonged sleeping will be highly risky and harmful. This will further create more critical problems like PUs, spasticity.

PUs are one of the most important medical problems in the western world, affecting millions of hospitalized immobile patient, elderly patients in nursing homes and their families, suffering, in addition to increased work load and requiring annual healthcare costs in order of billions dollar [1][2].

PUs occurs due to cell necrosis which is caused by unrelieved pressure and shearing forces on soft tissue overlying bony prominence when patient lying on hospital bed. These two forces can interrupt the blood circulation to underlying tissues. This results in oxygen deficiency in soft tissues and muscles. PU is difficult to cure, treat and is a major cost factor in the health care system. Classical treatment of pressure ulcer prevention involves extended

periods of bed rest but which is believed to affect general condition of patient and further deterioration of the patient's life [3]

Since the discomfort of these pressure ulcers for the patients is enormous and the costs for treatment are high, the prevention of PUs is important. Prevention starts with using special materials for mattresses and sheets as well as specially designed bed systems.

The primary cause of pressure ulcers is static IP applied to both the skin and underlying tissue. When this pressure is greater than the blood pressure within the capillaries, blood flow is interrupted. Maintaining IPs below capillary closing pressure (for example 32mmHg) is considered as standard for pressure relief [4].

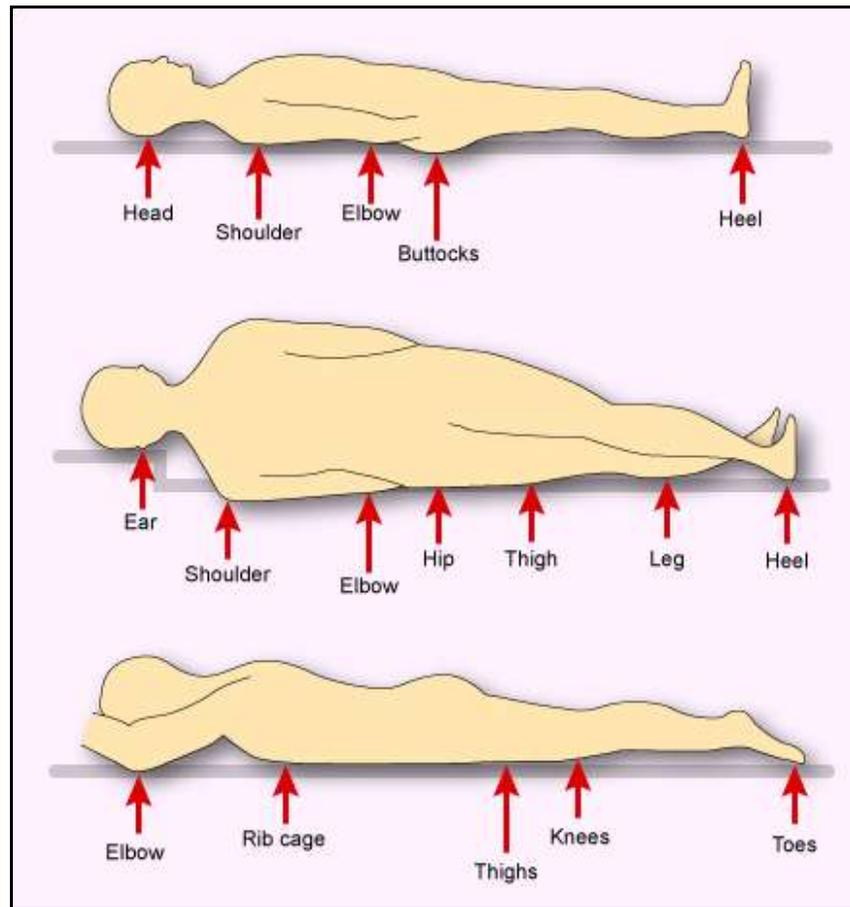
IP is defined as the pressure distribution on the human tissue when it is compressed between bony prominences and the supporting surface in sleeping posture. It has been extensively adopted to evaluate the occupant's postural behaviors and properties of the supporting surface.

Objective of this paper is to identify the location of maximum IP in bedridden patient and to check significance of location of center of mass with the location of Maximum interface pressure.

## II LITERATURE SURVEY

Prolonged sleeping behavior in bed due to surgery, injury to the spinal cord, or an illness cause's immobility even for less than a day, the pressure of the immobilized body on certain areas can break down the skin [5]. An early study conducted by researcher examined nearly 20,000 residents of 51 nursing homes and found that 11.3 % possessed a stage 2 or deeper pressure ulcer on admission and among those ulcer-free residents remaining in the nursing home for 1 year, 13.2 % developed a new pressure ulcer [6].

PUs develops when patient skin is continuously exposed to a persisting external interface pressure of support surface that is higher than capillary closing blood pressure. If this pressure is continued it can cause tissue necrosis [7]. The factors causing PU is complex phenomenon and according to various researchers, they mainly include the pressure under bony prominences, shear forces, temperature, moisture, nutrition, seating position and daily life routine [8-10]. Excessive pressure between human buttock and seating surface is generally recognized as the principal cause of the occurrence of PUs [11]. IP involves mapping using sensors to quantify the pressure between two contacting objects, such as a person and their support surface. It is commonly used by clinician and by researchers investigating the surface, risk factors for ulceration and ulcer prevention protocol [12]. Frederick Shelton [13] compared different surfaces for elderly people (65-70 years) mannequins with Tekscan 5315 system in his test. Inflated beds designed to reduce pressure ulcers requires segmented air bags that alternately inflate and deflate to reduce IP [14]. To locate these air bags we need to know the locations of PU developing areas. The sacrum, hips, spine, elbow, ears, shoulder blades and heels are areas that can breakdown if point is kept in one position for long period of time as shown in Fig.1.



**Fig.1 Common Sites of Pressure Ulcers When Lying Down**

### III METHODOLOGY

#### 3.1 Equipment Used

The reaction board used in this trial was wooden platform of 200 X 80 X 3 cm. electronic weighing scale and CONFORMat<sup>®</sup> pressure mapping system a product by Tekscan Inc. The system includes hardware, software and thin film pressure sensors (mats). The mats thinness enables the user to confidently incorporate the sensors in to the application without altering the characteristics of the support. The combination of these factors enables precise measurement of the location and magnitude of peak pressures and overall pressure distribution pattern.

#### 3.2 Subjects

Forty subjects (20- Male and 20- Female) from healthy group were participated in the experiment. Initial data were collected on admission to the trial.

#### 3.3 Procedure

For this study static supine posture condition were being considered. Experiment is carried out firstly on the objective questionnaires through hospital survey. 10 doctors and 5 nursing care unit nurses were asked question of

most vulnerable area of PU in bed bound patients. Secondly subjects were instructed to lie on reaction board to find the location of center of mass and then location of maximum IP by using pressure mapping system.

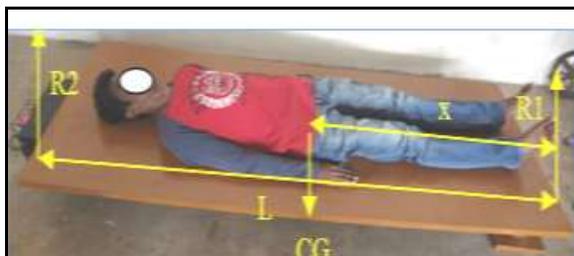
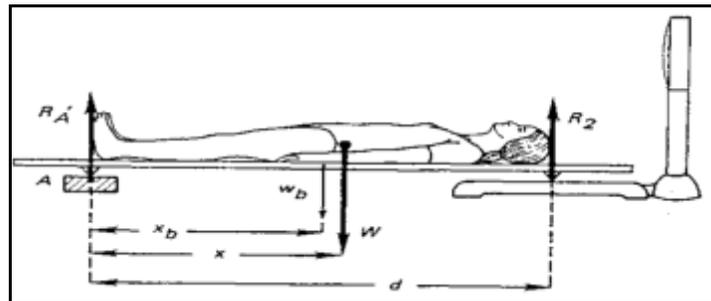
Determination of the center of mass location of a body with respect to a reference axis of rotation involves four steps:

1. A scale reading is taken when the reaction board is unloaded ( $R_1$ ).
2. Subject assumes the desired position on the reaction board.
3. A second scale reading is taken ( $R_2$ ) with the subject maintaining the desired position.
4. The Center of Mass location ( $x$ ) with respect to the reference axis is calculated using equation 1.

$$x = \frac{(R_2 - R_1) d}{W} \quad (1)$$

Procedural steps followed while collecting data are as follows

1. Accurate measure of height ( $h$ ) and weight ( $W$ ) using the same scale which will be used for the reaction board for each subject.
2. Initial scale reading ( $R_1$ ) and the distance between the knife edges of the reaction board ( $d$ ) were noted.
3. Participants were instructed to lie supine on the reaction board taking care to align the soles of the participant's feet with axis A (see Fig. 2).
4. Record scale reading,  $R_2$ , while the participant lies on the board with arms at sides.
5. The distance from axis A to the participant's CG in absolute terms (mm) and then as a percentage of the participant's standing height were calculated using equation



**Fig. 2: Experimental Setup**

Anthropometric data like Height, weight age and reactions on reaction boards for calculating center of mass were measured and collected through computer interface by using Ms Access form as shown in Fig. 3. Data collected were tabulated as shown in TABLE NO.1 and TABLE NO.2

**Fig.3: Data Collection Input Window.**

**Table1. Location of center of mass by using reaction board method**

Male Subjects	Height in (cm)	Weight in (Kg.)	Location of Center of Mass (mm)	Female Subjects	Height in(cm)	Weight in (Kg.)	Location of Center of Mass (mm)
1	173	64.88	100.04	21	163	54.66	90.63
2	174	65.74	98.86	22	161	56.00	82.61
3	168	64.52	94.19	23	157	44.25	87.66
4	171	67.16	94.56	24	152	49.08	86.31
5	180	66.87	102.71	25	159	61.52	88.86
6	175	58.77	98.62	26	159	63.02	89.88
7	171	78.12	95.61	27	159	57.07	84.59
8	172	85.70	100.55	28	159	47.88	84.85
9	171	57.06	97.64	29	157	47.20	83.96
10	178	75.04	99.88	30	152	49.53	81.07
11	171	76.66	98.71	31	149	38.28	81.26
12	167	65.74	94.58	32	151	53.60	79.88
13	173	49.75	99.25	33	164	64.42	92.00
14	170	73.63	97.45	34	159	41.85	90.97
15	170	68.00	99.88	35	163	69.10	85.95
16	178	75.00	103.51	36	159	40.60	89.37
17	181	66.27	104.89	37	152	49.50	86.14
18	166	52.16	93.29	38	149	41.70	83.32
19	171	85.26	97.85	39	147	41.52	80.65
20	175	59.45	99.19	40	164	58.66	87.1

**Table2. Location of maximum interface pressure by using pressure mapping system**

Male Subjects	Height in (cm)	Location of Max. IP (mm)	Max. IP (mm of Hg)	Female Subjects	Height in (cm)	Location of Max. IP (mm)	Max. IP (mm of Hg)
1	173	98.17	171	21	163	84.73	154
2	174	98.34	87	22	161	82.94	144
3	168	91.21	113	23	157	90.15	100
4	171	94.32	184	24	152	83.97	121
5	180	93.06	114	25	159	86.34	129
6	175	97.68	176	26	159	78.70	180
7	171	94.91	95	27	159	86.91	111
8	172	98.88	111	28	159	87.05	106
9	171	90.04	120	29	157	89.55	104
10	178	105.28	92	30	152	87.12	96
11	171	95.39	97	31	149	88.98	109
12	167	93.69	117	32	151	91.51	135
13	173	93.84	95	33	164	91.71	96
14	170	92.38	131	34	159	85.34	139
15	170	97.10	112	35	163	82.78	136
16	178	98.91	89	36	159	86.86	113
17	181	94.04	93	37	152	86.28	99
18	166	98.18	81	38	149	91.26	107
19	171	96.94	136	39	147	85.57	146
20	175	99.20	83	40	164	86.82	89

### 3.4 Statistical Analysis

After collecting the data for testing the significant relation between location of center of mass and location of maximum IP hypothesis were formulated and significance were tested by using two tailed t-test with 0.05 significance level by using equation 2.

Null hypothesis  $H_0: \mu_P = \mu_R$

Alternative hypothesis  $H_a: \mu_P \neq \mu_R$

$$t = \frac{\mu_R - \mu_P}{\sqrt{\frac{SR^2}{n-1} + \frac{SP^2}{n-1}}} \quad (2)$$

Where  $\mu_R$  = Average location of center of mass

- $\mu_P$  = Average location of Maximum IP
- $SR$  = S.D. of locations of center of mass
- $SP$  = S.D. of locations of maximum IP

Results of t-test are shown in TABLE 3.

**Table3. Two tailed t- Test Results**

$$t_{\text{statistic}} = 0.478$$

$$\mu_R = 92.20 \quad SR = 7.26$$

$$\mu_P = 91.49 \quad SP = 5.74$$

$$t_{\text{critical}} = -t_{0.025, 39} \text{ is } -2.0227 \text{ and } t_{0.025, 39} \text{ is } 2.0227$$

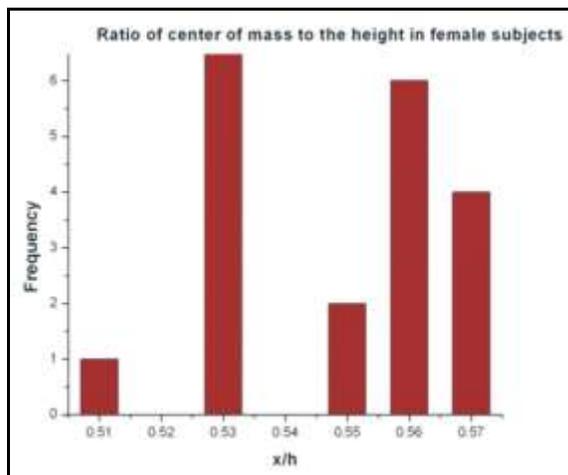
$$\text{d.f.} = n-1 = 39$$

$$\alpha = \text{significance level} = 0.05$$

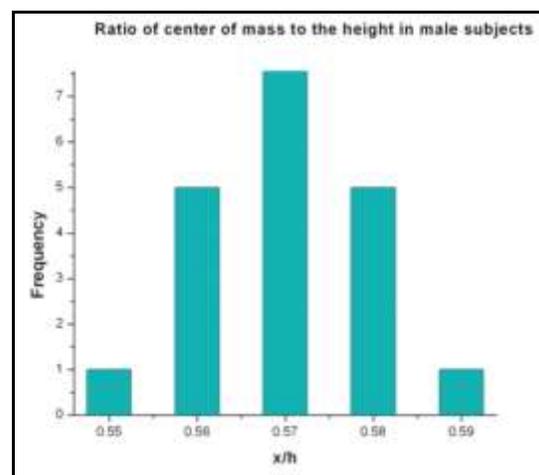
For two tailed test from statistical table  $-t_{0.025, 39}$  is  $-2.0227$  and the critical value  $t_{0.025, 39}$  is  $2.0227$ . Since  $t$ -statistical is fall between these values we have accepted the null hypothesis  $H_0: \mu_P = \mu_R$  in favor of the alternative hypothesis  $H_A: \mu_P \neq \mu_R$

Thus Average location of center of mass is equal to average location of maximum IP.

After determining the location of each person's center of mass, the ratio of the center of mass to the height of each person was calculated using formula  $x/h$ , and shown in Fig. 4 and Fig. 5. Where  $x$  is the location of the person's center of mass and  $h$  is the person's height.



**Fig. 4: Frequency of ratio of center of mass to height values obtained from the female subjects**



**Fig. 5: Frequency of ratio of center of mass to height values obtained from the male subjects**

## IV RESULTS AND DISCUSSION

### 4.1 Location of center of mass

1. Figure 2 and Table 1 gives the actual location of center of mass measured by reaction board method. Average location of center of mass calculated was ( $x = 92.31\text{cm}$ )
2. Figure 4 and 5 gives that ratio of center of mass to height values for female and male subjects. It was noted that Males and females have different centers of mass females' centers of mass are lower than those of males. The average ratio of center of mass to height in females is approximately 0.53 and the average ratio of center of mass to height in males is approximately 0.57

#### 4.2 Location of maximum IP

From Table 2 it was calculated that average location of maximum IP was ( $x = 91.49\text{cm}$ )

And from t –test it is tested that average location of maximum IP will locate at same location as that of average location of center of mass i.e test is significant.

#### V CONCLUSION

From this study it is clear that maximum interface pressure due to person's center of mass is slightly below his/her belly button i.e. at sacrum. Maximum Interface pressures noted at sacrum in male subjects were in the range of 83 - 184 mmHg and in female subjects were in the range of 89- 180 mmHg.

It was also noted that Males and females have different centers of mass females' centers of mass are lower than those of males. The average ratio of center of mass to height in females is approximately 0.53 and the average ratio of center of mass to height in males is approximately 0.57.

Also it is understood that Pressure redistributing support surfaces, designed to prevent and treat pressure ulceration are generally based on location and magnitude of IP. The outcomes of this study will help the researchers as well as designers for designing personalized support surface and checking the efficacy of support surfaces to reduce PUs.

#### REFERENCES

- [1] D. Bader, et al., Pressure ulcer research-current and, future perspectives, *Berling: Springer*, 2005, 382.
- [2] European pressure Ulcer Advisory Panel (EPUAP). Updated staging system, 4(1), 2002. Available from: <http://www.epuap.org/pr2.htm>; [accessed 5<sup>th</sup> Nov 2011]
- [3] H. Brem and, C. Lyder, Protocol for the successful treatment of pressure ulcers, *The American Journal of Surgery*, 188(1S1), 2004, 9-17,.
- [4] Krasner, Rodeheaver, Sibbald , *Chronic Wound Care* Third Edition 2001, 620.
- [5] J. Franks, Bedsores and Personal Care Services, Article Updated April 2013. Available from: <http://www.aplaceformom.com/senior-care-resources/articles/bedsores;>, [accessed 10<sup>th</sup> Nov 2014]
- [6] G.Brandeis, J. Morris, D. Nash, L. Lipsitz , The epidemiology and natural history of pressure ulcers in elderly nursing home residents, *JAMA* ;264, 1990, 2905–9.
- [7] D. Brienza, et al., The relationship between pressure ulcer incidence and buttock-seat cushion interface pressure in at-risk elderly wheelchair users, *Arch Phys Med Rehabil*, 82(4), 2001,529-33.

- [8] E. Guimaraes, and W. Mann, Evaluation of pressure and durability of a low-cost wheelchair cushion designed for developing countries, *Int J Rehabil Res*, 26(2), 2003, 141-3.
- [9] A. Gefen, Risk factors for a pressure-related deep tissue injury: a theoretical model, *Med Biol Eng Comput*, 45(6), 2007, 563-73.
- [10] Baldwin,*et. al.*, Damage control: Preventing and treating pressure ulcers, *Nursing Made Incredibly Easy!*, 4(1), 2006, 12-26.
- [11] M. Inhyuk, Control of air-cell mattress for preventing pressure ulcer based on approximate anthropometric model, In Proceeding of the 2005 IEEE, 9<sup>th</sup> International Conference on Rehabilitation Robotics, USA.
- [12] G.Webster , A pressure mat for preventing pressure sores, In IEEE Engineering in Medicine and Biology Society 11<sup>th</sup> International Conference 1989, 1479.
- [13] F. Shelton, Full – body interface pressure testing as a method for performance evaluation of clinical support surface, *In Applied Ergonomics*, 29 (6),1998, 491 – 497.
- [14] M.Edmund, Hospital bed with inflatable patient turning means, US 3485240 A, 1969

# ENERGY ADAPTIVE WIRELESS SENSOR NETWORK USING WAVELET BASED RSS PREDICTION

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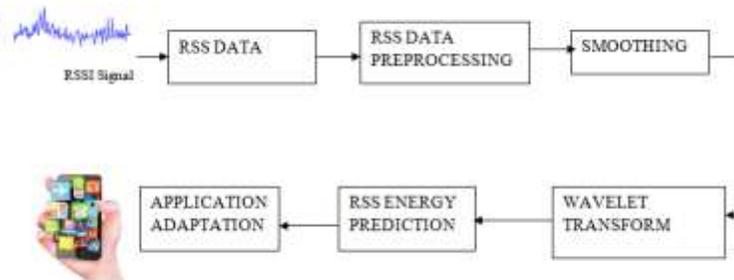
## ABSTRACT

*Energy efficiency of the smartphone is very important, which needs a effective management. The energy efficient management is a good understanding of where and how the energy is used. Having a smartphone seems to be the trend of the future of wireless communication. Smartphones are with many wireless based applications (Whatsapp, playstore, hike, facebook, google, etc.) which consumes more energy when the signal is weak. Signal prediction method is used in the proposed system to overcome this problem. The application adaptation will decide which application can be used at that moment.*

**Keywords:** *Energy Efficiency, Smartphones, Signal Prediction, Wireless Communication, Application Adaptation.*

## I. INTRODUCTION

Energy consumption of mobile devices, such as smartphones, has increasingly become a concern for various parties, ranging from smartphone manufacturers, mobile operators, to end users. Battery capacity has been increasing in the past few years; battery life of mobile devices, however, is not catching up proportionally. The reason lies in the recent tremendous growth in network deployment and energy-hungry applications enjoyed by mobile users. In the power breakdown of smartphones, wireless communication components, including Wi-Fi and cellular network interfaces, account for a prominent part of the overall power consumption. A smartphone is a mobile phone with more advanced computing capability and connectivity than basic feature phones. A major source of smartphone battery drain is accessing the internet over cellular or WiFi connection when running various applications and services.



**Fig. 1 System Processing Model Block Diagram**

Smartphones supports a large set of applications and many applications consumes more battery energy. The energy consumption should be monitored in smartphones to save the energy. The energy consumption can be monitored by predicting the received signal strength and application adaptation is used which helps in saving the energy.

## II. RELATED WORK

In the previous studies different methods have been used for signal prediction. The authors in [3] analyzed power consumption of android based G1 and magic handsets, data transmission is different between handset, operating system and device context. The authors in [6] used tail ender protocol for reducing the energy consumption. The authors in [1] used openmoko neo freerunner which finds out the exact breakdown of power consumption. The authors in [7] proposed a new model for 3G and WiFi it is to increase the signal strength and improves accuracy. The authors in [5] proposed a location-assisted Wi-Fi discovery scheme, which discovers the nearest Wi-Fi network access points (APs) by using the user's location information.

In the proposed system signal prediction is done with non parametric kernel moving average and discrete wavelet transform is used. Application adaptation will sense which application can be runned at a particular signal strength.

## III. METHODOLOGY

The files are transmitted using the tarang module and the data signal is predicted. The predicted signal is preprocessed using wiener filter. This wiener filter is used to denoise the predicted signal. Smoothing is done with moving average method which gives the filtered data. The smoothed signal is given as a input to the wavelet transform. Here discrete wavelet transform is used which separates the low and high frequency components. The higher frequency signals are considered here and it is taken for energy prediction.

Then energy estimation is done using a following equation,

$$\beta_{Wi-Fi\_h} = 710mW + \beta_{cr}(R_{channel}) * R_{data} \quad (1)$$

$$\beta_{cr}(R_{channel}) = 48 - 0.768 * R_{channel} \quad (2)$$

Where,

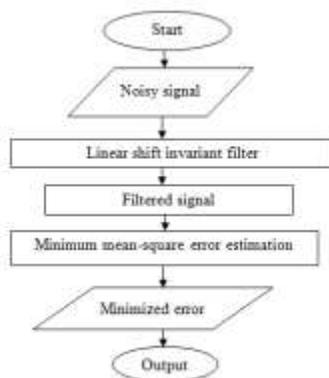
$R_{channel}$  is the received channel rate.

$R_{data}$  is the received data rate.

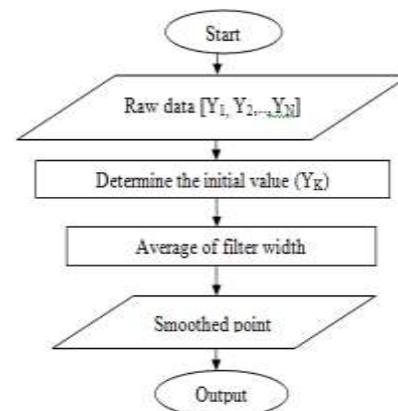
After the energy estimation application adaptation will decide which application can be used at that moment as shown in Fig. 1. When using these methods in smartphones it helps to save the energy in smartphones.

#### IV. ALGORITHMS

In the proposed approach the signals are preprocessed using wiener filtering as shown in Fig. 2. Noisy signals are filtered using linear shift invariant filter. Then the error is estimated using the minimum mean square. Finally the error will be minimized. The minimized errors are smoothed using moving average as shown in Fig. 3. At first the initial values are determined and it takes the average value. Then the smoothed points are obtained.



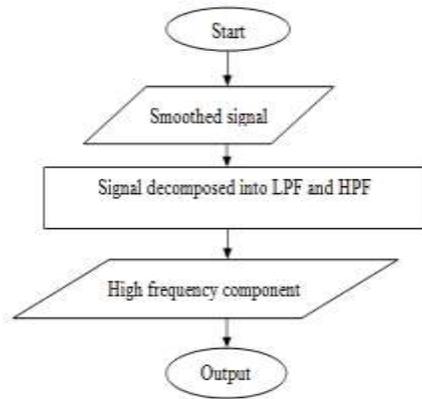
**Fig. 2 Wiener Filter Algorithm**



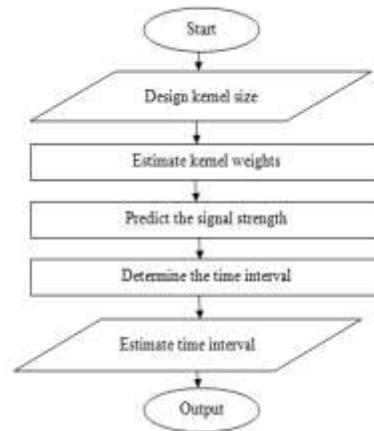
**Fig. 3 Moving Average Algorithm**

The discrete wavelet transform is used for obtaining higher frequency components. It transforms discrete time signal to a discrete wavelet representation. The smoothed signal is given as a input and then the signals are decomposed into low pass filter and high pass filter. Then finally the higher frequency components are obtained as shown in Fig. 4. The higher frequency components are used for energy estimation. Then the higher frequency components are used for energy estimation.

The energy estimation is done with non parametric kernel moving average in which the kernel weights are estimated. Then the signal strength is predicted, after the prediction time interval is determined as shown in Fig.5. Time interval is estimated and then the final signal strength is obtained. Then the final signal strength is used with application adaptation which will decide which application can be used for the obtained signal strength.



**Fig. 4 Discrete Wavelet Transform Algorithm**



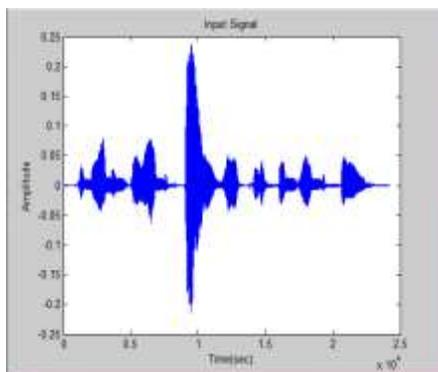
**Fig.5. Non parametric Kernel Moving Average Algorithm**

**V. SIMULATION RESULTS**

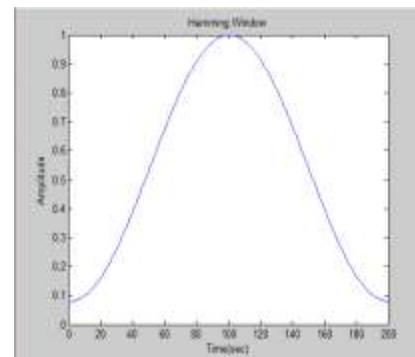
These are the simulation results and in Fig.6 it shows the input signal and in Fig. 7 it shows the hamming window. In the Fig. 8 it shows the FFT of frame, in Fig. 9 it shows overlap add signal, in Fig. 10 shows the denoised output and in Fig 11. It shows the smoothed signal output. Then the wavelet decomposed of level 1 and 2 outputs is shown in Fig. 12 and Fig. 13 with the approximate coefficients and detailed coefficients.

Then the final output is RSSI signal strength is shown in the Fig. 14. The signal strength which is obtained here is,

**Signal Strength : -25.6215dbm**



**Fig. 6. Input Signal**



**Fig. 7 Hamming Window**

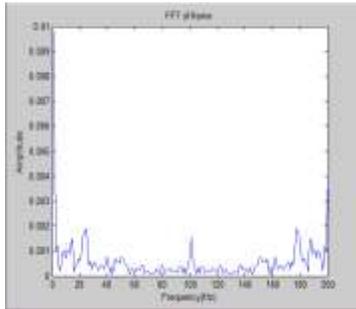


Fig. 8 FFT of Frame

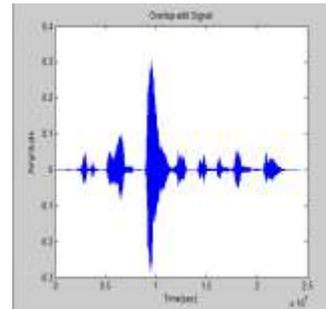


Fig. 9 Overlap-add Signal

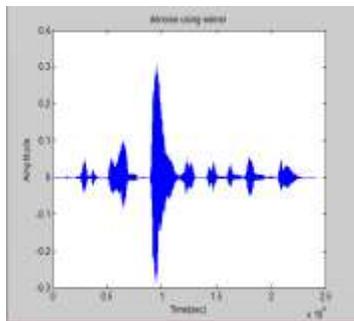


Fig. 10 Denoise using Wiener

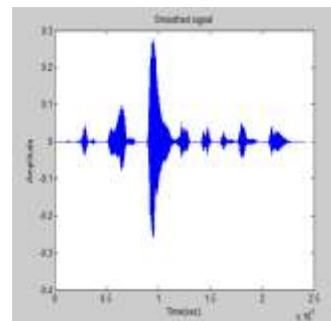


Fig. 11 Smoothed Signal

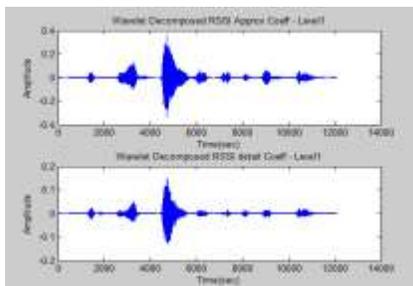


Fig. 12 Wavelet Decomposed RSSI (level 1)

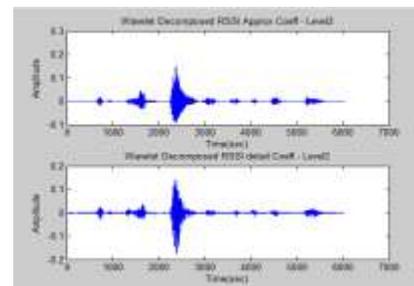


Fig. 13 Wavelet Decomposed RSSI (level 2)

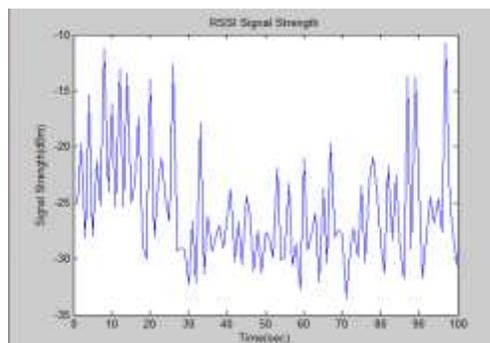


Fig. 14 RSSI Signal Strength

## VI. CONCLUSION

This paper presents an effective approach to save energy in smartphones based on a signal prediction and application adaptation schemes. The RSS are preprocessed and smoothed using wiener and moving average algorithms respectively. The discrete wavelet transforms are used for obtaining the higher frequency components, finally the energy is predicted using the non parametric kernel moving average algorithms. The signal strength is obtained which can be used with application adaptation which will decide which application can be used at that particular signal strength to save the energy in smartphones.

## REFERENCES

- [1] A. Carroll and G. Heiser, "An analysis of power consumption in a smartphone," in Proc. of USENIX ATC, 2010.
- [2] A. Rice and S. Hay, "Decomposing power measurements for mobile devices," in Proc. IEEE Int. Conf. Pervasive Comput. Commun. (PERCOM), 2010, pp. 70–78.
- [3] A. Rice and S. Hay, "Measuring mobile phone energy consumption for 802.11 wireless networking," Pervasive Mobile Comput., vol. 6, no.6, pp. 593–606, Dec. 2010.
- [4] A. Shye, B. Scholbrok, and G. Memik, "Into the wild: Studying real user activity patterns to guide power optimizations for mobile architectures," in Proc. 42nd Annu. IEEE/ACM Int. Symp. Microarchit., 2009, pp. 168–178.
- [5] Feng Xia, Ching-Hsien Hsu, Xiaojing Liu, Haifeng Liu, Fangwei Ding, Wei Zhang, "The power of smartphones," 2013 – Springer.
- [6] Goran Kalic, Iva Bojic and Mario Kusek, "Energy consumption in android phones when using wireless communication technologies," may 2012.
- [7] Ning Ding, Daniel Wagner, Xiaomeng Chen, Abhinav Pathak, Y. Charlie Hu, Andrew Rice, "Characterizing and Modeling the Impact of Wireless Signal Strength on Smartphone Battery Drain," june 2013.

# DESIGN AND ANALYSIS OF 2:1 MULTIPLEXER CIRCUITS FOR HIGH PERFORMANCE

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## ABSTRACT

*A multiplexer is a unidirectional device and used in any application in which data must be switched from multiple sources to a destination. The low power circuits have become a top priority in modern VLSI design. This paper presents the power consumption comparisons and delay of various designs of 2:1 Multiplexer. The various logic styles such as Differential Cascode Voltage Switch Logic (DCVSL), Modified Differential Cascode voltage switch logic (MDCVSL), CMOS logic and Pseudo NMOS Logic, these designs are analyzed using the Tanner EDA tool. The Pseudo NMOS Logic design demonstrates its superiority against other styles of 2:1 multiplexer design in terms of power consumption.*

**Keywords:** CMOS Logic, DCVSL, MDCVSL, Low power, 2:1 Multiplexer and VLSI.

## I INTRODUCTION

In electronics, a multiplexer is a device that selects one of several analog or digital input signals and forwards the selected input into a single line. A multiplexer of  $2^n$  inputs has 'n' select lines, which are used to select which input line to send to the output. Multiplexers are mainly used to increase the amount of data that can be sent over the network within a certain amount of time and bandwidth. A multiplexer is also called a data selector. An electronic multiplexer makes it possible for several signals to share one device or resource, for example one A/D converter or one communication line, instead of having one device per input signal.

An electronic multiplexer can be considered as a multiple-input, single-output switch, and a demultiplexer as a single-input, multiple-output switch. The schematic symbol for a multiplexer is an isosceles trapezoid with the longer parallel side containing the input pins and the short parallel side containing the output pin. The schematic on the right shows a 2-to-1 multiplexer on the left and an equivalent switch on the right. The wire connects the desired input to the output. The basic function of a multiplexer: combining multiple inputs into a single data stream. Multiplexers can also be used as programmable logic devices. By specifying the logic arrangement in the input signals, a custom logic circuit can be created. The selector inputs then act as the logic inputs. This is especially useful in situations when cost is a factor and for modularity. Therefore study on multiplexer is inevitable [1].

## II. LITERATURE REVIEW OF DIFFERENT 2:1MULTIPLEXER CIRCUITS

### 2.1. DCVSL Multiplexer Circuit

Cascode Voltage Switch Logic (CVSL) refers to a CMOS-type logic family which is designed for certain advantages. This logic family is also known as Differential Cascode Voltage Switch Logic (DCVS or DCVSL).It requires mainly N-channel MOSFET transistors to implement the logic using true and complementary input signals, and also needs two P-channel transistors at the top to pull one of the outputs high. In this paper, we explore the Differential Cascode Voltage-Switch Logic (DCVSL) circuit design methodology. The key benefits of DCVSL are consumes no static power, uses latch to compute output quickly, requires true/complement inputs, produces true/complement outputs [2]-[4]. Allows “Complex” gates, never needs inverters in the logic path and low power consumption. A logic function and its inverse are automatically implemented in this logic style [4], [5].The schematic diagram of DCVSL 2:1 multiplexer is shown in Fig.1. The pull-down network implemented by the NMOS logic tree generates complementary output. This logic family is also known as Differential Cascode Voltage Switch Logic (DCVS or DCVSL).The advantage of DCVSL is in its logic density that is achieved by elimination of large PFETS from each logic function. It can be divided it to two basic parts: a differential latching circuit and a cascoded complementary logic array [6]-[10].

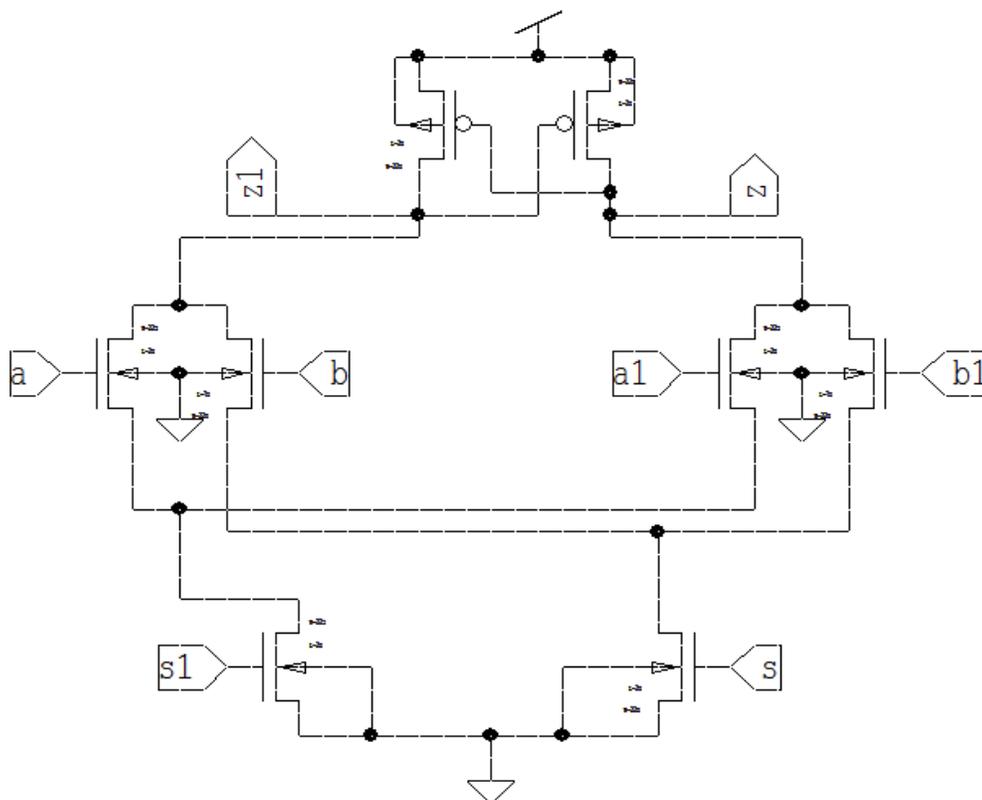
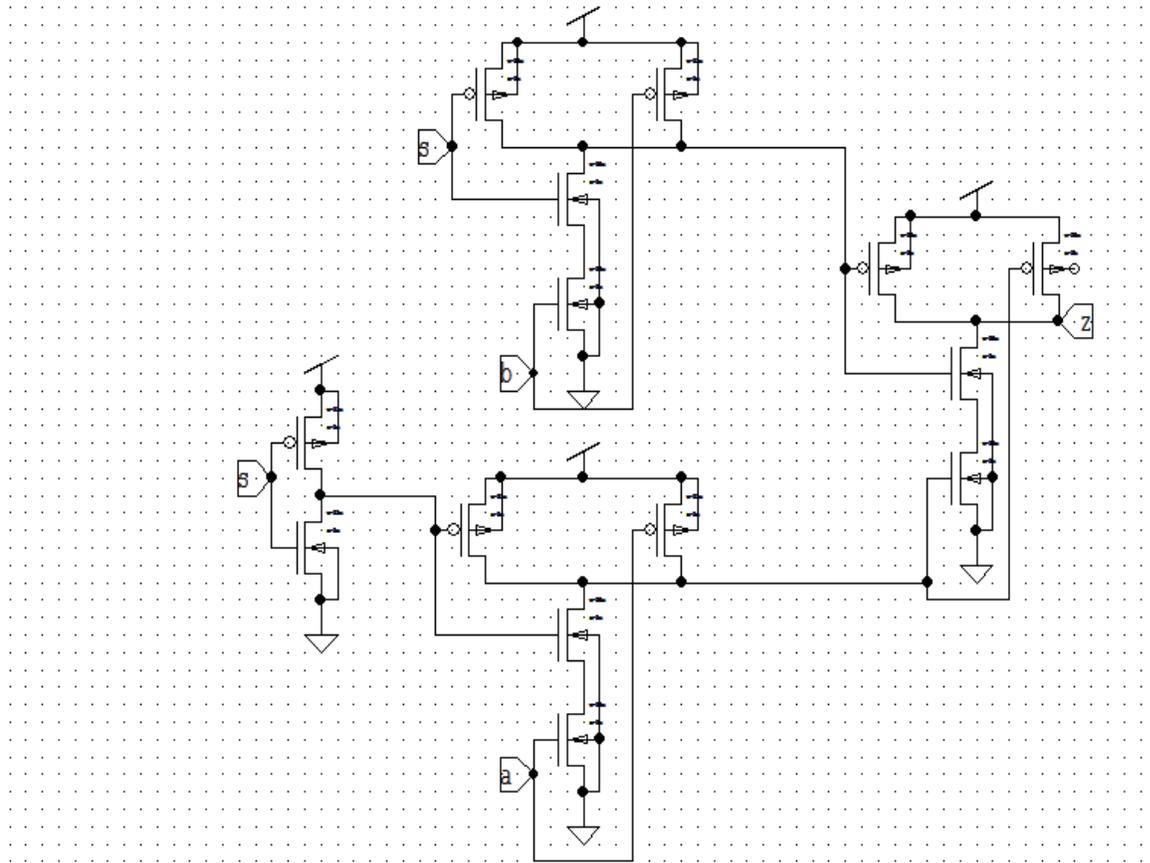


Fig. 1 Schematic of DCVSL Circuit



### 2.3. CMOS Logic Based Multiplexer Circuit



**Fig. 3 Schematic of CMOS 2:1 Multiplexer Circuit**

The Schematic of CMOS logic based 2:1 multiplexer circuit has shown in the Fig. 3, if both of the A and B inputs are high, then both the NMOS transistors will conduct, neither of the PMOS transistors will conduct, and a conductive path will be established between the output and VSS, bringing the output low. If both of the A and B inputs are low, then neither of the NMOS transistors will conduct, while both of the PMOS transistors will conduct, establishing a conductive path between the output and VDD, bringing the output high. If either of the A or B inputs is low, one of the NMOS transistors will not conduct, one of the PMOS transistors will, and a conductive path will be established between the output and VDD, bringing the output high. As the only configuration of the two inputs that results in a low output is when both are high, this circuit implements a NAND logic gate.

### 2.4 PSEUDO NMOS Logic Based Multiplexer Circuit

The design of Pseudo NMOS Logic is shown in Fig.4. Using a PMOS transistor simply as a pull-up device for an n-block is called pseudo-NMOS logic. The pull-up transistor must be chosen wide enough to conduct a multiple of the n-block's leakage and narrow enough so that the n-block can still pull down the output safely



Tanner EDA's design entry and simulation system includes S-Edit for schematic capture T-Spice for circuit simulation, and W-Edit for waveform probing.

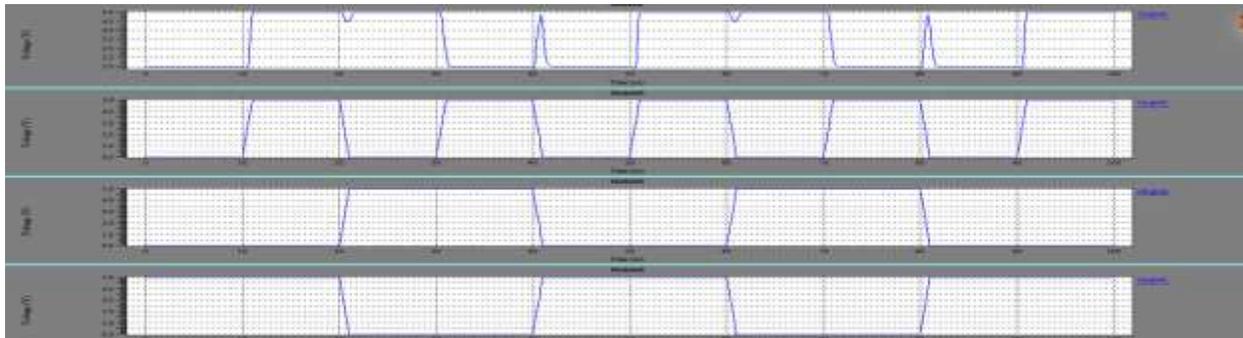
### 3.2 Performance Analysis

TABLE 1 depicts the Delay over a range of Power Supply voltages and as it is shown in the table that Pseudo NMOS Logic circuit for 2:1 multiplexer shows minimum Power and Delay.

**TABLE 1: Power Delay Product Comparison of different 2:1 Multiplexer Circuits**

PARAMETER	VDD (volt)	Existing DCVSL	MODIFIED DCVSL	Pseudo NMOS Logic	CMOS logic
Power consumption (watts)	0.7	6.493e-001	3.1764e+001	3.5345e+000	5.746e-001
	0.8	7.532e-001	1.764e+001	1.7084e+001	6.648e-001
Delay	0.7	1.82ns	1.64ns	1.64ns	1.64ns
	0.8	2.19ns	1.27ns	1.09ns	1.09ns

The simulation result for Pseudo NMOS Logic is shown in Fig.5,



**Fig. 4 Simulation result for pseudo NMOS logic based 2:1 multiplexer circuit**

## IV. CONCLUSION

The post layout simulation have been done for the for pseudo NMOS logic based 2:1 multiplexer circuit in order to show the improvement in power consumption and delay over different supply voltage. The proposed 2:1 multiplexer has been designed and proved it to be a better option for low power complex system design. The net

effect is that for pseudo NMOS logic based 2:1 multiplexer circuit shows a much better performance compared to all other 2:1 multiplexer. In future different logic are going to implement to obtain low power consumption and delay.

## REFERENCES

- [1] Yano, K., Sasaki, Y., Rikino, K. and Seki, K. (1996) "Top-down pass transistor logic design", IEEE Journal of Solid-State Circuits 31(6), 792–803.
- [2] Shen-Fu Hsiao, Jia-Siang Yeh and Da-Yen Chen, "High-performance Multiplexer-based Logic Synthesis Using Pass-transistor Logic", VLSI Design, 2002 Vol. 15 (1), pp. 417–426.
- [3] Kiseon Cho and Minkyu Song, "Design Methodology of a 32-bit Arithmetic Logic Unit with an Adaptive Leaf-cell Based Layout Technique" VLSI Design, 2002 Vol. 14 (3), pp.249-258.
- [4] P. K. Lala and A. Walker, "A Fine Grain Configurable Logic Block for Self-checking FPGAs", VLSI Design 2001, Vol. 12, No. 4, pp.527-536.
- [5] Jan M. Rabaey, Digital Integrated Circuits; a design prospective, Upper Saddle River: Prentice-Hall, 1996.
- [6] Heller, L. G. et al., "Cascode Voltage Switch Logic: A differential CMOS Logic Family", Proceedings of 1984 IEEE International Solid-state Circuits Conference, pp. 16-17.
- [7] Ila Gupta, Neha Arora, Prof.B.P.Singh, "Analysis of Several 2:1 Multiplexer Circuits at 90nm and 45nm Technologies" International Journal of Scientific and Research Publications, Vol.2, Issue.2, February 2012.
- [8] Ila Gupta, Neha Arora, Prof.B.P.Singh, "Design and Analysis of 2:1 Multiplexer for High Performance Digital Systems" International Journal on Electronics & Communication Technology (IJECT) Vol.3, Issue1, Jan-March 2012, pp-183-186.

# ECONOMIC GROWTH IN INDIA THROUGH SEZ: A CASE STUDY OF NOIDA SPECIAL ECONOMIC ZONE, NOIDA

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## ABSTRACT

*Today is the era of Globalization and international trade is the precursor of it. International trade comprising of exports and imports, shapes the world we live in. In order to become a developed nation and to have a sound economy, it is essential to raise the level of a country's export. Exports are helpful in generating foreign exchange inflow which would further help in developing the economy. India has rightly undertaken the journey towards Globalization as it does not want to be left behind in encasing the fruits of global trade.*

*India is gifted with innumerable advantages in almost every sphere, viz., amenable environment, huge strength of skilled human resources, cost-effective technology and other natural resources, to produce a variety of goods and services. Despite having such favorable conditions for international trade, it could not grow up to the desired levels. Since 1950-51, exports have seen a high growth, but still it is lesser than the growth in imports, resulting in a highly negative Balance of Trade.*

*A stable and hassle-free environment is essential to carry out exports and this in turn would require raising the level of production, reduction in duties and taxes and other forms of financial support. Keeping these goals in mind, the Government of India designed a framework to setup Special Economic Zones (SEZs) throughout the country which are involved in the production of cheap and quality export oriented goods and services. To evaluate and analyze all these and other related aspects, the research study entitled "Economic Growth in India through SEZ: A Case Study of Noida Special Economic Zone, Noida" is undertaken.*

**Keywords: Economy, Growth, Indian Policy, NSEZ, SEZ.**

## I. INTRODUCTION

India has shown an increasing trend in foreign trade since the last five decades as per the plan framed by the Government of India. India achieved a major milestone in its journey towards globalization when the Government decided to established specially delineated duty free enclaves, appropriately named as Special Economic Zones

(SEZs). SEZs are effectively contributing in generation providing employment, export promotion, inflow of foreign capital and many more areas. Moreover, the Government is providing number of incentives and various schemes have been launched to promote SEZs.

Although the existing SEZs are functioning very well, still some issues were needed to be relooked such as whether the existing SEZs are working up to their full potential, whether, especially, NOIDA Special Economic Zone (NSEZ) has been successful in attaining its mission, whether the various incentives and schemes provided to NSEZ are sufficient, whether any new step is being taken by the Government to promote NSEZ, etc. These and many more questions were needed to be answered in a comprehensive manner, hence, to address all these issues, an attempt was made to explore various dimensions concerned with NSEZ through this present research. The Study included the following objectives:

- ❖ To analyze Indian Global Trade
- ❖ To review Indian Economic Policies in context of Special Economic Zones (SEZs)
- ❖ To get an insight into the salient features and performance of SEZs in India
- ❖ To have a look at the organizational structure of NOIDA SEZ (NSEZ)
- ❖ To examine the functioning and appraise the performance of NSEZ
- ❖ To investigate the factors affecting NSEZ and assess future plans of it.
- ❖ To study the steps taken by the Government of India regarding NSEZ

## II. RESEARCH METHODOLOGY

This research work was based on both primary and secondary data. The main sources of secondary data were various Journals, Periodicals, News Papers and documents of the related Institutes. The study was mainly based on data compiled from the Annual Report of the related Institutions, Government Offices and Agencies, especially NOIDA Special Economic Zone. The study directly dealt with the functioning of NOIDA Special Economic Zone (NSEZ), for which detailed informations were collected directly from the NSEZ offices and other concerned Government institutions. Also, it is intended to collect relevant data from the various units operating in NSEZ. Information about other existing SEZs in India and other countries were also collected which helped in making comparative analysis and finding the status of NSEZ. The study was completed under the following stages:

**2.1 Collection of Secondary Data:** In this phase, the data and information about the international business, environment, export procedure, logistics, Government polices, special economic zones, export processing zones, export oriented zones and much more were collected through various books, journals, magazines, newspapers and websites.

**2.2 Collection of Primary Data through Field Survey:** In this phase, as it reflects, the data, materials and information regarding NOIDA Special Economic Zone were collected from the various offices, agencies of the Government and by making discussions and interviewing the officials.

**2.3 Desk Research:** First and second phases were used time by time as per the demand of the research work. In the third phase, the data and material collected during the first and second phases were tabulated and analyzed in clear reference to the research objectives.

### III. RESEARCH INSTRUMENT

The primary information was collected through Direct Field Survey. The mode of data collection method was survey, which was usually incorporated for collecting raw information. One questionnaire was prepared to gather the relevant information by conducting a sort of personal interviews with the zone officials, unit's developers and the employees working there.

### IV. ANALYTICAL TOOLS

After collecting the relevant information with the help of primary and secondary data collection processes, the analysis was done from the entire data available. Tabulation and Graphical presentation methods have been used to analyze the entire study. Mathematical functions like percentage and conversion rate etc. were also used to analyze the study. By analyzing all facts and figures, the findings of the study were interpreted in a systematic manner which helped in bringing various particulars into light. In the end, some constructive suggestions were also proposed which would be helpful for the Government of India, Policy makers, Traders and developers involved in export business, NOIDA SEZ and Researchers.

### V. THE RESEARCH / STUDY

Economic policy is a powerful instrument for a nation on the part of policy makers to direct the economy in the desired direction. The Indian Economic Policy is formulated keeping into consideration India's immediate as well as long term economic requirements. Considering the need to enhance foreign investment and promote exports from the country and realizing the need of such environment which can prepare the domestic enterprises and manufacturers to compete globally, the Government of India announced the introduction of SEZ policy in April, 2000 in the country deemed to be foreign territory for the purposes of trade operations, duties and tariffs. According to the policy, the units in the Zone are required to be a net foreign exchange earner. Sales in the Domestic Tariff Area by SEZ units are subject to payment of full Custom Duty and as per import policy in force. Further Offshore banking units are being allowed to be set up in the SEZs. According to the policy, A SEZ can be set up in the public/ private/ joint sector or by State Governments. It was also being envisaged that some of the existing Export Processing Zones would be converted into Special Economic Zones.

To provide a stable economic environment for the promotion of Export-import of goods in a quick, efficient and hassle-free manner, Government of India enacted the SEZ Act, which received the assent of the President of India on June 23, 2005. The SEZ Act and the SEZ Rules, 2006 were notified on February 10, 2006. The SEZ Rules

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provides the simplification of procedures for development, operation, and maintenance of the Special Economic Zones and for setting up and conducting business in SEZs. This includes simplified compliance procedures and documentation with an emphasis on self-certification; single window clearance for setting up of an SEZ, setting up a unit in SEZs and clearance on matters relating to Central as well as State Governments; no requirement for providing bank guarantees; contract manufacturing for foreign principals with option to obtain sub-contracting permission at the initial approval stage; and Import-Export of all items. Various states in India have taken initiative to speed up the process of establishing the SEZ's in their respective lands and accordingly formulating rules and enacted laws. State policy on SEZ for various states is more or less similar to each other. U.P. Government has also taken steps in this direction and come out with a U.P. SEZ Act and policy framework. India, the fourth largest economy in terms of purchasing power parity and the tenth most industrialized country in the world- is one of the fastest growing developing economies today, a result of wide ranging on-going economic reforms undertaken in the early nineties. It has attracted favorable international attention due to its recent remarkable growth as well as its undoubted potential to sustain this performance for years to come. Its sustainable growth offers exciting opportunities to industry and business to the world over to partner India. India initiated the process of industrial growth in 1948 when it announced its first Industrial Policy Resolution, IPR 1948. The strategy adopted was one of import-substitution industrialization across all sectors. Export promotion had also been a concern of the government. Thus, attempts to promote the EPZ as an export platform on the basis of economic incentives, such as the provision of better infrastructure and tax holidays became a feature of Indian development.

Government of India offers a multitude of fiscal and non-fiscal concessions including Customs & Excise Concessions, Income Tax Concessions, 100% foreign direct investment is allowed in manufacturing sector in SEZ units, Exemptions on Banking/Insurance/External Commercial Borrowing, Exemption to sales made from Domestic Tariff Area to SEZ units, Exemption from Service Tax to SEZ units, permission of having non-polluting industries in IT and facilities like golf courses, desalination plants, hotels and non-polluting service industries in the Coastal Regulation Zone area, relaxation in Companies Act and, Exemption from port restriction under Drugs & Cosmetics Rules etc. Apart of all these, various facilities are also provided to the SEZ developers.

**NOIDA SEZ** is located in NOIDA, Uttar Pradesh. Uttar Pradesh has some unique features like the most populous state of the country, accounts for around 66% of the total exports from the country, the second largest exporter of the country after Bangalore, one of the largest untapped markets available to industry, large, inexpensive and disciplined labour oriented place, has more than 0.69 million industrial units in operation out of which 2616 are large and medium sized units providing employment to around 2.9 million people, has attracted the three highest industrial Entrepreneur memorandums and the five highest letter of intents. The state has 379 numbers of projects worth Rs. 649.80 billion (Approx. US\$13 Bn) under various stages of implementation. **NOIDA Export Processing Zone** was set up in 1985 by the Ministry of Commerce, Government of India. This special area is one of the country's seven export processing zones and the only one located off shore. After implementation of SEZ Act, the existing **NEPZ converted into NSEZ**. On-site customs clearance, warehouse with clearing and forwarding facilities, nationalized banks and a post office are also functioning here. Special Economic Zone NOIDA is located in the most developed

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part of UP falling within National Capital Region. The size of the zone has presently been set at 310 acre. The official work is distributed among various Assistant Development commissioners, account officer, superintendent and appraisers under the guidance of deputy, joint and development commissioner. Apart of general facilities, various banks, post office, restaurant, warehousing corporation, transportation agent and travel planner also exist in the zone. Salient features of the zone are:

- Total Area of Zone: 310 Acres
- Only 24 kms away from Delhi.
- First Land Locked SEZ
- Skilled manpower available at competitive rate
- Close to Technology and other educational institute's of repute
- Connected to Super Highway
- Powers of Labour Commissioner delegated to DC
- Fully Developed Infrastructure and Operational Ease.
- Efficient Telecom Facilities.
- Dependable Local Transport Services.
- Inland Container Depot (ICD, inside the zone) And Delhi International Airport In closes Proximity.
- Medical Facilities for Workers.
- Banking and Insurance Facilities.
- Postal Including Foreign Postal Services.
- Offshore Banking Unit.
- Public Utility status granted by the Uttar Pradesh (UP) Government
- Exemptions given by the Government of UP
- Continuous Power Supply
- Efficient Communication Infrastructure
- Dependable Local Transport Service
- On The Spot Custom Clearance and Warehousing Facilities
- World class Banking Infrastructure within the zone
- Separate Complex and Support service for Gems & Jewellery Units
- Satellite data link communication facility for software exporters

The units in NSEZ are producing high standard products in large volume. This Zone is producing almost all type of goods which are having very good share in export. Engineering Goods, Gems & Jewelry, Textile, Readymade & Garments, Chemicals, Drugs, Pharmaceuticals, Leather Goods, Plastic, rubber, synthetics, Electronic software and Hardware are the major sectors in which NSEZ is putting its efforts for high production. Gems & Jewelry and Engineering goods are the prime products being manufactured in NOIDA SEZ sharing 35 and 34 units respectively. Apart of it, Electronic Hardware and Software are also produced in 20 and 18 units respectively within the zone. The

units for Chemicals, pharmaceuticals, leather, sports goods and other miscellaneous products are not in large volume but are producing quality goods in good quantity.

NSEZ the only Central Government SEZ in the northern India, headed by the Development Commissioner, was set up in 1985 in Noida Phase-II on a 310 acre plot of land. Government of India has so far invested a sum of Rs. 10570 million on its development. These two sectors have contributed more than 30 per cent of the export turn over during the year 2011-12. NSEZ has maintained high export growth rate for the past many years. Exports from the zone during 2011-12 has been Rs. 109847.50 million. Employment in the zone has gone up from 32550 in June, 2009 to 44228 in March, 2013. During the same period, number of operational units in the zone has increased from 245 to 335. Besides, one hundred units are under active implementation. NSEZ has 202 developed plots of varying sizes, besides fourteen standard design factory complexes that can accommodate one hundred seventy six units mtrs.). One SDF block of sixteen units is also under construction. Future expansion has been strategically planned and when implemented fully, the zone would be able to provide 224 SDF units.

**Table 1: SECTOR WISE EXPORTS OF NSEZ****(Rs. in million)**

S.No.	Product Sector	2008-09	2009-10	2010-11	2011-12	2012-13
1.	Textile/Garments	1096.6	1673.17	1552.3	929.5	976.80
2.	Computer Software	5763.0	7408.63	10588.1	13295.4	14455.90
3.	Electronic Hardware	2342.7	3977.62	8706.9	6446.0	8922.30
4.	Electronics*	--	--	--	2794.5	3184.60
5.	Engineering	3221.8	3876.16	1521.5	1689.2	2051.60
6.	Gem & Jewellery	46659.3	33094.69	63851.9	55876.8	44248.90
7.	Chemical & Pharmaceuticals	207.9	360.87	220.6	417.9	682.80
8.	Leather & sports goods	261.3	297.47	116.0	144.3	408.80
9.	Plastic & Rubber	154.1	289.45	155.2	257.3	340.10
10.	Food & Agro Industry*	105.3	121.83	648.8	252.7	266.70
11.	Tobacco Products*	400.1	561.50			
12.	Misc. Items*	24323.9	3420.67	4822.3	4146.4	5679.50
13.	Trading	78945.1	31082.11	1867.2	23197.4	0
	<b>TOTAL:</b>	<b>163081.0</b>	<b>85602.67</b>	<b>94050.8</b>	<b>109847.5</b>	<b>81779.50 *</b>

\* These sectors have been added subsequently.

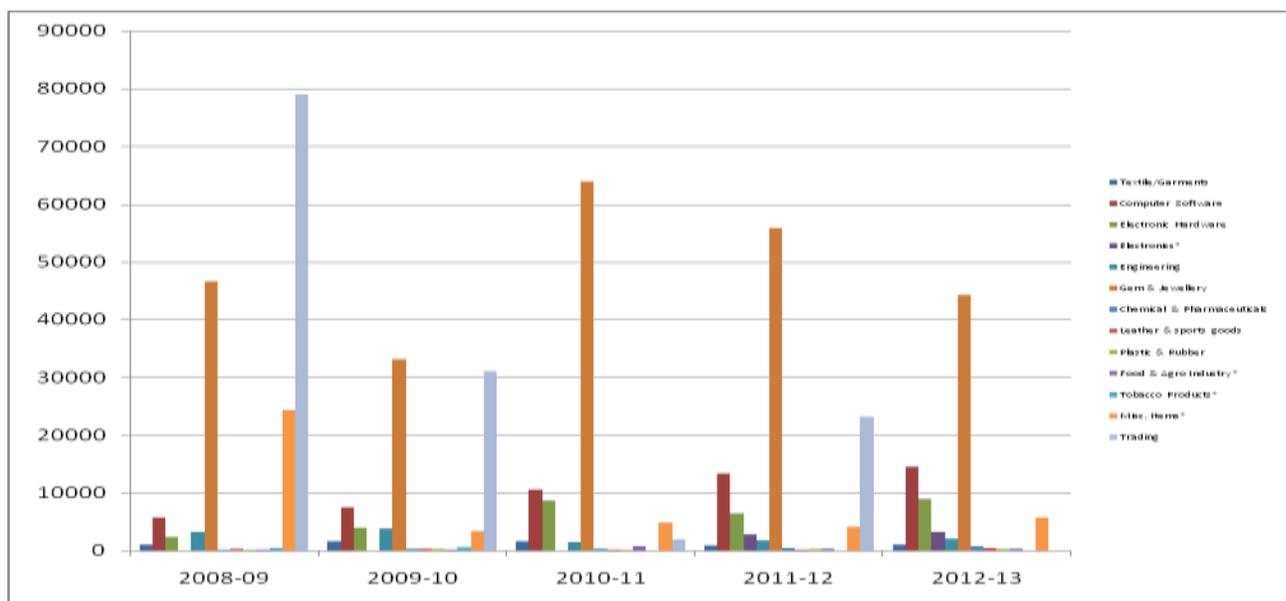


Figure 1: SECTOR WISE EXPORTS OF NSEZ

Table 2: IMPORTS IN NSEZ (Rs. in million)

S. No.	Nature of goods imported	2008-09	2009-10	2010-11	2011-12	2012-13
1.	Capital Goods	94.40	239.81	752.00	1317.7	880.60
2.	Raw material/components etc.	137643.70	65441.5	61755.00	67353.4	46945.10
	<b>TOTAL:</b>	<b>137738.10</b>	<b>65681.31</b>	<b>62507.00</b>	<b>68671.1</b>	<b>47825.70</b>

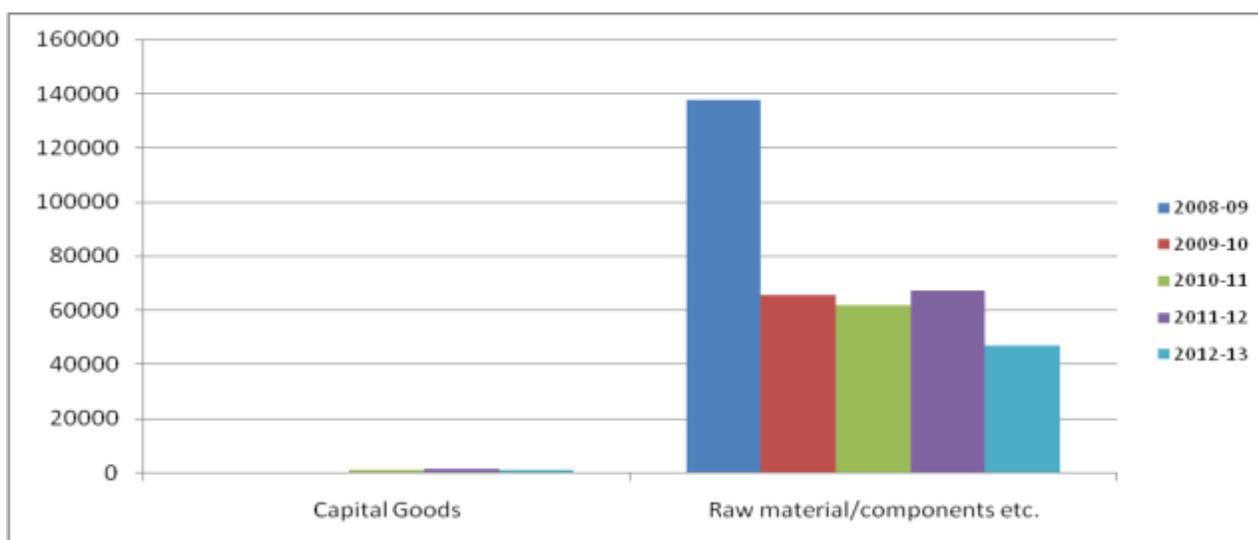


Figure 2: IMPORTS IN NSEZ

Finance is the blood of an organization. It can be generated through different types of funds viz. private, government, foreign and NRIs. The Private sector is playing key role in fulfilling the requirement of finance of NOIDA SEZ by dominating 70% (approx.) of total investment made by all sectors. Government, Foreign and NRI sectors are also putting their efforts which are also a great help for NSEZ. Investment (as on 31/03/2013) are Government: Rs. 1057.03 Crores, Private: Rs. 2970.56 Crores, FDI : Rs. 149.22 Crores. Whereas the employment (as on 31/03/2013) is 44224 Persons, Units in Production (as on 31/03/2013) are **335**.

By benefits of tax exemptions, the SEZs are saving tax and generating huge profit but the Government of India is losing revenue generated by such taxes. Therefore, the SEZs are required to play a direct and active role in Indian economy. The NOIDA SEZ is contributing to Indian Economy with the help of following efforts made by:

- Fetching Foreign Currencies through Foreign Direct Investment and Export
- Providing Employment
- Centralizing business activities
- Managing inflation
- Utilizing available Resources optimumly
- Making relation with other countries

The NOIDA SEZ is putting so many efforts for generating and making high volume of exports by various actions which are as follows:

- Export through Exhibitions
- Personal Carriage of Gems and Jewellery for Export Promotion Tours
- Export through Show Rooms Abroad /Duty Free Shops
- Personal Carriage of Import/Export Parcels Including Through Foreign Bound Passengers
- Export/Import by Post / Courier
- Replacement/ Repair of Goods
- Sale of Unutilized Material / Destruction

## VI. CONCLUSION

THERE are always various factors which affect the working procedure of a firm / corporation / organization, same happens with NOIDA SEZ. Both internal and external factors affect the zone in positive as well as negative way. Satellite Data Link Communication Facility, Separate Complex and Support Facilities for Gems & Jewellery Units, Locational Advantage, Fully Occupied by Units, No Power Cut Zone, High Profiled Companies, High Employment Rate, Excellent Infrastructure, Cost Effective Skilled Manpower, Frequent Transport Service, Warehousing Facilities and World Class Banking Facility are affecting zone internally. Whereas Tax Policy, Labour Laws, Employment, Domestic Tariff Areas, Gender Ratio, Competition, NSEZ and India's Energy Security, Developers of

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NSEZ, Foreign Direct Investment Policy, NRI Investment Policy and Banking / Insurance / External Commercial Borrowings affect the zone externally. The **future plans** of the zone are:

- To bring NOIDA SEZ at First position.
- To fetch more FDI and NRI investment.
- To generate more employment.
- To make more export.
- To identify sources available in India for purchasing raw material and capital goods as imports can be reduced.
- To use best technologies for better productions.
- To emphasize over more infrastructure development.
- To maintain healthy relation with existing countries.
- To make relations with new countries.

For executing these plans positively, the authority of the zone has to take wise steps and to focus sharply over the units operated in the zone and new units to be setup and their developers. Regarding it, the zone is also planning to provide more benefits to the units and their developers. No doubt that NOIDA SEZ is doing extremely well since its origin in all areas but still requires more initiatives to be taken for further development. **Few suggestions**, which will help the NSEZ in performing much better, are as follows:

All the zones must have a **strong coordination** among them by which they can support each other by inter-exchanging Raw Material, Capital Goods, Technologies and Working Style. This will help all zones of the country in producing standard products efficiently.

**Land expansion** can solve the problem of space as Indian government and NOIDA authority can allot more land to NSEZ for its expansion. This will help NSEZ in offering space to new units which can play participative role in more productions.

NOIDA SEZ can think about the **production of new products** in the zone like Sports Goods, Stone Made Statues and Handicrafts.

The zone can be divided in various sectors. For making strong control over them, different controlling units can be established in form of small zones within the NOIDA SEZ. It gives a feeling of various small **zones within the zone** and helps in controlling the entire setup as well as facilities and benefits can be provided easily and frequently to all.

**Transportation facility** always needs improvement. The zone can have own Charters, Goods Carrier Trains and Helicopters to avoid the adverse impact of increasing population and increasing vehicles on Road which increase the traffic jam on road and cause delay in supply of goods (inward and outward).

The zone can also plan for having its own an **Aerodrome or Airstrip (Hawai Patti) within the zone** by which zone's officials can travel to various areas of countries as well as across the border for business purpose without any obstacles. This will also help in transporting goods in emergency and urgency.

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By research the produced commodities and goods can be improvised, therefore there is a need of a specific and standardize *Research and Development Cell within the zone* which can work at international level where the services of Indian as well as foreign scientist and engineers can be hired and quality goods can be produced.

Various quality control organizations in India and outside are in existence for quality checking like ISI, ISO etc. But the NOIDA zone also requires having its *own Quality Control Unit of international standard within the zone* which will have direct link with other existing quality control organizations and gives direction to all units in producing quality goods.

NOIDA SEZ must set *Chinese SEZs as its role model*. Chinese SEZs are big, economically sound and able to compete any firm or business of this world. By setting Chinese SEZs as roll model, NOIDA SEZ can work in that areas in which either it is lagging behind or even has not yet taken a step.

The zone must *identify new markets* in the world *for making export* where either the local markets are not developed or they do not have proper production facilities. It will help such nations in satisfying their needs and surely the zone as well as the nation will be developed.

**100% FDI** will transfer the controlling power and ownership to the investor which will open the door of dependency for the local operators. Permission of 100% FDI is giving the clue of British ruling over India. The zone must retain the authority of all units operated in zone with itself and at least a small part of the total holding must be in Indian hands.

The zone must put more efforts in *identifying new markets* locally as well as at international level from which *goods can be purchased* with high quality and at lower prices.

NOIDA SEZ is also required to have its *export promotion unit within the zone* which will take care of all export promotional activities i.e. import of raw material, supply of finished goods, international marketing, channels of distribution, logistics measures etc.

**Gender ratio** in the zone is insignificant as 20378 men and 1920 women are providing their services as workers. The zone is following the ratio of 10.61:1 which is showing the non-reliability over women. As per my suggestion, the NSEZ must look in this matter with an instant effect. Both men and women must get equal opportunity. This will not only help the zone but also in economical and social development of the country.

## BIBLIOGRAPHY

- ICRIER; “Export Processing Zones In India: Analysis Of The Export Performance” Working Paper No. 148 by Aradhna Agarwal Nov., 2004
- Employment News, Weekly; “New dimensions in Foreign Trade Policy 2004-09”, 30<sup>th</sup> Oct.,2004
- ICRIER; “Performance Of Export Processing Zones: A Comparative Analysis Of India, Sri Lanka And Bangladesh” Working Paper No. 155 by Aradhna Agarwal, Nov., 2004

YMCA, New Delhi (India), 1 Feb 2015

[www.conferenceworld.in](http://www.conferenceworld.in)

- Confederation of Indian Industry Northern Region, New Delhi; “Special Economic Zones-Engines for growth”, May, 2006
- Confederation of Indian Industry Northern Region, New Delhi; “India SEZ Summit 2006-Driving Investment & Exports : Building Growth Centres”, May, 2006
- The Metropolitan Corporate Counsel; “An interview based on SEZs with Nishith Desai, founder of Nishith Desai Associates, Nov., 2006
- Govt. of India: “Rationalization of the FDI Policy” Press Note 4 (2006 series), ministry of Commerce & Industry, Department of Industrial policy and Promotion, 2006
- Colliers International India Research; “Policy View- Special Economic Zones”, January, 2007
- The Economic Times, New Delhi; “Freeze on SEZs likely to go”, 12<sup>th</sup> March,2007
- The Times of India, New Delhi; “Kalam suggests for three SEZs in Meghalaya”, 17<sup>th</sup> March,2007
- The Times of India, New Delhi; “India to make SEZ in its own way”, 30<sup>th</sup> March,2007
- The Times of India, New Delhi; “Centre all set to revive policy on SEZs”, 31<sup>th</sup> March,2007
- The Times of India, New Delhi; “SEZ Policy in for complete overhaul”, 4<sup>th</sup> April,2007
- The Times of India, New Delhi; “New SEZ rules short of what’s needed”, 8<sup>th</sup> April,2007
- Financial Management, Caspian Publishing, “Twilight Zones”, April, 2007
- The Hindustan Times, Jaipur; “Govt clears 16 SEZs, keep RIL on hold”, 9<sup>th</sup> May, 2007
- ICRIER; “Impact of Special Economic Zones on Employment, Poverty and Human Development ” Working Paper No. 194 by Aradhna Agarwal, May, 2007
- ASIEN,106; “Special Economic Zones in India-An Introduction”, Jona Aravind Dohrmann, January,2008
- The Economic Times, New Delhi; “SEZ Matters: FINMIN-SPONSORED”, 12<sup>th</sup> January,2008
- Business Standard; “Fin Min asks ICRIER to revisit SEZ findings” 7<sup>th</sup> March, 2008
- Dainik Amar Ujala (Hindi Newspaper, Meerut issue); “SEZ se Aath Lakh Logoo ko Rojgar Milega”, 17<sup>th</sup> Sep., 2008,
- Indian Business Journal; “Island of Excellence”, Sep.,2008

## BOOKS

- Agarwal, N. K. and Ramani VV: Special Economic Zone: to be or not to be, ICFAI Book House, Hyderabad
- Aswathappa- International Business, Tata McGraw-Hill, New Delhi, 2008
- Cherunilam, F.- International Business- Text and Cases, Prentice Hall of India, New Delhi, 2008
- Daniels- International Business, Pearson Education, New Delhi, 2007
- Hill C W- International Business, Tata McGraw-Hill, New Delhi, 2007
- Joshi, S.M.- Macroeconomic Policies- Issues and Evidence, Anmol Publication Pvt. Ltd., New Delhi, 1995
- Lal, D.- India in the World Economy, Oxford University Press, New Delhi, 2006

**REPORTS & HANDBOOKS**

- Broachers published by NOIDA SEZ, NOIDA

**WEBSITES**

- [www.sez.nic.in](http://www.sez.nic.in)
- [www.sezindia.gov.in](http://www.sezindia.gov.in)
- [www.sezindiaweb.com](http://www.sezindiaweb.com)
- [www.nepz.gov.in](http://www.nepz.gov.in)
- <http://www.nsez.gov.in>
- [http://finance.indiamart.com/investment\\_in\\_india](http://finance.indiamart.com/investment_in_india)

# T-NORM BASED ENHANCED CRYPTOSYSTEM

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## ABSTRACT

Multibiometric systems are preferred over unibiometric systems due to their several advantages such as large population coverage. Multibiometric systems like the Government of India's Unique Identification Authority of India (UIDAI) in India, maintain large databases for storing individuals' biometrics. It is required to secure these databases from attackers. For this, multibiometric systems are combined with fusion and cryptography techniques. It leads to a highly secure system where an attacker cannot retrieve individual's data without knowing his both iris and the key. To secure dual iris of an individual, a single secure score is made by fusing their wavelet and texture features. For this, fusion is performed at two levels – feature and score. Texture features of same biometric are fused by feature level fusion. Then, this output is fused with wavelet features (obtained for the same biometric) using score level fusion and a single secure score is made. The final scores obtained from two irises are fused through Triangular Normalization (T-norm) to acquire higher recognition rate. Cryptography provides higher security to this data by encrypting it with a key, which is only known to the individual. In this paper, it is described how fusion of multiple features are encrypted using Rivest Cipher 5 (RC5) and how a highly secure database can be generated.

**Keywords:** Multibiometric, Score level fusion, Feature level fusion, T-Norm, Cryptography, RC5

## I INTRODUCTION

Multibiometric systems employ more than one biometry of an individual. They overcome the drawback of unibiometric systems. Multibiometric systems have high reliability, scalability, uniqueness and universality. When these systems are combined with key, they become highly secure. The scope of the paper is confined to store both the iris biometrics of an individual, fusing the features, encrypting with a key and store in the database. When a person has to be identified the images stored in the database are compared with the existing details.

The objective of this work is to examine the feasibility of creating a single multibiometric secure fused score when the traits that are being fused have different feature representations. This paper makes the following contributions,

1. Fusing the spatial and frequency features of same biometric trait (e.g. Left iris) into a single fused score.
2. Then fuse different biometrics' scores using score level fusion.

- Merge a key to individual's score level fusion output using Rivest Cipher 5 (RC5) encryption method and store them in database.

## II RELATED WORK

In previous works various frequency and spatial parameters of iris have been used in biometric cryptography systems. Authors in [1] proposed that out of fourteen Gray Scale Co-occurrence Matrix (GLCM) parameters, energy and contrast are more efficient. It is a statistical approach which provides relative position of the neighboring pixels in an image. Local Binary Pattern (LBP) and Local Ternary Pattern (LTP) are the most popular texture classifications which have shown excellent face detection performance in [2]. Support-LBP proposed in [3] established the relationship among all the pixels in the local region. The most discriminating features of iris are extracted in [4] using Haar wavelet and only the significant features are encoded. It provides low template sizes and fast verifications. In [5] authors have proposed PCA based Iris Recognition DWT algorithm. It has shown 99.07% accuracy with K-Nearest Neighbor (KNN) classifier, which is better when compared to SVM and RF. Compared to all other biometrics present, iris cryptography systems have highest accuracy rate [6]. Here a key of 140 bits length is generated from iris codes itself and FAR obtained is 0%. In Multi Biometric Crypto (MBC) systems more than single biometrics are fused and combined with key. A key can be combined either after or before the fusion. Based on it, [7] has proposed four major MBC models. In [8] the score level fusion has been applied after obtaining the feature level fusion scores of iris and face biometrics. They have proposed T-norms (Triangular Normalisation) for fusing different scores. With Hamacher t-norm 100% GAR has been obtained on PolyU Database, whereas with Frank t-norm same performance has been obtained on IITD Database.

## III PROPOSED SYSTEM

The main architecture of proposed system consists of dual iris, their feature extraction algorithms, fusion strategies and cryptography, as shown in Fig. 1. For an individual both irises are used for identification. The iris is an internal organ of an eye and its pattern variability among different persons is enormous. No two persons (even twins) have the same iris pattern. Also for an individual both iris patterns are different. Another major advantage of iris is its age stability i.e. the patterns remain same throughout the life time.

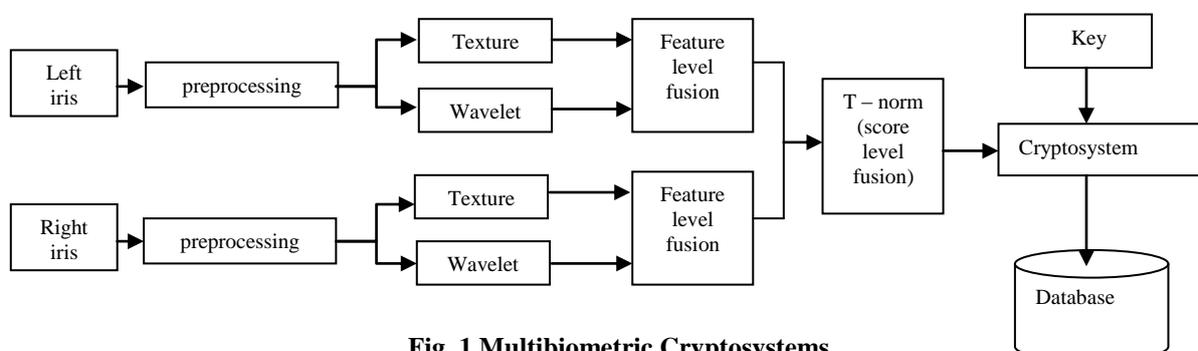


Fig. 1 Multibiometric Cryptosystems

## IV ALGORITHMS

The input iris images are colored and hence are converted into gray-scale images. Then the spatial and frequency parameters are extracted from these gray-scale images.

### 4.1 Texture feature extraction module

From each iris image texture features are extracted using LBP and LTP. These are non-parametric methods, robust to illumination and contrast variations. LBP is combined with GLCM to improve the detection performance. The LBP vector is created as,

**Step 1:** Divide the examined window to cells (e.g. 16x16 pixels for each cell)

**Step 2:** For each pixel in a cell, compare the pixel to each of its 8 neighbors. Follow the pixels along a circle, i.e. clockwise.

**Step 3:** Where the center pixel's value is greater than the neighbor, write 1. Otherwise, write 0. This gives an eight digit binary number.

**Step 4:** Compute the histogram, over the cell, of frequency of each number occurring.

**Step 5:** Optimally normalize the histogram

**Step 6:** Concatenate normalized histograms of all cells. This gives feature vector for the window.

It is a non-parametric method that captures the local structures of images by comparing each pixel with eight neighbors' [3].

$$LBP(z_c) = \sum f(z_n, z_c) 2^n \quad (1)$$

$$f(z_n, z_c) = \begin{cases} 1, & I(z_n) \geq I(z_c) \\ 0, & I(z_n) \leq I(z_c) \end{cases} \quad (2)$$

where  $I(z_c)$  is the intensity of center pixel and  $I(z_n)$  is the intensity of neighboring pixel. Using a statistical approach such as co-occurrence matrix will help to provide valuable information about the relative position of the neighboring pixels in an image. Given an image  $I$  of size  $N \times N$ , the co-occurrence matrix  $P_{\Delta x, \Delta y}(i, j)$  can be defined as,

$$P_{\Delta x, \Delta y}(i, j) = \sum_{p=1}^n \sum_{q=1}^m \begin{cases} 1, & \text{if } I(p, q) = i, I(p + \Delta x, q + \Delta y) = j \\ 0, & \text{otherwise} \end{cases} \quad (3)$$

where  $I(p, q)$  is intensity of the center pixel and matrix  $P(i, j)$  is GLCM. The four parameters that are calculated here are,

$$\text{Energy} = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} g^2(i, j) \quad (4)$$

$$\text{Contrast} = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (i - j)^2 \cdot g(i, j) \quad (5)$$

$$\text{Correlation} = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} (i - \mu)(j - \mu) \cdot g(i, j) / \sigma \quad (6)$$

$$\text{Homogeneity} = \sum_{i, j} \frac{p(i, j)}{1 + |i - j|} \quad (7)$$

## 4.2 Wavelet Feature Extraction Module

Wavelets decompose the data of the iris region into components that appear at different resolutions. The Haar wavelet is one of the simplest wavelet transform which can transform huge data sets to considerably smaller representations. Here the image is decomposed up to 3<sup>rd</sup> level. The first level Haar wavelet decomposition is shown in Fig. 2.

LL1	LH1	LH
HL1	HH1	
HL		HH

Fig. 2 Haar Wavelet Decomposition

## 4.3 Feature Level Fusion Module

Here, the different feature sets extracted from multiple biometric sources are combined at feature level fusion. It reduces the dimensionality of the feature vector. But it provides concatenation only for compatible feature sets, such as face and thermal face. The average technique employed here, computes  $x'$  as,

$$x' = \frac{X - \min(F(X))}{\max(F(X)) - \min(F(X))} \quad (8)$$

where,  $X$  and  $x'$  denote a feature value before and after normalization, respectively. And  $F(x)$  is the function that generates  $x$ . The average technique is effective when the minimum and the maximum values of the component feature values are known beforehand.

## 4.4 T-Norm Fusion Module

T-norm is one of the score level fusions. It is defined in [8] as the class of aggregation operators such as product rule and sum rules. Here four t-norms are implemented. The two separate scores obtained from different biometrics are fused to make a single secure sketch by T-norm fusion. It is a score level fusion which is done after obtaining the feature level fusion scores of left and right iris. T-norms are applied to fuse scores  $S_1$  and  $S_2$  in score level, which are as follows,

$$\text{Yager} : [1 - \{ (1-S_1)^p + (1-S_2)^p \}^{1/p}, 0] \quad (9)$$

$$\text{Frank} : \log_p \left( 1 + \frac{(p^{S_1} - 1)(p^{S_2} - 1)}{p - 1} \right), \quad p > 0 \quad (10)$$

$$\text{Einstein product} : \frac{S_1 S_2}{2 - (S_1 + S_2 - S_1 S_2)} \quad (11)$$

$$\text{Hamacher} : \frac{S_1 S_2}{S_1 + S_2 - S_1 S_2} \quad (12)$$

#### 4.5 RC5 Algorithm

Cryptography is a method of converting plain data into cipher data using a key (encryption). Then the plain data is retrieved from cipher data using same key (decryption). There are various algorithms for securing the biometrics information using different keys. Here, RC5 algorithm has been used for securing the single secure fused score. The key is merged with the fused data and the output is stored in the database. For testing, again the same is used to merge with the test fused data and the output is matched with stored sketches in the database.

RC5 is a symmetric block cipher which uses Feistel-like structure. A novel feature of RC5 is the heavy use of data-dependent rotations. RC5 has variable size block (32/64/128 bit), variable size key (0-2048 bit) and variable number of rounds (0-255). Also the encryption and decryption algorithms are extremely simple. Here, the following are selected,

- i. Key size – Random
- ii. Number of rounds – 64
- iii. Block length – 32 bits

#### V RESULTS

In our implementation we have used real time iris images which we have collected from Roop Eye Hospital, Meerut (UP). The algorithms are implemented in MATLAB. The key size is random here i.e. between 0-2044 bits. For a single iris image gray-scale, LBP constructed and LTP output images are generated as given in Fig.3, Fig.4 and Fig. 5.

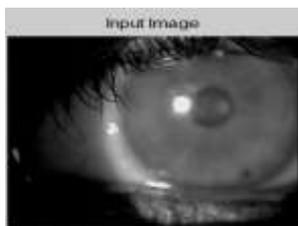


Fig. 3 Gray-scale image

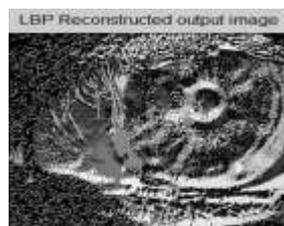


Fig. 4 LBP image

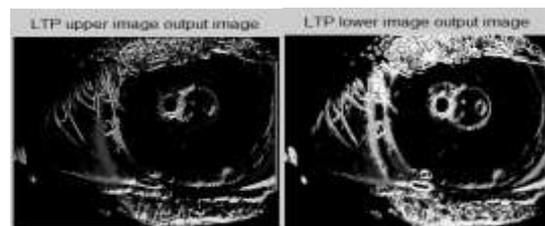


Fig. 5 LTP images

Then the GLCM parameters are calculated as,

```
spatial parameters OUTPUT
Contrast: 4.7196

Homogeneity: 0.6478

Energy: 0.0497

Correlation: 0.5715
```

```
GLCM parameters are successfully loaded in the library for training
```

The same outputs are obtained for the second iris too. Then the parameters obtained from two different irises (left and right) of an individual are fused by T-norm methods.

```
FUSION OUTPUT
hamachar: 1.0526
Yagar: 8.8882
Frank: 55.4518
EP: 1.0512
```

This fused output is merged with a key and stored in the database. Likewise, for all the iris pairs a fused score is generated and encrypted with key. The key is only known to the individual and it is impossible to access the database without knowing all biometrics and key.

## VI CONCLUSION AND FUTURE WORK

The proposed fusion framework for the design of MBC protects multiple templates of a user by generating a single secure sketch using T-norm. The feasibility of such a framework has been demonstrated for real-time iris database. This work has discussed various feature extraction and fusion modules along with RC5 encryption algorithm. Fused scores have been obtained of each iris from frequency and spatial features. Then these scores are successfully merged into single secure score by T-norm, which is further encrypted with key. The advantage of proposed approach is increase in recognition accuracy.

The critical issues that need to be investigated are,

1. Key generation is not automatic. Hence, it is like a PIN which user must remember. For this the key should generate automatically from one of the biometrics.
2. Instead of using only irises, inclusion of palm and fingerprint will increase the recognition rate and the system will be highly universal, i.e. if one biometric gets corrupt, other can be used for authentication.

## REFERENCES

- [1] Baraldi A. and Parmiggiani F., An Investigation of the Textural Characteristics Associated with GLCM Statistical Parameters, IEEE Transactions on Geoscience and Remote Sensing, Vol. 33, No. 2, pp. 293-30, 1995.
- [2] Satpathy A., Jiang X. and Eng H. L., LBP-Based Edge-Texture Features for Object Recognition, IEEE Transactions on Image Processing, Vol. 23, No. 5, pp. 1953-1964, 2014.
- [3] Nguyen V. D., Nguyen D. D., Nguyen T. T., Dinh V. Q., and Jeon J. W., Support Local Pattern and Its Application to Disparity Improvement and Texture Classification, IEEE Transactions on Circuits and Systems for Video Technology, Vol. 24, No. 2, pp. 263-276, 2014.
- [4] Abdullah A. M., Al-Dulaimi F. H., Waleed Al-Nuaimy and Ali Al-Aataby, Efficient Small Template Iris Recognition System Using Wavelet Transform, International Journal of Biometrics and Bioinformatics (IJBB), Vol. 5, No. 1, pp.16-27, 2010.
- [5] Shashi K., Raja K. B., Chhootaray R. K. and Sabyasachi P., PCA Based Iris Recognition Using DWT, Int. J. Comp. Tech. Appl., Vol. 2, No. 4, pp. 884-893, 2011.
- [6] Hao F., Ross A. and Daugman J., Combining Crypto with Biometrics Effectively, IEEE Trans. Comput., Vol. 55, No. 9, pp. 1081-1088, 2006.

- [7] Fu B., Yang S., Li J. and Hu D., Multibiometric Cryptosystem: Model Structure and Performance Analysis, IEEE Transactions on Information Forensics and Security, Vol. 4, No. 4, pp. 867-882, 2009.
- [8] Hanmandlu M., Grover J., Gureja A. and Gupta H., Score Level Fusion of Multimodal Biometrics Using Triangular Norms, Pattern Recogn. Lett., Vol. 32, No. 14, pp. 1843-1850, 2011.

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# EFFECT OF GRAIN SIZE ON VOLUME THERMAL EXPANSION OF NANOMATERIALS

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## ABSTRACT

*Size effects on Volume thermal expansion of nanomaterials. The experimental measurements show that volume thermal expansion of nanosolids is larger than those of their bulk counterparts. On considering the surface effect, a simple model is derived to study the size dependence of volume thermal expansion of nanomaterials for spherical nanoparticles, nanowire and nanofilms. The size dependence of Zn nanowire is found to present the good agreement with the existing experimental results. We have also computed the size dependence volume thermal expansion of Si and Ni for spherical nanosolids, nanowires and nanofilms. It is shown that volume thermal expansion of nanomaterials decreases with increase in the grain size.*

**Keywords:** *Size Effect, Cohesive Energy, Thermal Expansion, Nanosolids*

## I INTRODUCTION

Size affects the thermoelastic properties of the nanosolids. A substantial research has been done on understanding their physical and chemical properties of the nanosolids<sup>1</sup>. Nanomaterials with particle size of 1-100 nm are of current interest because they show noble physical and chemical properties that may differ from those of the corresponding bulk counterparts<sup>2</sup>. Nanosolids can be the spherical nanosolids, nanowires or nanofilms. Many physical properties such as hardness, melting temperature, sintering ability and electronic structure may be dependent upon the particle size<sup>3</sup>. Gold and silver at nanosize have proven many chemical and physical properties. It is observed that elastic modulus and melting point change linearly with the inverse of size of nanomaterials<sup>4</sup>. Theoretical reconciliation of the observed size dependence of the lattice strain, elastic modulus and melting point for Ag and Au nanostructures can be understood by the theory of undercoordination<sup>5</sup>. Chang *et al.*<sup>6</sup> observed that the volume thermal expansion of Cu nanomaterial is three times the linear thermal expansion irrespective to the crystal orientations. Molecular dynamics simulation to study the thermomechanical properties of copper nanofilm is studied at different temperatures<sup>7</sup>. Thermal expansion coefficient of Zn nanowire was measured using the *in situ* high resolution X-ray diffraction technique<sup>8</sup>. Qi<sup>9</sup> calculated the size dependent melting temperature of Pb, Sn, and In nanoparticles using the theory that the cohesive energy of the nanosolids is the sum of interior atoms and the surface atoms, which is read as

$$E_{Total} = E_0(n - N) + \frac{1}{2} E_0 N, \quad (1)$$

Where  $n$  is the total number of nanoatoms,  $N$  is the total number of surface atoms and  $E_0$  is the cohesive energy per atom of the bulk material. Eq. (1) is redefined as

$$E_p = E_b \left( 1 - \frac{N}{2n} \right), \quad (2)$$

Where  $E_p = \frac{AE_{Total}}{n}$ ,  $E_b = AE_0$  and  $A$  is the Avogadro constant. Cohesive energy and melting temperature both describe the bond strength of the materials. Rose *et al.*<sup>10</sup> stated the linear relation of cohesive and melting temperature of the materials. Since  $N/n$  of nanosolid is a function of cohesive energy, so the relation developed for melting temperature is as follows<sup>9</sup>

$$T_p = T_b \left( 1 - \frac{N}{2n} \right), \quad (3)$$

$T_p$  And  $T_b$  are defined as the melting temperature of nanosolid and corresponding bulk modulus respectively.

Using Eq. (3) Qi<sup>9</sup> calculated the melting temperature of Sn, Pb and In nanosolids and it is shown that the melting temperature of the nanosolids decreases with decrease in solid size.

Thermoelastic properties of the nanomaterials depend upon the size of the particle. Experimentally, it is shown that the thermal expansion coefficient of nanomaterials is greater than that of their bulk equivalents. In the present work, we discussed a relation of volume thermal expansion  $V/V_0$  for Zn, Si and Ni nanosolids viz. spherical nanosolids, nanowires and nanofilms with free surface. The efficiency of the model is confirmed by the available experimental data.

## II METHOD OF ANALYSIS

Using molecular dynamics simulation, Prakashet *al.*<sup>11</sup> determined  $\alpha$  of a single wall carbon nano tubes (CNT) and used the temperature dependence of  $\alpha$  as:

$$\alpha = a + bT + cT^2, \quad (4)$$

One can write Eq. (4), in order to satisfy the initial boundary condition as follow:

$$\alpha = a + b(T - T_0) + c(T - T_0)^2,$$

$$\text{Or, } \alpha = \alpha_0 + \alpha_0'(T - T_0) + \alpha_0''(T - T_0)^2, \quad (5)$$

The first and second order derivatives of  $\alpha$  with  $T$  are defined by  $\alpha'$  and  $\alpha''$ . It is possible to define  $\alpha_0'$  and

$\alpha_0''$  in terms of  $\alpha_0$ , which reads as follows<sup>12</sup>:

$$\alpha_0' = \alpha_0^2 \delta_T,$$

$$\text{And, } \alpha_0'' = \alpha_0^3 \delta_T^2,$$

Where,  $\delta_T$  is the Anderson parameter and suffix 0 refers to the reference condition. So, Eq. (5) is written as

$$\alpha = \alpha_0 + \alpha_0^2 \delta_T (T - T_0) + \alpha_0^3 \delta_T^2 (T - T_0)^2, \quad (6)$$

In fact Eq. (6) is an incomplete equation in which higher order terms are excluded. On including all the higher order terms in Eq. (6), it becomes:

$$\alpha = \alpha_0 + \alpha_0^2 \delta_T (T - T_0) + \alpha_0^3 \delta_T^2 (T - T_0)^2 + \alpha_0^4 \delta_T^3 (T - T_0)^3 + \dots + \dots$$

$$\text{Or, } \frac{\alpha}{\alpha_0} = \{1 - \alpha_0 \delta_T (T - T_0)\}^{-1}, \quad (7)$$

By definition of thermal expansion coefficients which is read as

$$\alpha = \frac{1}{V} \left( \frac{dV}{dT} \right) \quad (8)$$

From equation (7) and (8), one can get

$$V = V_0 \left( \frac{1}{1 - \delta_T \alpha_0 (T - T_0)} \right)^{\frac{1}{\delta_T}}, \quad (9)$$

Where,  $V_0$  and  $\alpha_0$  are the reference value of the volume expansion and coefficient of thermal expansion respectively. For simplicity one can write  $\alpha_0$  as  $\alpha_p$ , which is a size and shape dependent parameter. Kumar *et al.*<sup>13</sup> derived the relation for  $\alpha_p$ , which is read as

$$\alpha_p = \alpha_b \left( 1 - \frac{N}{2n} \right)^{-1}, \quad (10)$$

$N$  is the total number of surface atoms and  $n$  is the total number of nanosolids.  $\alpha_b$  is coefficient of volume thermal expansion of bulk material. The surface atoms refer to the first layer of the nanosolid. The method to find  $N/2n$  for different shape of nanomaterials has been discussed by Heet *al.*<sup>12</sup>. The expression of  $N/2n$  has been tabulated in Table 1. Where,  $D$  is the diameter of spherical nanosolid,  $d$  is the diameter of atom,  $l$  is the length of nanowire and  $h$  is the height of nanofilm.

**Table 1.  $N/2n$  For Different Nanosolids<sup>12</sup>**

Nanomaterials	$N/2n$
Spherical Nanosolids	$2d/D$
Nanowires	$4d/3l$
Nanofilms	$2d/3h$

**Table 2. Input Parameters**<sup>8,14</sup>

Nanomaterials	$\alpha_b$ ( $10^{-5}\text{K}^{-1}$ )	d (in nm)
Zn	0.54	0.495
Si	0.3	0.337
Ni	3.3	0.248

From Eqs. (9-10), the general expression for  $V/V_0$  becomes as:

$$\frac{V}{V_0} = \left\{ 1 - \alpha_b \delta_T \left( 1 - \frac{N}{2n} \right)^{-1} (T - T_0) \right\}^{-1/\delta_T}, \quad (11)$$

Putting the values of  $N/2n$  From Table 1 in Eq. (11), the expressions for  $V/V_0$  for different shape and size of nanosolids become as:

For spherical Nanosolid

$$\frac{V}{V_0} = \left\{ 1 - \alpha_b \delta_T \left( 1 - \frac{2d}{D} \right)^{-1} (T - T_0) \right\}^{-1/\delta_T}, \quad (12)$$

For Nanowire

$$\frac{V}{V_0} = \left\{ 1 - \alpha_b \delta_T \left( 1 - \frac{4d}{3L} \right)^{-1} (T - T_0) \right\}^{-1/\delta_T}, \quad (13)$$

And for Nanofilm

$$\frac{V}{V_0} = \left\{ 1 - \alpha_b \delta_T \left( 1 - \frac{2d}{3h} \right)^{-1} (T - T_0) \right\}^{-1/\delta_T}, \quad (14)$$

In the present paper, we use Eqs. (12-14) to study the temperature and size dependence volume thermal expansion for different nanomaterials. Throughout the calculation the value of  $\delta_T$  is taken four as discussed by Kumar and Kumar<sup>15</sup>. Using Eqs. (12-14) and input parameter as given in Table 2, we calculated the  $V/V_0$  of Zn, Si, Ni nanosolids in different forms for spherical nanoparticles, nanowire and nanofilms.

### III RESULTS AND DISCUSSION

The grain size dependence volume thermal expansion ( $V/V_0$ ) of Zn, Si and Ni nanomaterials has been calculated from Eqs. (12-14) from the room temperature to the higher temperature. A positive volume thermal expansion is noted in all nanomaterials in different shapes (spherical, nanowire, and nanofilm), which may be understood by the effects of the anharmonic lattice potential on the equilibrium lattice separations and characterized by the Gruneisen parameter<sup>16</sup>. The results are reported in the Figs. 1-7 along with the available experimental data. For comparison purpose we also included the temperature dependence bulk materials also. Experimentally thermal expansion coefficient of Zn nanowires were measured by high resolution XRD with temperature<sup>8</sup>.  $V/V_0$  is

calculated using Eq. (13) for the Zn nanowire (40 nm) and it is reported in the Fig 1 along with the available experimental data<sup>8</sup>. It is seen from the figure that up to the temperature about 600 K; our results are very close to the experimental data. Beyond 600 K, there is a slightly change with the experimental records. Figs. 2-4 predict the size dependence  $V/V_0$  of Si nanomaterials from temperature 300 K to 1050 K for different shapes, viz. spherical nanosolid, nanowire and nanofilm along with the temperature dependence bulk materials. In fig. 2 temperature dependence of Si nanomaterial in spherical shape at 10nm, 25 nm and 50nm is presented. It is clear from the plot that the as grain size decreases, volume thermal expansion increases with increase in temperature and the value is higher as compared to the bulk materials. From figs. 2-4, it is clear that as the shape is changing from spherical nanosolid to nanowire to nanofilm, the impact of size is decreasing. However, in all cases it is slightly greater than bulk materials. The theoretical predictions for Ni for different shape (spherical nanosolid, nanowire, nanofilm) are presented in the Figs. 5-7. It is established that as the size is decreasing volume thermal expansion increasing. The present theory is mainly to deal with the volume thermal expansion of nanosolids with free surface.

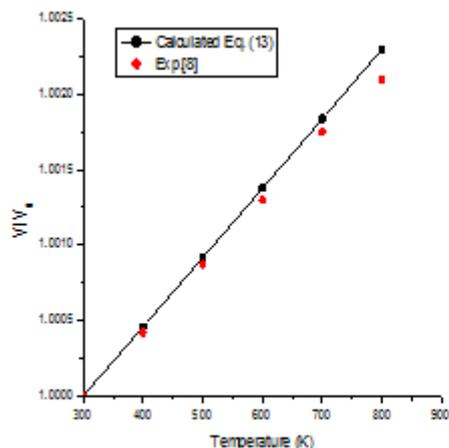


Fig.1. Temperature dependence of Zn nanowire(40nm)

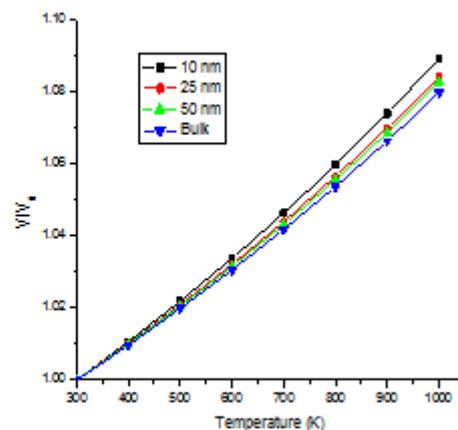


Fig.2. Temperature dependence of Si Spherical nanosolid by Eq.(12)

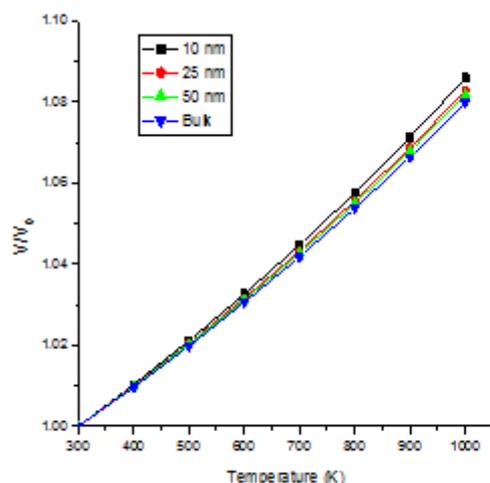


Fig.3. Temperature dependence of Si nanowire by Eq.(13)

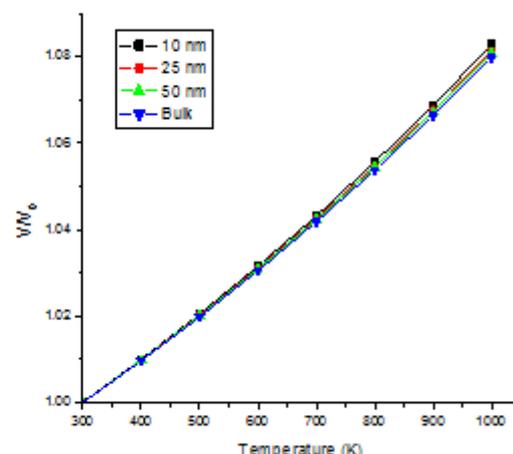


Fig.4. Temperature dependence of Si nanofilm by Eq. (14)

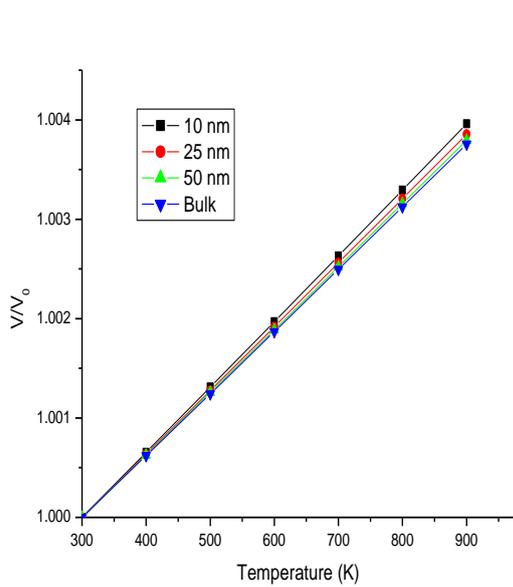


Fig.5. Temperature dependence of Ni Spherical nanosolid by Eq.(12)

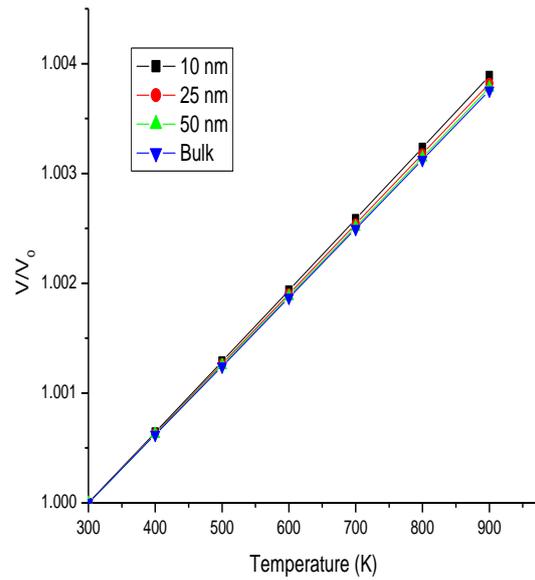


Fig.6. Temperature dependence of Ni nanowire by Eq. (13)

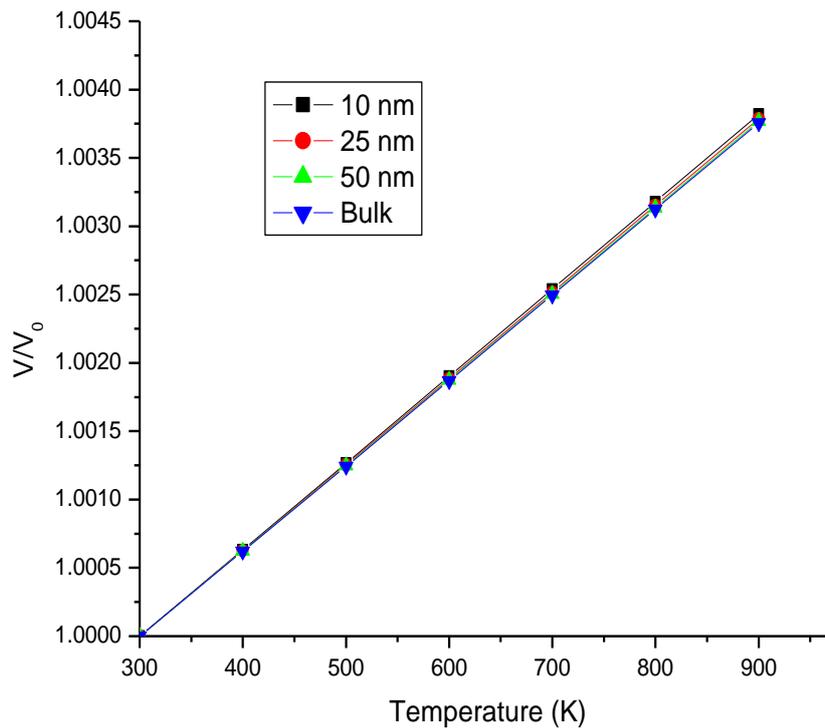


Fig.7. Temperature dependence of Ni nanofilm by Eq.(14)

#### IV CONCLUSIONS

A simple theoretical method is discussed to calculate the volume thermal expansion for spherical nanosolid, nanowire and nanofilm. The method has been derived on the bases of the concept of thermal expansion as discussed by Prakash<sup>11</sup> and the theory of cohesive energy as discussed by Qi<sup>9</sup> of the nanosolids. It is reported from the theory that thermal expansion increases with decreasing grain size. The method presented in this paper may have potential application in the research of temperature and size dependent properties of nanomaterials.

#### REFERENCES

- [1] C Q Sun, *Prog. Solid State Chem.* **35**, (2007), 1.
- [2] 2.P Alivisatos, P F Barbara, A W Castleman , J Chang , *Adv matter*, 10, (1998), 1297.
- [3] E Roduner, *Chem Soc, Rev.*, 35, (2006), 583.
- [4] F G Shi, *J Mater. Res.* **9**, (1994), 1307.
- [5] X J Liu, Z F Zhou, L W Yang, J W Li, G F Xie, S Y Fu and C Q Sun, *J of Applied Physics***109**, (2011), 074319.
- [6] I Ling Chang and Fu Rong Chang, *Computational Materials science***54**, (2012), 266.
- [7] Y Gan and J K Chen, *Mech. Res Commun.* **36**, (2009), 838.
- [8] Y Wang, H Zhao, YHu, C Ye and L Zhang, *J Crystal Growth*, **305**, (2007), 8.
- [9] W H Qi, *Physica B*, **368**, (2005), 46.
- [10] J H. Rose, J Ferrante and J R Smith, *Phys. Rev. Lett.* **47**, (1981), 675.
- [11] N Prakash, *Master of Science thesis*, The Florida State University (2005).
- [12] Q He and Z T Yan, *Phys. Stat. Sol. B***223**, (2001), 767.
- [13] R Kumar, M Kumar, *Int J of Nanoscience*, **9**, (2010), 537.
- [14] O L Anderson and K Zou, *J. Phys. Chem. Ref. data*, **19**, (1970), 69.
- [15] R Kumar and M Kumar, *High temp-High Press.* **39**, (2010), 251.
- [16] N W Ashcroft and N D Mermin, *Solid State Physics* (Saunders, Philadelphia), chap. 25, (1976).