

**Proceeding  
Of  
10th International Conference on Academic Research in  
Engineering Science and Technology  
(AREST-2016)**

**Date: 24th July, 2016  
Pune**

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**Organized by:**



**TECHNICAL RESEARCH ORGANISATION INDIA  
Website: [www.troindia.in](http://www.troindia.in)**

**ISBN: 978-93-85225-70-3**

## About Conference

Technical Research Organisation India (TROI) is pleased to organize the 10th International Conference on Academic Research in Engineering Science and Technology (AREST-2016). AREST-2016 is a comprehensive conference covering the various topics of Science, Engineering & Technology. The aim of the conference is to gather scholars from all over the world to present advances in the aforementioned fields and to foster an environment conducive to exchanging ideas and information. This conference will also provide a golden opportunity to develop new collaborations and meet experts on the fundamentals, applications, and products of Engineering and Technology. We believe inclusive and wide-ranging conferences such as AREST can have significant impacts by bringing together experts from the different and often separated fields of Engineering and Technology. It creates unique opportunities for collaborations and shaping new ideas for experts and researchers. This conference provides an opportunity for delegates to exchange new ideas and application experiences, we also publish their research achievements. AREST shall provide a platform to present the strong methodological approach and application focus on Science, Engineering and Technology that will concentrate on various techniques and applications.

Topics of interest for submission include, but are not limited to:

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- Information Technology
- Electrical Engineering
- Electronics Engineering
- Instrumentation Engineering
- Industrial Engineering
- Mechanical Engineering
- Chemical Engineering
- Aeronautical Engineering
- Environmental Engineering
- Nano-Technology,
- Genetic Engineering
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**Editorial**

The conference is designed to stimulate the young minds including Research Scholars, Academicians, and Practitioners to contribute their ideas, thoughts and nobility in these two integrated disciplines. Even a fraction of active participation deeply influences the magnanimity of this international event. I must acknowledge your response to this conference. I ought to convey that this conference is only a little step towards knowledge, network and relationship.

The conference is first of its kind and gets granted with lot of blessings. I wish all success to the paper presenters.

I congratulate the participants for getting selected at this conference. I extend heart full thanks to members of faculty from different institutions, research scholars, delegates, TROI Family members, members of the technical and organizing committee. Above all I note the salutation towards the almighty.

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# STRESS PATTERN ANALYSIS USING THERMAL CAMERA

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## Abstract

**This report aims to illustrate the use of infrared thermography as a nondestructive and noncontact technique to do stress pattern analysis on metallic specimen when subjected to tensile force under static loading. In addition, this thermal imaging technique readily shows the structural failure mechanism and location of damage. For this report, the stress pattern analysis was done on mild steel specimen and the thermal images of the specimen while loading/experimentation were obtained with the help of thermal camera. With the experimentation, stress and temperature values were obtained and with mathematical modeling, the experimental results were validated. These findings have significant implications for industrial application in material inspection technique under dynamic condition. Further research will also help in site inspection of materials in real time structures.**

**Index Terms: Nondestructive technique, Thermal camera, Stress, mathematical modeling.**

## I. INTRODUCTION

Measuring instruments play a vital role in every technical field. These measuring instruments are basically divided into two types, one is the contact type of measuring instruments and other is the non contacting type measuring instruments. The non contacting type of measuring instruments have the advantage of having no physical contact with the specimen, thus does not cause even a minute deformation on the specimen. One of the non-contacting measuring field is thermal imaging. Thermal

imaging is a very powerful field of noncontact technique that can be used to measure the temperature. It has a wide range of applications in all industrial sectors like chemistry, agriculture, medicine etc. Most of applications deal with high temperature measurements of static objects and measurements on moving, very minute or inaccessible objects. It is very less known that thermal imaging can be used even in measurement of minute changes of temperature and quantities associated [1]. Circa-1930 Evaporograph was the first thermal imaging device. It was insensitive and nonscanning. This device could not successfully satisfy thermal imaging properties due to its inherent contrast, the sensitivity, and also because of the long response time it took [2].

There are not much non contacting techniques to monitor the stresses on material on real time structures. Stress applied on an object can be defined as force per unit area and the amount of deformation an object experiences compared to its original size and shape is strain. The concept of material changing its temperature when subjected to loading is known. With this background, the above said non contact technique with the help of thermal cameras can be established for monitoring purpose. From statistical consideration of loading, engineers can obtain the basic characteristics of a material. For this, it takes large amount of specimen and time for analysis. This discourages the engineer to get into the detail property of material under dynamic loading. With the help of thermal imaging technology, one can also characterize the properties of material under static and dynamic loading with ease. In this report an



attempt to find a relation between stress and temperature for a material is made by studying the stress pattern analysis using thermal imaging.

## II. THERMAL IMAGING AND RELATED WORK

### A. THERMAL IMAGING: WORKING

Thermal imaging help human to see wavelengths beyond the ability of naked human eye. With the help of thermal imaging, humans can view objects even in dark night as the human eye does in the day.

Following are the basic working of thermal imaging [3]:

1. All the infrared emitted by the objects, which are in view, are focused by a special lens.
2. The light which is focused is scanned by a infrared detector element, which then creates a thermogram, which is a detailed temperature pattern.
3. The so created thermogram is converted into impulses in electric form.
4. The electric impulse are then sent to a signal processing unit, having a circuit board that consists of a dedicated chip which helps in translating the received information into data for the display.
5. The data for the display appears as different colors which depend on the IR emission intensity.

### B. Types Of Thermal Imaging Devices

There are basically two common types of thermal imaging devices:

- i. Cryogenically cooled devices
- ii. Un-cooled Thermal imaging devices

Cooled thermal imaging: - These devices are more prone to damage due to rough use and are also expensive than un-cooled thermal imaging. These systems basically have elements sealed in a container which will cool them to below 32F or 0°C. These systems have incredible sensitivity & resolution that are results from cooling the elements. A

difference as minute as 0.2 Fahrenheit (0.1°C) can be seen from a cryogenically cooled system from more than 300m away, i.e. an operator is possessing a gun can be view at that distance. The modern thermography camera consists an imaging sensor which is combined with a cryocooler. The cryocooler reduces the temperature of sensor to cryogenic temperatures.

The cryogenic temperature is needed to minimize the noise which is induced thermally to a lower level than that of signal from the scene which is getting imaged. They can be used to get thermal imaging in the long-wave infrared (MWIR) band & the mid-wave infrared (LWIR) band of spectrum.

Un-cooled thermal imaging: - Un-cooled TI cameras are those which do not need any cryogenic cooling. The device has a detector which is based on micro bolometer, which are small resistor of vanadium oxide and has high temperature coefficient on a silicon element with thermal insulation, excellent thermal isolation and less heat. When the temperature of scene changes, bolometer temperature changes which are converted to electrical signals and the images are processed. Un-cooled sensors work in LWIR band, where the most of IR energy is emitted by targets in terrestrial temperature. Cheaper than the cooled cameras, they have less moving components in number and have long product life than cooled cameras under same operating conditions

### C. Current Thermal Imaging Technology

Currently the thermal imaging technology allows detectors for infrared systems to operate at higher temperatures using small and compact systems at a very low cost. The technology is easily available. The cost of the cheapest thermal camera is starting from 10000 Indian rupees [2]. Thermal camera are also available as an accessory for modern mobile phones which has a sensitivity of 0°C and can be used to sense scene temperatures from 0°C to 100°C.

### D. Applications

Thermal imaging in the future will make significant applications into consumer and commercial sector. The significant improvements are bringing down the cost of this technology, while promising that thermal imaging devices become lighter & smaller and which also consumes less power. Initially built for military purpose, thermo graphic cameras have moved into other fields as varied as archaeology and medical. Firefighters use thermal cams to see through smoke, localize hot spots of fires and find people who are trapped when it's smoky around. Law and enforcement

uses the technology for surveillance activities, locate and catch suspects, crime scenes investigation and to conduct search operations and rescue operations. Power line maintenance technicians locate overheating joints and parts to eliminate potential failures. Where the thermal insulation becomes faulty, construction technicians can see heat leaks and improve the efficiency of heating or cooling. Fever in human beings and other warm-blooded animals can be viewed with thermal imaging. Thermo graphic cameras are common tools used by home inspectors. Some of the applications are listed below:

1. Security
2. Law and enforcement
3. Surveillance of building/house to determine water leaks or heat losses.
4. To find out hot spots in electrical devices.
5. A vision tool for driving in dark places.
6. Inspection of overheated mechanical parts in a system.
7. To determine material defects like crack on parts.
8. Thermal imaging in medical health.
9. Veterinary thermal imaging.
10. Non destructive technique.
11. Chemical imaging.
12. Process control.
13. Volcanology, etc

*E. Industrial Use Of Thermal Imaging*

Some of the industrial uses of thermal imaging are as follows:

*i. Construction Inspection*

Building constructions can benefit a lot using thermal imaging. Heat loss due to wall, poor window and roof performance can be viewed before hand and hence can be repaired. The air quantity inside the building can also be viewed using thermal imaging. Possible moisture content & water leaks can be easily predicted and repaired using thermal imaging. It can view exhaust gases from vehicles or factories nearby which are leaking into the building.

*ii. Mechanical*

Inspections of mechanical system require similar pieces of equipment's to be compared and their actual temperature of operations are also needed to be compared. For an example, two

motors having same specifications and which is working under the same load must look alike through a thermal camera. If they don't, the reason for the failure can be analyzed and precautive measures can be taken. Using the thermal camera, a technician can make out if the mechanical device or parts are working in prescribed temperature design tolerance.

*iii. Process Monitoring*

All the process applications can be viewed and the problem can detected to ensure proper conditions for operations. Potential problems of operations consisting of robots in assembly line can be continuously monitored.

*F. Temperature- Stress Relation*

Metals in microscopic level are having a crystalline structure. These crystals form the grains and each grain is a distinct crystal with its very own orientation. The area which divides two grain areas is known as grain boundary. These grain boundaries are defects in the crystal structure. When a metal is under increasing tensile load, it's structural defects like grain boundary, point vacancies, line and screw dislocation gets displaced and gets thermally activated. This causes an increase in the temperature at the area of defect. In this report, an attempt to bring up a template for a metal showing a mathematical relation between its stress and temperature under static loading is made.

**III. METHODOLOGY**

*A. Methodology Flow Chart*

The following chart represents the methodology for this report:

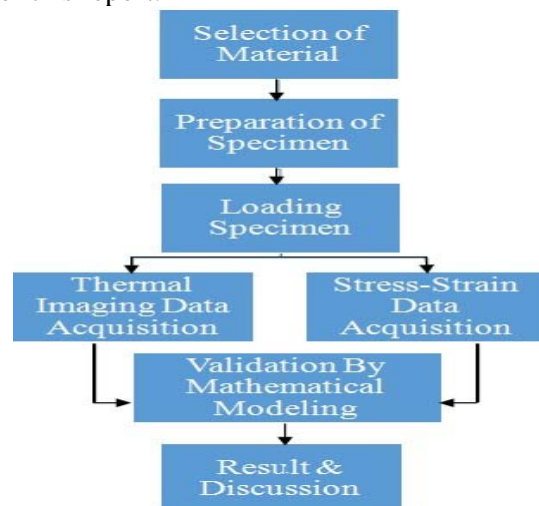


Fig 1. Methodology Flow Chart

### B. Methodology Explanation

The first step to perform the experiment is to select the suitable material; the material selected is Mild Steel, as mild steel has enormous application in various industrial sectors. The next step is to prepare the specimen so that the specimen would be clamped into the experimental setup, which is to take the thermal images of the specimen when applied when forces are applied. The specimen is then tensile loaded under static condition into the universal testing machine, where the tensile force is applied by the machine onto the specimen. The force applied ranges from zero KN to the force where the specimen ultimately breaks. The feed rate is selected before loading the specimen. After performing many experiments and observing the thermal pattern, the feed rate of 0.25mm/s was selected. The feed rate is selected considering the adiabatic conditions that are given to the specimen while performing the experiment. The thermal camera is then mounted onto the experimental setup (the lens of the thermal camera is focused in such a way that notch area is covered). The data of temperature and the stress strain are obtained. The experimental results so obtained are substituted in the mathematical model generated and validated. In this way the result from one specimen is obtained. After obtaining the result, a new mild steel specimen is loaded and the same method is repeated. The results are compared for its consistency and the overall result is plotted.

## IV. EXPERIMENTATION

### A. Experimental Setup

#### 1. Specimen

Due to wide range of application of mild steel in industrial & commercial purpose, the specimen material used was mild steel. Mild steel are also known as plain carbon steel having carbon percentage of 0.02-0.2%. The less percentage of carbon content makes it ductile and malleable. It has tensile strength ranging between 42 -54 kgf/mm<sup>2</sup> and yield stress around 26 kgf/mm<sup>2</sup>.

#### 2. Preparation Of Specimen

Mild steel at bar was used. Flat bars compared to round bars can show better thermal pattern on the surface. Length, width and thickness of the specimen used are 400mm, 25mm and 5mm respectively. V-type notch was made at the

center of the specimen, as shown in the figure. The purpose of the notch was to concentrate the stress produced in the material, while loading in universal testing machine, to a region.



Fig. 2 Specimen Mild Steel with V-Notch

#### 3. Testing Machine

For loading the specimen with constant feed rate for tension stress, a 40TR manually operating universal testing machine is used. The setup is as shown in the figure.



Fig. 3 Thermal Camera Setup on UTM

#### 4. Flat Jaws

To hold the mild steel bar specimen, appropriate jaws were made as shown in the figure. The jaw dimensions are as follows:

- \_ Length: 100 mm
- \_ Base Width: 79 mm
- \_ Top Width: 67 mm
- \_ Thickness: 20 mm
- \_ Groove Depth: 2 mm
- \_ Groove Width: 25 mm

Knurling was done on the upper surface of the jaw for extra gripping.



Fig. 4 Flat Gripping Jaws

5. Thermal Camera

FLIR ONE First generation for Iphone 5/5s is used as thermal camera. Its specifications are as follows [4]:

1. Scene temperature range: 0°C to 100°C.
2. Operating temperature: 0°C to 35°C.
3. Weight: 110 grams.
4. Sensitivity: ability to detect temperature difference as small as 0.1°C.



Fig. 5 Thermal Imaging Camera [4]

6. Camera Clamp

To clamp the thermal camera to the universal testing machine, a 3d printed camera mount was made in Ultimaker 2 Extended 3d printer. This 3d printed mount was fixed to a grooved wooden support as shown in the figure and the upper at surface of wooden support was fixed to the machine with the help of a circular neodymium magnet.

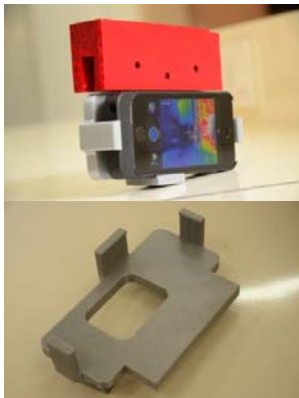


Fig. 6 Camera Clamp

V. MATHEMATICAL MODELING

From M.P.Luong's paper on "Fatigue limit evaluation of metals using an infrared thermographic technique" [5] and his other paper on "Infrared thermography of fatigue in metals" [6], the following thermo-mechanical equation was obtained

$$\rho C_v \dot{T} + r_0 + k \nabla^2 T - (\beta D: E^e) T + S: E^I$$

Where;

- $\rho$  = Density
- $C_v$  = Specific Heat
- $\dot{T}$  = Absolute Temperature per Unit Time
- $r_0$  = Heat Generated
- $k$  = Thermal Conductivity
- $\beta$  = Coefficient of Thermal Expansion
- $D$  = Elastic Tensor
- $E^e$  = Strain Tensor
- $S$  = Stress Tensor
- $E^I$  = Inelastic Strain Tensor

Restricting this equation to only single dimension, we get:

$$\rho C_v \frac{dT}{dt} = r_0 + k \frac{d^2 T}{dx^2} - (\beta D \epsilon) T + \sigma \frac{d\epsilon}{dt} \dots (1)$$

where t is time, x is the distance along the length of specimen,  $\epsilon$  is the strain and  $\sigma$  is the stress. The term order close to one. From equation 1, the heat generated and the coefficient of thermal expansion terms can be neglected due to its negligible value. The heat dissipation in the form of conduction along the length of the specimen is less due to its feed rate. Therefore the conduction term can also be neglected.

$$\rho C_v \frac{dT}{dt} = \sigma \frac{d\epsilon}{dt}$$

Integrating both sides,

$$\rho C_v \int_{T_i}^T dT = \int_0^{\epsilon\sigma} \sigma d\epsilon$$

$$T = \frac{1}{\rho C_v} \int_0^{\epsilon\sigma} \sigma d\epsilon + T_i$$

Where  $T_i$  is the initial temperature of the specimen &  $\epsilon\sigma$  is the value of strain corresponding to the stress.

VI. RESULTS AND DISCUSSION

The following images show the change in temperature and thermal pattern around the notch area when the tensile force applied on the specimen increases. These images shows the increase in temperature where the specimen subsequently failed and was clearly evident virtually few seconds after beginning of the test.

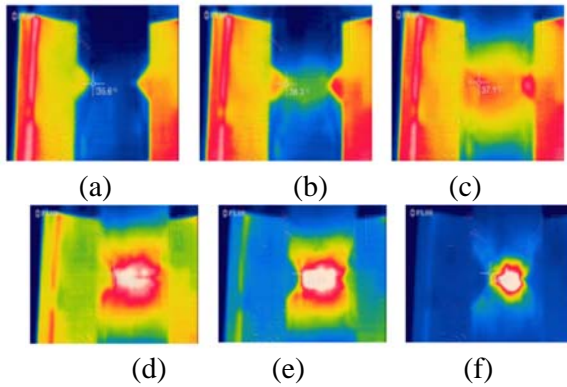


Fig. 7 Thermal images showing increase in temperature as the load increases.

From the mathematical modeling the following relation was obtained,

$$T - T_i = \frac{1}{\rho C v} \int_0^{\epsilon \sigma} \sigma d\epsilon$$

If a graph with [T-T<sub>i</sub>] values from the experimental data is plotted on the x-axis and on the y-axis  $\int_0^{\epsilon \sigma} \sigma d\epsilon$  values are plotted, a linear curve is obtained with slope equal to the constant value 1/ρCv. Computing the logic on matlab software we get the following graph.

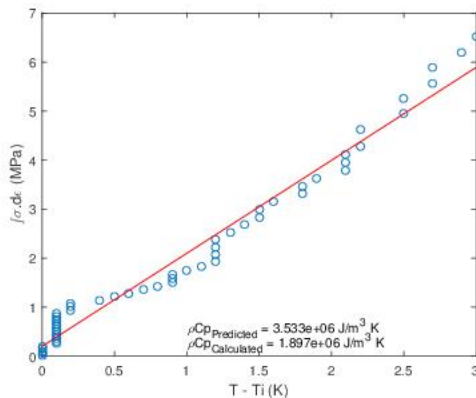


Fig. 8 Stress- Strain energy Vs Temperature Difference

From the graph it can be clearly seen that there is an error between the predicted value and the calculated value. Ideally there should not have been any mode of heat transfer like conduction, convection and radiation while loading the specimen. But practically from the thermal pattern, conduction of heat along the length of the specimen and convection of heat to the surrounding can be seen. Also while mathematical modeling the conduction part was ignored, though it had a significant value when

scaled. If all the above parameters are taken into consideration, the error can be minimized significantly and a more accurate mathematical relation can be obtained.

## VII. CONCLUSION AND FUTUREWORK

The relation of stress and temperature for mild steel under static loading was obtained through mathematical modeling. More accurate results can be obtained by minimizing the heat transfer from the notches where the stresses are generated. Apart from the static loading, the mathematical relation of stress and temperature under dynamic loading can also be determined, which can help engineers in material selection. Like the test carried on mild steel, the relation can be obtained for other metals and alloys and a standard template for materials can be formed.

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# APPLICATIONS OF BIG DATA ANALYTICS IN ENTERPRISE

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## Abstract

**The key to success for any enterprise lies in the ability to collect right data at right time and deliver the right data, at the right velocity, and in the right quantities to a wide set of analytics Here in this paper we look into how many big enterprises used big data to improve their efficiency and hence the profit.**

**Index Terms: Big Data Applications, Big Enterprise.**

direction, drive, performance. This data is used to analyse performance and also analyse optimal route structure.

They use ORION algorithm. It is used to analyse 20000 possible routes for each track in real time.

By using big data, they are able to improve the performance of each route and delivery of packages. They saved upto 8.4 million gallons of fuel by cutting 85 millions of miles. With this they could save upto 25 million dollar per year.

## I. INTRODUCTION

Big data analytics is used to analyze large amount of data sets that contain data of different variety, velocity, and veracity collected from many different channels to find hidden patterns, relations, understand customer preferences and other useful information. There are many big enterprises who have led the example of use of big data analytics. Here we present few findings of few big enterprises who are leaders in use of big data analytics.

### A. Big Data at UPS

UPS United Package Service is one of the biggest package shipping company. They gather about 16 petabytes of data[6]. They keep track of drivers and package movement and also keep track of transactions.

They used the system called ORION (On-Road Integrated Optimization and Navigation) algorithm, for data analysis.

UPS capture and track their package movements and transactions. They track about 16 million packs per day for about 8 million customers. Thus they store about 16 petabytes of data per day.

It uses telematics sensors in their vehicles. The data thus collected may include their speed,

### B. Big Data at Caesars Entertainment

**Caesars** (formerly called Harrah's) is one of the world's largest gaming and entertainment companies. They run the company with multiple brands and operate in four different continents[7].

Caesars mainly focus on its customers loyalty, marketing and services provided by the company. The objective of the company in using big data is to respond to the customer requirement and provide them required service in real time.

They gathered their customer data from its Total Reward Loyalty Program, web clickstreams, and while playing at slot machine or in the resort.

The company found it traditionally difficult to analyse and react to the customers in real time. Hence they switched to big data. With video analytics in big data tools, they were able to recognize more service issues. Caesar is also now analysing mobile data so that it can keep their loyal customers and also attract less frequent customers with their real time offers.

Caesars use both Hadoop clusters and open source and commercial analytic software for their analysis.

#### *C. Big Data at United Health Care*

United Healthcare provides health services to more than 50 million people. They have around 8.5 million physicians and more than 6000 hospitals associated with them. The big problem faced by them was in ensuring correct claims and if found correct than paid on time. They deal with around 10 TB of data daily[7].

United Healthcare is now able to use Hadoop to leverage their large amount of data and reduce cost, increase quality and operational efficiencies.

United Healthcare is mainly focusing on voice based data which is collected from customer desks of call centre. Thus collected voice data is than converted into text data. United also goes for integrated statistical analysis with Hadoop.

#### *D. Big Data at GE*

GE, General Electricals, Company helps customers realize greater returns faster from Industrial Internet – a technology framework that connects machines, facilities and people to deliver business value and improve productivity. In a gas/oil industry, with about 1200-turbine wind farm contains approximately 50 sensors with data sampled at different rates [9].

The first level analysis, the real-time analytics within the turbine controller use sensor data collected, and saved in an onboard data historian, every 40 milliseconds to optimize the pitch of the turbine's blades, the conversion of rotational energy into electricity, and to determine whether electricity should be stored in / discharged from batteries or sent to the transmission grid.

The second level of analysis and interaction occurs at the farm. The farm controller receives more than 30 signals from each turbine at 160-millisecond intervals, and its real-time analytics ensure the right combination of turbines deliver predictable power to the utility. In addition, the farm monitoring software processes 200 tags from each turbine at a one-second interval. These real-time analytics evaluate turbine health and performance for the site operations team. Turbine data is then transmitted at one-minute intervals from this and

other wind farms to a remote monitoring center miles away.

There, individual turbines and entire wind farms are analyzed to finely tune their process and asset algorithms, and these enhanced analytics are pushed down to the machines. Simultaneously, a high-performance computer cluster is utilizing years of operating data to build predictive models that find correlations and critical issues hidden amongst the tags of thousands of individual turbines. When millisecond granularity is needed to match signatures and patterns found in the streaming asset and process data, queries from the monitoring center can be distributed over thousands of wind turbines' data historians. The insights help operations teams prioritize maintenance, parts warehousing, logistics, and other services for the farm.

Finally, analyses that blend operational data from the farm with financial and other data from the operator's enterprise systems are delivered to the CFO's office in the form of forecasts and power production reports. Similarly, the VP of Operations can access reports on turbine capacity, while field management uses reports that detail a prioritized list of maintenance requirements. All are delivered with a modern user interface on whichever is the most appropriate device for the job.

The key to success for this wind farm lies in the ability to collect and deliver the right data, at the right velocity, and in the right quantities to a wide set of well-orchestrated analytics and provide insights at all levels in the operation. This requires a distributed computing fabric optimized for industrial big data in its many forms and in support of its many different uses. These requirements span the industrial world and are what drive the need for an industrial big data platform.

#### *E. Big Data at Macys.com*

Macys.com is considered the equivalent of a single store at the giant retailer's structure, but it's growing at a 50% annual rate—faster than any other part of the business. The division's management is very oriented to and knowledgeable about IT, data, and analytical decisions. Like other online retailers, Macys.com is heavily focused on customer-oriented analytical applications

involving personalization, ad and email targeting, and search engine optimization. Within the Macys.com analytics organization, the “Customer Insights” group addresses these issues, but it also has a “Business Insights” group (focused primarily on supporting and measuring activity around the marketing calendar) and a “Data Science” organization. The latter addresses more leading-edge quantitative techniques involving data mining, marketing, and experimental design.

Macys.com utilizes a variety of leading-edge technologies for big data, most of which are not used elsewhere within the company. They include open-source tools like Hadoop, R, and Impala, as well as purchased software such as SAS, IBM DB2, Vertica, and Tableau. Analytical initiatives are increasingly a blend of traditional data management and analytics technologies, and emerging big data tools. The analytics group employs a combination of machine learning approaches and traditional hypothesis-based statistics.

#### *F. Big Data at Schneider National*

Schneider National, one of North America’s largest truckload, logistics and intermodal services providers, has been pursuing various forms of analytical optimization for a couple of decades. What has changed in Schneider’s business over the past several years is the availability of low cost sensors for its trucks, trailers and intermodal containers. The sensors monitor location, driving behaviors, fuel levels and whether a trailer/container is loaded or empty. Schneider has been transitioning to a new technology platform over the last five years, but leaders there don’t draw a bright line between big data and more traditional data types. However, the quality of the optimized decisions it makes with the sensor data – dispatching of trucks and containers, for example – is improving substantially, and the company’s use of prescriptive analytics is changing job roles and relationships.

New sensors are constantly becoming available. For example, fuel-level sensors, which Schneider is beginning to implement, allow better fueling optimization, i.e., identifying the optimal location at which a driver should stop for fuel based on how much is left in the tank, the truck’s destination and fuel prices along the way.

In the past, drivers have entered the data manually, but sensor data is both more accurate and free of bias.

Safety is a core value at Schneider. Driving sensors are triggering safety discussions between drivers and their leaders. Hard braking in a truck, for example, is captured by sensors and relayed to headquarters. This data is tracked in dashboard-based safety metrics and initiates a review between the driver and his/her leader. Schneider is piloting a process where the sensor data, along with other factors, goes into a model that predicts which drivers may be at greater risk of a safety incident. The use of predictive analytics produces a score that initiates a pre-emptive conversation with the driver and leads to less safety-related incidents.

#### *G. Big Data at Bristol-Myers Squibb*

Bristol-Myers Squibb reduced the time it takes to run clinical trial simulations by 98% by extending its internally hosted grid environment into the AWS Cloud. The company has also been able to optimize dosing levels, make drugs safer, and require fewer blood samples from clinical trial patients.

Because clinical trial data is highly sensitive, Bristol-Myers Squibb built a dedicated, encrypted VPN tunnel to the Amazon gateway and configured a virtual private cloud so the environments would be isolated from public customers.

Before moving into the cloud, scientists were using a shared internal environment, so it took 60 hours to run hundreds of jobs. Now that each scientist has a dedicated environment, 2,000 jobs can be processed in 1.2 hours without causing an impact to other members of the team.

As a result of the move, Bristol-Myers Squibb was able to reduce the number of clinical trial subjects in a pediatric study from 60 to 40, while shortening the length of the study by more than a year.

#### *H. Big Data at an International Financial Services Firm*

For one multinational financial services institution, cost savings is not only a business goal, it’s an executive mandate. The bank is



historically known for its experimentation with new technologies, but after the financial crisis, it is focused on building its balance sheet and is a bit more conservative with new technologies. The current strategy is to execute well at lower cost, so the bank's big data plans need to fit into that strategy. The bank has several objectives for big data, but the primary one is to exploit a vast increase in computing power on dollar-for-dollar basis. The bank bought a Hadoop cluster, with 50 server nodes and 800 processor cores, capable of handling a petabyte of data. IT managers estimate an order of magnitude in savings over a traditional data warehouse. They take existing analytical procedures and converting them into the Hive scripting language to run on the Hadoop cluster.

### *I. Big Data at Sears*

When it comes to the adoption of information technology, Sears was years ahead of most retailers, implementing an enterprise data warehouse in the 1980s while most retailers were still relying on manually-updated spreadsheets to examine their sales numbers. These days the company is using big data technologies to accelerate the integration of petabytes of customer, product, sales, and campaign data in order to understand increase marketing returns and bring customers back into its stores. The retailer uses Hadoop to not only store but process data transformations and integrate heterogeneous data more quickly and efficiently than ever.

The company is now leveraging open source projects Apache Kafka and Storm to enable realtime processing. The main goal of the company is to measure what's just happened.

The company has cited big data's capability to decrease the release of a set of complex marketing campaigns from eight weeks to one week. Faster and more targeted campaigns are just the tip of the iceberg for the retailer, which recently launched a subsidiary, MetaScale, to provide non-retailers with big data services in the cloud.

### *J. Big Data at The Weather Company*

A recent partnership between "The Weather Company" and "IBM" will allow companies to better manage the impact of weather on business performance. According to The Weather

Company, weather has an economic impact of half a trillion dollars annually in the US alone[2].

The weather data is being collected from more than 100,000 weather sensors and aircraft, as well as millions of smartphones, buildings, and moving vehicles. That data is combined with data from other sources to yield 2.2 billion unique forecast points, and an average of more than 10 billion forecasts on an active weather day. Retailers will be able use the data to adjust staffing and supply chain strategies. Energy companies will be able to improve supply and demand forecasting. Insurance companies will be able to warn policy holders of severe weather conditions, so they can minimize the possibility of car damage in the event of a hail storm, for example.

## **II. CONCLUSION**

It is clear from this research that most of the large organizations from different area are already into big data making full utilization of big data analytics. They are not just using the traditional analytics but also integrated big data separate with them to form a new analytics.

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## SMART POLYMER STRUCTURES

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### Abstract

**Gecko has an amazing & peculiar ability to climb with ease on vertical surfaces. The study has shown that this ability is due to the geometry of its feet. Van der waals force is responsible for its climbing ability. In this paper, an attempt has been made to mimic this rarely found geometry which can help us build future climbing robots. Here a novel but a low cost method is developed to fabricate an adhesive non-sticky pad. Co<sub>2</sub> LaserPro laser cutting machine is being used for making the desired mold & silicone rubber (OOMOO 30) as its casting material. Two different types of structures are developed to build a mechanism which can withstand the desired load. Through testing of these structures it was observed that with a preload of 10gms a material weighing 4gms can withstand a load upto 30gms approximately.**

**Index Terms: silicone rubber, micro-suction cups, adhesive, van der waals force.**

### I. INTRODUCTION

Nature has evolved a variety of mechanisms to enable species of different kinds to move across (or through) various media, including friction based mechanisms (e.g. Snakes, Birds) and adhesive organ based mechanisms (e.g. Tree, frogs, Bats). Researchers have looked to insects, mammals, and the gecko lizard for insight on how to stick to and maneuver on vertical surfaces. Not surprisingly, nature has evolved a variety of ways to stick to surfaces, from

secretions of glue-like substances in ants, slugs, and worms to the sharp, penetrating claws of cats and rodents; from the small spine arrays of cave angel fish to the complicated dry-adhesive pads of geckos. This work seeks to identify the important features of climbing adhesives, to design synthetic adhesives that adhere to those guidelines, and to then apply those adhesives in various applications.

Many attributes of the gecko adhesive system were described, but perhaps most importantly, evidence implicated van der waals forces as the primary mechanism of adhesion, and second, the adhesive strength of this contact was found to be very dependent on the loading trajectory. Synthetic adhesives with gecko-like attributes have great promise for climbing applications where this directional dependence creates a mechanism for controlling adhesion.

The main objective of this work focuses on designing a engineering material that would show gecko like adhesive properties which can be later applied in various possible applications like wall mounts, inspection, cleaning, robot that can scale vertical wall etc.

### II. GECKO ANATOMY & RELATED WORK

Studies have shown that gecko setae originate from the  $\beta$  layer of the reptile's epidermis. These proteinaceous structures are a cellular, and are replaced at each molting cycle. Recent biochemical evidence has identified  $\beta$ -keratin as the primary molecule in gecko setae. A further study confirmed this using the gecko foot has evolved a complex

structure which is useful to adhere to rough surfaces in its natural habitat [1].

Foot of the Tokay gecko consists of five toes which act as an element in adhesive system. On the largest length scale, the flap like structure is called lamellae. This can be measured at millimeter scale. The typical Tokay gecko has 20 lamellae per toe. Each lamella is covered by setal stalks at an average density of 14400 per square millimeter. Setal stalk at its tip if observed closely is divided into several setae. Setae also vary along the length of the toe. It becomes thinner and shorter at the end of the toe; they are not straight but curved inwards towards palm [2]. The tips of setae branch apart like a tuft of broccoli into 100-1000 terminal spatula. Spatulas are triangular and generally are outwards from the branched setal end. These are generally 10nm thick and 150-275 nm across the widest part [3], [4].

The largest of these fibrillar adhesives was fabricated for the Stickybot robot platform. These posts were cast in a three part mold manufactured using a traditional 3 axis computer numerical controlled (CNC) milling machine. A very soft polymer of Young's Modulus 660 kPa was used for these pillars. 4cm<sup>2</sup> patches of this material were tested, sustaining adhesive forces greater than 1 N [5].

The second generation design generation of the previously mentioned PVS fibers incorporated a mushroom shaped tip with a very thin flared tip only 2 μm thick shown in Figure 2.5. The height remained 100μm and fiber diameter was 40μm. These structures showed higher adhesive pressures with an experimental sample size of 0.07cm<sup>2</sup> sustaining adhesive forces up to 0.4 N [6].

Kim et al [7] presented polyurethane fibers with a 4μm diameter, 20μm height, and a flared tip and base that had a diameter of 9 μm. This mushroom like structure showed 4 to 5 time's higher adhesion than unstructured polyurethane. Tests were conducted using a 6mm hemispherical probe in a vertical-preload vertical-pull off trajectory and showed adhesive pressures of up to 180KPa and elastic strain of individual fibers greater than 500 percent.

### III. METHODOLOGY

Our focus is to develop different kinds of geometry and to look for a low cost and repeatable method for developing a material having gecko like adhesive properties. Casting technique is being used to serve the purpose. CO<sub>2</sub> Laser Pro Laser cutting machine has been used for making the desired mold and Silicone rubber (OOMOO 30) as its casting material. Various structures are developed to build a mechanism which can withstand the desired load.

Two types of structures are being developed

#### 1. Lamellar structures

A lamella is a thin plate-like structure, often one amongst many lamellae very close to one another, with open space between. Aside from respiratory organs, they appear in other biological roles including filter feeding, the traction surfaces of geckos, and chloroplast membranes where high permeability is important. To mimic these lamellae like structures vertical straight cuts are being on the mold material using laser cutter. As there are open spaces between lamellae, while making samples the space between every successive lamellae was varied.



Fig1. Lamellar Structure

#### 2. Cantilever beam Structures

Here as the name states actual cantilevers were not developed but this is tiny hair like structures which has length bit longer than the width which helps to increase the overall surface area of the material recreated. To design the mold for this structure points were paced at a particular spacing and then cut with a laser cutter.

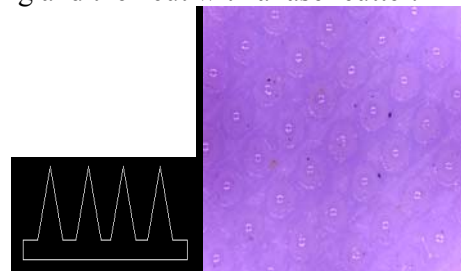


Fig2. Cantilever beam structure

A. Experimentation

Once the molds were created with the help of a laser cutter silicone rubber compound (Fig 2.) was made using smooth-on OOMOO -30 and casted into the mold created.

Then for complete curing of the material it was kept for 10hrs and extra 4 hrs for easy extraction of the material without any wear and tear. Then the material was extracted from the mold and testing was done. For the testing two different setups were made.



Fig3. Silicone Rubber Compound

Then for complete curing of the material it was kept for 10hrs and extra 4 hrs for easy extraction of the material without any wear and tear. Then the material was extracted from the mold and testing was done. For the testing two different setups were made.



Fig4. Test setup

IV. RESULT AND DISCUSSION

A. Lamellar structures

The first structure was made with a spacing of 0.6mm. Then the spacing was reduced till 0.2mm. Further it was not possible to decrease the spacing as the cuts started to overlap. So we had five structures with varying spacing i.e. 0.2mm, 0.3mm, 0.4mm, 0.5mm, 0.6mm.

Later based on the results few more structures were tested with varying spacing between 0.2-0.3.

Table 1: Results for space between Lamellas ranging from 0.2mm-0.6mm

Sr. no.	Gap between two successive lamellae (mm)	Weight Lifted (gms) (Weight actually lifted + weight of the pan)
1.	0.2	10
2.	0.21	9.51
3.	0.23	13
4.	0.25	14
5.	0.27	10
6.	0.29	12
7.	0.3	11.5
8.	0.4	3
9.	0.5	2
10.	0.6	0

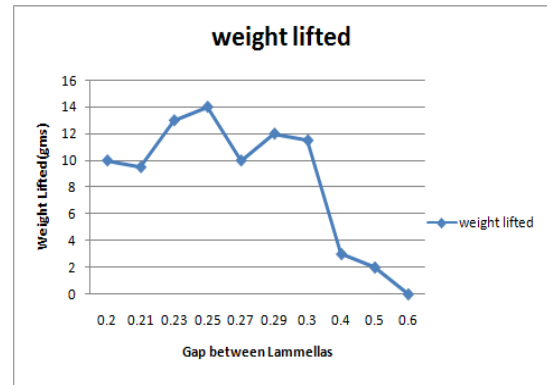


Fig5. Gap between Lamella v/s weights lifted

B. Cantilever beam structure

Cantilever beam is a type of structure in which looks like tiny hairs or beams which is in micro scale. Here the horizontal and vertical spacing is varied. The readings are also taken with the varying speed and constant power Laser cutter.

i. Varying horizontal and vertical spacing

For the first kind of cantilever beam structure the horizontal and vertical spacing between the micro hairs is varied. Here the horizontal spacing is kept as 0.3mm and vertical spacing is 0.5mm. Also here the reading is taken with the varying speed of the Laser cutter and the spacing is kept constant throughout.

Table 2: weight lifted according to varying speed of the Laser cutter

Sr. no.	Speed(ips)	Weight Lifted (gms) (Weight actually lifted + weight of the pan)
1.	12	7
2.	6	2
3.	3	2

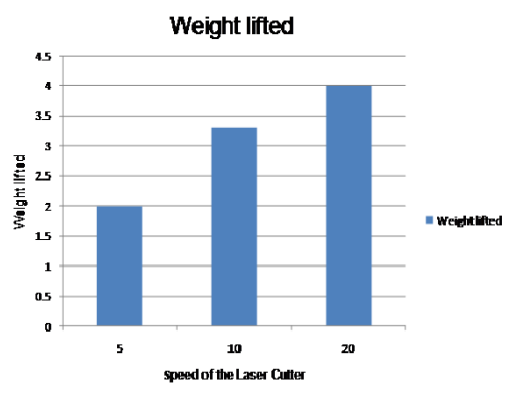


Fig7. Speed of laser cutter v/s Weight lifted

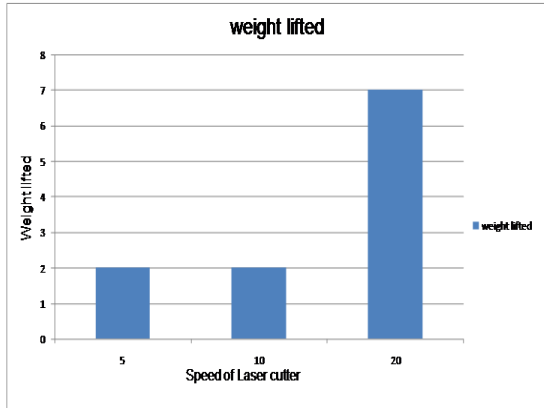


Fig6. Speed of Laser cutter v/s weight lifted

ii. Constant horizontal and vertical spacing

For the second kind of cantilever beam structure the horizontal and vertical spacing between the micro hairs are kept constant. Here both the horizontal spacing and vertical spacing is 0.5mm. Here also the reading is taken with the varying speed of the Laser cutter and the spacing is kept constant throughout.

Table 3: weight lifted according to varying speed of Laser Cutter in Cantilever beam type structure

Sr. no.	Speed(ips)	Weight Lifted (gms) (Weight actually lifted + weight of the pan)
1.	12	4
2.	6	3.3
3.	3	2

iii. Cantilever beam structure with preloading 10gms

After trying out different combinations of speed and power it was clear that at speed 1 and power 0.1 we get the lowest depth possible. Also after studying further on Gecko feet, preloading came out to be very important in order to adhere to surfaces. So henceforth preloading is taken into consideration and the testing was carried out with the constant preloading of 10gms. As in previous results we found that between 0.2mm to 0.3mm better results were observed. Here speed of the laser cutter is kept constant and spacing between micro hairs is kept constant.

Table 4: weight lifted according to the internal spacing in a cantilever beam structure

Sr no.	Spacing (mm)	Weight Lifted (gms) (Weight actually lifted + weight of the pan)
1.	0.2	21.714
2.	0.3	32.714

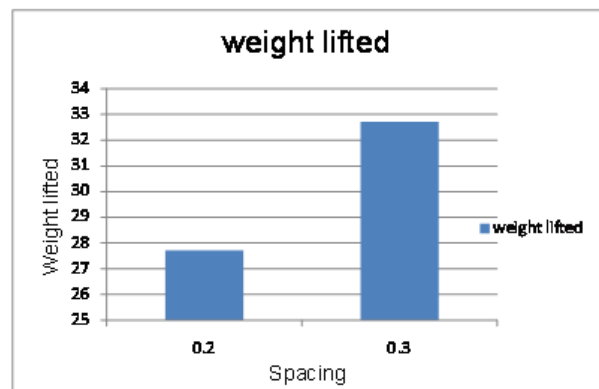


Fig8. Spacing v/s Weight lifted



Fig9. Testing

### V. CONCLUSION AND FUTURE WORK

With the lamellar spacing of 0.2mm-0.3mm the results were considerable. The minimum feature size that can be achieved in a Spirit Laser Pro is 200 micron. With Lower speed and Lower power combination better feature size were achieved for the mold. Power of the laser cutter happened to be crucial for determining depths of the cuts. At 0.3mm spacing we got remarkable results using preload.

In future a material having Micro-suction cups is planned

And frictional force is to be calculated for all the structures.

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## **RADIATIVE HEAT TRANSFER MODEL DEVELOPMENT FOR INDIAN PHWR FUEL BUNDLE**

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### **Abstract:**

**During the normal operation of the Pressurized Heavy Water Reactor (PHWR), fuel bundle is cooled through sufficient flow of heavy water. In certain postulated accident scenario, the coolant flow may cease and the fuel bundles may expose to steam and heat up as it continues to produce decay heat even after the reactor is shutdown. Under such condition, the fuel pins in the bundle would radiate heat to the enclosing tube called Pressure Tube. To model and analyze such scenario, an integral thermal-hydraulic code, PRABHAVINI, is being developed at BARC. A radiation heat transfer model was developed for the code based on the radiosity method and accounting for the anisotropic effect arising due to large/curve surfaces. Verification of the model was carried out using finite element package ANSYS. A detailed 2D finite element modeling and simulation of the radiative heat exchange in the channel was also carried out in ANSYS postulating a typical accident condition. Results of the simulation indicate that the assumption of uniform radiosity around the fuel rod may significantly affect the average surface temperature of the fuel.**

**Index Terms: PHWR channel, Radiation in fuel bundle, Anisotropic correction, ANSYS radiation model**

### **I. INTRODUCTION**

During the normal operation of the PHWR, the coolant passes through the fuel bundles in a horizontal channel, gaining heat through the convective mode and maintains the fuel temperature. In certain postulated accident scenario such as loss of coolant accident along with the failure to activate emergency core cooling system, the channel would be devoid of coolant flow and the fuel bundle would be exposed to steam. Under such situation the only dominant mode of heat rejection is the radiation heat transfer from the fuel bundle to the surrounding Pressure Tube enclosure.

A radiation heat transfer model based on Radiosity Matrix Method was developed for an integral thermal-hydraulics code PRABHAVINI. This code is being developed at Bhabha Atomic Research Centre (BARC) to address the severe accident phenomena in PHWRs. The code does not evaluate circumferential temperature gradient in the fuel pins. It assumes a uniform temperature and uniform flux around the fuel pin surface. The radiation model based on this assumption has the advantage of reduced computational cost but overestimates the heat transfer due to isotropic reflection. In reality there could be large temperature gradient for some fuel pins due to bounding geometry and boundary conditions.

For such cases, dividing the surfaces into smaller elements would improve the prediction substantially but this may not be always feasible to implement in system codes. Andersen [1] developed a semi-empirical method to address the non-uniform radiosity in the conventional radiation model through an anisotropic correction factor. A further improvement in the correction factor suggested by Tien et al.[2] was implemented in the model. Verification of this model was carried out with Finite Element (FE) package ANSYS. A detailed 2D FE modeling and analysis of the channel which includes fuel bundle, PT and CT was also carried out in ANSYS for a typical accident condition where in the radiative exchange plays the dominant role. It is observed that large temperature gradient can develop in the outer pins of the PHWR fuel bundle which warrants judicious use of the conventional radiation model in system code.

## II. DESCRIPTION OF PHWR CHANNEL

The Primary Heat Transport (PHT) system of a typical 220 MWe Indian PHWR consists of 306 horizontal reactor channels submerged inside calandria vessel filled with moderator. Each reactor channel is connected to a common inlet and outlet header and consists of two concentric tubes, the PT and the CT, and the fuel bundles placed horizontally inside the PT (Fig.1). The pressure tube acts as a pressure boundary for the PHT system through which coolant at high pressure flows axially over the fuel bundles. The gap between PT and CT is maintained through four garter springs. During normal reactor operation, this gap essentially reduces the radial heat loss from the core to the moderator.

A 19 pin fuel bundle of 0.5 m length consists of three rings of pins generating heat in the ratio of 1: 1.1: 1.33 from inner to outer ring. The pins are arranged in the combination of triangular and square pitches as shown in Fig.2.

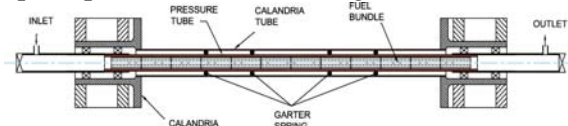


Fig.1 PHWR reactor channel

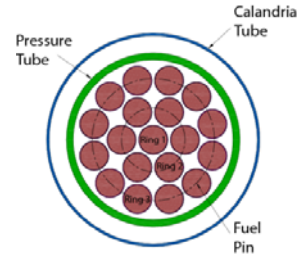


Fig.2 Fuel bundle configuration

## III. RADIATION MODEL DEVELOPMENT

The PHWR fuel bundle along with the pressure tube is idealized as four sided enclosure filled with transparent medium. Three sides represent the pin surfaces at each ring and the fourth one represents the PT surface. The surfaces are considered gray and diffuse. For a planer surface at uniform temperature, radiosity (reflected plus emitted radiation) may be considered uniform in all direction referred as isotropic radiation. But for large and curved surfaces like PT and fuel pins, part of the reflected radiation would travel back to the origin surface of the incident radiation. This is taken into account through anisotropic correction factor proposed by Andersen [1] and Tien [2]. The formulation described below is adopted from Sohal [3].

In the anisotropy correction method, it is assumed that for each fuel rod  $i$  a fraction  $(1 - \mu_i)$  of the incident radiation  $I_i$  is reflected isotropically and the rest  $\mu_i$  is reflected back to the source rod  $j$ . The isotropic part of the radiosity,  $J_i^I$ , from the surface  $i$  is given as

$$J_i^I = \epsilon_i \sigma T_i^4 + (1 - \mu_i)(1 - \epsilon_i)I_i \quad (1)$$

And the anisotropic part which is reflected back to the originating surface  $j$  is given as

$$J_{ij}^A = \mu_i(1 - \epsilon_i)I_{ij} \quad (2)$$

where  $I_{ij}$  is the incident radiation to surface  $i$  from surface  $j$

$$I_{ij} = \frac{1}{A_i} [J_j^I A_j F_{ji} + J_{ji}^A A_j] \quad (3)$$

Using above equations and view factor reciprocity relation, following equation for radiosity,  $J_i^I$ , may be obtained.

$$\sum_{j=1}^n \left\{ \left[ 1 - \sum_{k=1}^n \frac{(1-\mu_i)(1-\epsilon_i)\mu_k(1-\epsilon_k)F_{ik}}{1-\mu_i(1-\epsilon_i)\mu_k(1-\epsilon_k)} \right] \delta_{ij} - \frac{(1-\mu_i)(1-\epsilon_i)F_{ij}}{1-\mu_i(1-\epsilon_i)\mu_j(1-\epsilon_j)} \right\} J_j^I = \epsilon_i \sigma T_i^4 \quad (4)$$

Where,  $\delta_{ij}$  is given as



$$\delta_{ij} = \begin{cases} 1, & \text{for } i = j \\ 0, & \text{for } i \neq j \end{cases}$$

Equation (4) can be written for each of the 'n' surfaces of the enclosure giving 'n' simultaneous equations. It can be expressed in the Matrix form as

$$[C_{ij}^1][J_i^1] = [\sigma T_i^4] \quad (5)$$

Where,

$$C_{ij}^1 = \left[ 1 - \sum_{k=1}^n \frac{(1-\mu_i)(1-\epsilon_i)\mu_k(1-\epsilon_k)F_{ik}}{1-\mu_i(1-\epsilon_i)\mu_k(1-\epsilon_k)} \right] \delta_{ij} - \frac{(1-\mu_i)(1-\epsilon_i)F_{ij}}{1-\mu_i(1-\epsilon_i)\mu_j(1-\epsilon_j)} \quad (6)$$

)

For known values of  $T_i$ , the radiosities  $J_i^1$  are obtained through Gauss-Seidel method.

The net radiation heat flux from the surface  $i$  can be calculated from the radiosity and the incident radiation as below

$$q_i = (J_i^1 + \sum_{j=1}^n J_j^A) - I_i$$

$$q_i = \frac{\epsilon_i}{(1-\mu_i)(1-\epsilon_i)} \{ \sigma T_i^4 [1 - \mu_i(1 - \epsilon_i)] - J_i^1 \} \quad (7)$$

)

For surfaces where net heat fluxes are prescribed,

$$[C_{ij}^2][J_i^1] = \left[ \frac{q_i(1-\mu_i)(1-\epsilon_i)}{1-\mu_i(1-\epsilon_i)} \right] \quad (8)$$

)

$$C_{ij}^2 = \left[ 1 - \sum_{k=1}^n \frac{(1-\mu_i)(1-\epsilon_i)\mu_k(1-\epsilon_k)F_{ik}}{1-\mu_i(1-\epsilon_i)\mu_k(1-\epsilon_k)} - \frac{\epsilon_i}{(1-\mu_i(1-\epsilon_i))} \right] \delta_{ij} - \frac{(1-\mu_i)(1-\epsilon_i)F_{ij}}{1-\mu_i(1-\epsilon_i)\mu_j(1-\epsilon_j)} \quad (9)$$

)

Based on Tien et al.[2] recommendation, anisotropic factor  $\mu$  of 0.5 for the fuel rods and 0.15 for the enclosure tube (PT) were used.

The view factors  $F$  for the 19 pin fuel bundle were calculated by Hottel's cross-string method

$$F = \begin{bmatrix} 0.0 & 0.9577 & 0.0367 & 5.64 \times 10^{-3} \\ 0.1596 & 0.3357 & 0.4918 & 0.0129 \\ 3.0587 \times 10^{-3} & 0.2459 & 0.3301 & 0.4209 \\ 1.0399 \times 10^{-3} & 0.0143 & 0.9313 & 0.0534 \end{bmatrix}$$

#### IV. VERIFICATION ANALYSIS

##### A. Single Pin Enclosure

In this exercise, a single pin generating heat

enclosed in a concentric tube was analyzed. The temperature of the tube was maintained constant. Both the pin and the tube were assumed to have the same material properties and emissivity. Problem definition, the boundary conditions and the corresponding FE model in ANSYS is shown in Fig.3. The surface temperature of the fuel rod is evaluated through steady state analysis in ANSYS. Comparison of the predicted temperature is shown in Table 1. Here the radiosity around the pin is uniform and hence anisotropic factor is assumed zero in the model prediction.

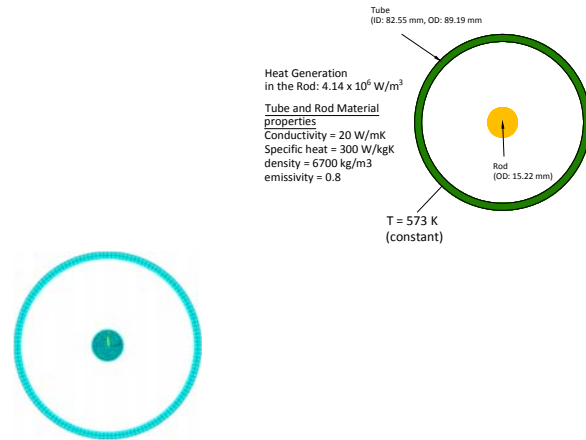


Fig.3 Problem definition and meshing

Table 1 Results of the analysis

	Analytic al	ANSYS	PRABHA VINI
Pin surface temperature	827 K	827.75 K	827 K

##### B. PHWR fuel bundle

Radiative heat exchange in PHWR 19 pin fuel bundle with the PT enclosure was analyzed using PRABHAVINI and ANSYS code. Detail of the model is shown in Fig.4. It is assumed that the fuel bundle is exposed to the non-participating medium steam. The bundle is generating decay heat of 8.9 kW with radial power factor of 1: 1.1: 1.33. PT is maintained at a temperature of 1275 K.

In the radiation model, the heat fluxes on the enclosure surfaces (the inner, the middle and the

outer pins) were prescribed based on the power generation and area. Using (5) for the pins and (8) for the PT, coefficient matrix was formulated. The matrix was then solved for isotropic radiosity  $J_i^I$  and the surface temperatures of the fuel pins were calculated using (7). The predicted temperatures are shown in Table 2.

The FE meshing of the fuel, the clad and the PT in ANSYS is shown in Fig.5. PLANE55 element was used for the solid components for temperature calculation and a surface element SURF251 was used for radiation heat flux calculation. Each pin generates heat based on the radial power factor. At the interface of the fuel and the clad, temperature continuity is assumed. A steady state solution was obtained for the imposed PT temperature.

The temperature distribution obtained from ANSYS solution is shown in Fig.6. The circumferential temperature profile for the pins shown in Fig.7, Fig.8 and Fig.9 indicate large temperature gradient along the pin surface. Average temperatures calculated from the ANSYS results are shown in Table 2. The differences in the predicted temperature between the model and the ANSYS can be attributed to the non-uniform local view factor effects which introduce significant two-dimensional non-uniformity in the temperatures and heat fluxes in the FE model. In the conventional model, the assumption of uniform radiosity and uniform temperature around the pin surfaces overestimate the transfer of heat and reduce the surface temperature.

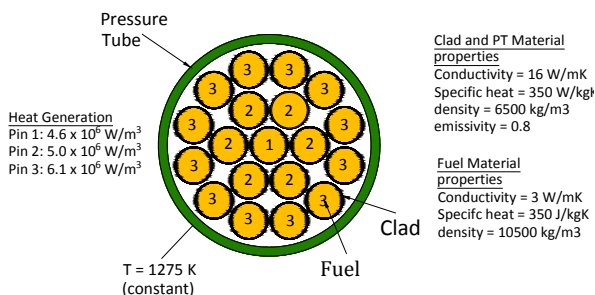


Fig.4 Problem definition

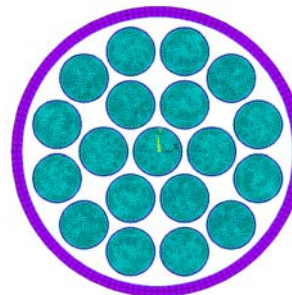


Fig.5 Meshing of the fuel bundle and PT

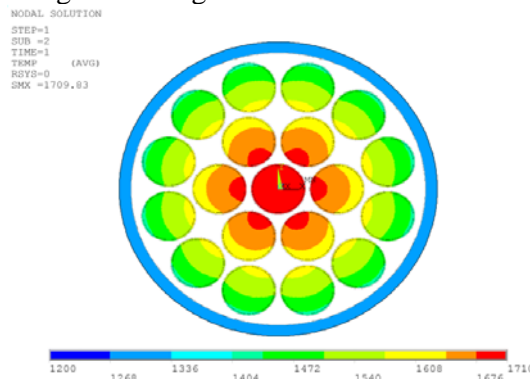


Fig.6 Channel temperature distribution

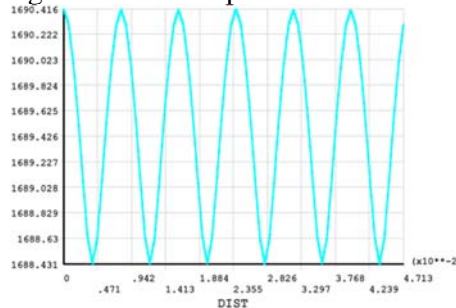


Fig.7 Center pin circumferential temperature

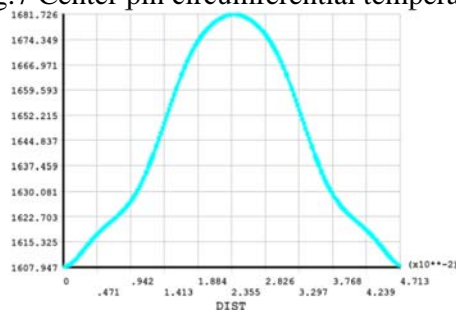


Fig.8 Middle pin circumferential temperature

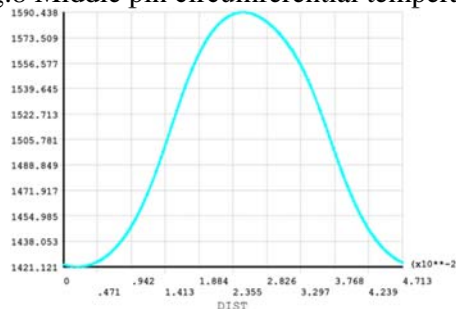


Fig.8 Outer pin circumferential temperature

Table 2: Surface temperature predictions

	PRABHAVINI		ANSYS
	Isotropic radiation	With Anisotropic correction	
Centre pin surface temperature	1508.0 K	1530.0 K	1689.5 K
Middle pin surface temperature	1490.6 K	1509.0 K	1643.0 K
Outer pin Surface temperature	1440.3 K	1448.6 K	1506.0 K
PT temperature (imposed condition)	1275.0 K	1275.0 K	1275.0 K

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**V. CONCLUSION**

A radiation exchange model was developed for PRABHAVINI code based on the formulation of anisotropic correction factor. The model accounts for non-uniform reflected radiation and found to predict improved fuel surface temperature compared to the conventional isotropic radiosity method. A detailed analysis of PHWR fuel bundle performed with ANSYS indicates large circumferential temperature gradient and non-uniform heat fluxes around the surface of the fuel pins, consequently, higher surface temperature is predicted. In spite of the limitations, the conventional method of lumping fuel surfaces is widely and successfully used in system codes for simulating radiation specifically in reactor core with large number of rods e.g. in Pressurized Heavy Water reactors. In such configuration non-uniformity mainly exists at the peripheral rods and its influence is less felt away from the bounding surface.



# GRAPHEME-TO-PHONEME CONVERSION SCHEME FOR SENTENCE-BY-SENTENCE LEARNING OF KOREAN MANUSCRIPT USING JOINT SEQUENCE STATISTICAL MODEL

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## Abstract

**Grapheme-to-Phoneme (G2P) conversion plays an important role in speech synthesis and recognition. In this paper, we used Joint Sequence model where relation between input and output sequence can be generated from a common sequence of joint units. This method is tested on large Korean corpus. The percentage of correct words conversion is 99.94% and 99.99% of word-by-word learning and sentence-by-sentence learning approaches respectively including all exceptional words. Performance of these approaches reduced the relative rate of phoneme error and word error which are relatively higher in other researches.**

**key words: Grapheme-to-Phoneme( G2P), Joint Sequence model, word-by-word learning approach, sentence-by-sentence learning approach, Korean text.**

## 1. Introduction

Grapheme to Phoneme (G2P) has an inevitable role in natural language processing, speech synthesis as well as spoken dialog systems development. Grapheme to Phoneme conversion is the process to produce a pronunciation for an input word (spelling only) to build a pronunciation dictionary. These conversions are based on some pre-defined rules which are usually created by a automated statistical analysis of a pronunciation dictionary. The main purpose to build pronunciation dictionaries is to provide pronunciation

specifically to those words which do not appear in the dictionary.

In the year 2008, Bisani and Ney proposed a joint sequence model based on co-sequence and grapheme-phoneme joint multigram. They concurrently aligned and segmented a pronunciation dictionary using discounted Expectation Maximization (EM) scheme and joint sequence modeling into a successful G2P model. The fundamental idea of joint-sequence models is to generate the relation of input and output sequences from a common sequence of joint units which carry both input and output symbols. In the simplest case, each unit carries zero or one as input and zero or one as output symbol. It was a rational approach to grapheme-to-phoneme conversion which was profounder on statistical decision theory. They experimented this approach on English, German and French with promising results and minimal phoneme error rate (PER) and word error rate (WER) [1]. This approach currently sets the prominent and precise standard for G2P conversion. This model[1] we have used in our experimental purpose for training and testing of Korean corpus. We assessed this model in two kinds of approaches:- word-by-word learning and sentence-by-sentence learning approach for Korean G2P conversion. Section 2 describes the methodology of Korean G2P converter. Elaborate explanation on results and discussion has provided in Section 3. Lastly, conclusion and future work has been drawn.

## 2. Korean Orthography and Methodology used in G2P conversion

In Korean writing, a set of jamo(alphabets) is collection of an eumjeol (syllables), and a series of eumjeol is grouped into eojeol (words). An eumjeol consists of up to three components: an initial consonant (onset), a vowel (nucleus), and a final consonant (coda). Thus, each eumjeol can be separated into three parts like onset-nucleus-coda(CVC). Korean alphabets set consist of 21 vowels and 19 consonants.

Romanization is the translation of sounds of a foreign language into English letters. Romanization of Korean words allows those who can't read Korean to phonetically pronounce it. From [2] , Korean segments using jamo(Hangul alphabets) and romanization are being referred. We have used statistical approach for G2P analysis. G2P converter takes Korean texts in English transliteration as input. From here, our approach is divided into two fields:

1. Word-by-word learning approach
2. Sentence-by-sentence learning approach

In both approaches, removes all punctuation marks except '-', '@', '#', '\$', '%', '^', '&', '\*', '\_', '!'. The chances of error to extract grapheme from raw data are almost negligible because we used 1-to-1 alignment from Korean alphabets to transliteration in English. For both the learning approach, transliterated output send as input to G2P converter. Since this is statistical approach, so each grapheme has predefined rules to generate the phonetic transcription of the current grapheme. Once the grapheme is produced, it will generate the correct phonetic transcription of original Korean sentences. For word-by-word learning approach, converter tokenized the words into graphemes. Furthermore, graphemes are mapped to their corresponding phonemes. The pronunciation of each grapheme may vary, depends on the occurrence of the preceding and succeeding graphemes. So during alignment of each grapheme to its respective phoneme, system needs to check the preceding and succeeding graphemes.

Previous researches was relied on word learning approach which commonly lengths the duration of grapheme conversion. Nevertheless, conversion of grapheme to phoneme are yet to be captured before concluding the results extracted from testing

data. It takes several days in constructing the training models and testing the test data. Sentence-by-sentence learning approach is the solution for word tokenization problem . It has unlimited context length feature. It is not limited to number of words or context length per line. This practical solution reduces the processing time of training and testing data. It takes only few hours to supply the final results.

## 3. Results and Discussion

The corpus used in the experiment was the transcription of conversational style speech synthesis database provided by ETRI (Electronics and Telecommunications Research Institute). It was a recording of simulated conversational sentences performed by a professional female announcer. The pronunciation was manually transcribed by a native Korean speaker. Originally, corpus contains 18,030 sentences . For the experiment, the corpus should divided into two modes:

1. 80-20 approach: Whole corpus was divided into two portions : one was training data (80%; 1,06,217 words or 14424 sentences) and other was evaluation test data (20%; 20,069 words or 3606 sentences).

2. 5fold cross validation: We conducted K-fold-cross-validation in the experiments. In this research, K = 5 was adopted. The data were randomly partitioned into five equal folds, each including 25260words or 3606 sentences from whole document. Whole document division based on words was target as input text for word-by-word learning approach and partition based on sentences was aimed as input data for sentence-by-sentence learning approach. On each round of experiment, four folds were used a training data set, and the remaining fold was used as the testing data set. Since a jackknife approach was used, each fold was in a test set once and in a training set four times.

We conducted each round of experiment by increasing the number of training examples with each experiment; this was repeated 5-fold. Finally, the five results from the folds will be averaged to produce a single estimation. All the reported results are on the evaluation test data. Four metrics were used to evaluate performances:

(1) Phoneme level accuracy (a measure which scores insertion, deletion, and substitution errors equally),

(2) Phoneme error rate (PER) (an edit distance between the automatic transcription result (candidate) and reference pronunciation divided by the number of phonemes in the reference pronunciation.)

(3) Word level accuracy (a measure which counts a word as correct if all the phonemes within it are correct).

(4) Word error rate (WER) (the relative proportion of words that have at least one phoneme error)

Table1 and Table2 present the performance of G2P conversion accuracy and error rate of 80-20 approach and 5fold cross validation approach of word-by-word learning and sentence-by-sentence learning approaches respectively.

**TABLE 1** G2P conversion accuracy our proposed approach

Joint Sequence Model [1]	Word-by-word approach-- Testing data	
	80-20 approach	5fold approach
Phoneme level accuracy	99.97	99.99
Word level accuracy	99.70	99.94
Phoneme Error Rate (PER)	0.022	.07
Word Error Rate (WER)	0.294	.07

**TABLE 2** G2P conversion accuracy our proposed approach

Joint Sequence Model [1]	Sentence-by-sentence approach-- Testing data	
	80-20 approach	5fold approach
Phoneme level accuracy	99.99%	99.99%
Word level accuracy	99.97%	99.99%
Phoneme Error Rate (PER)	.002%	.0004%

Word Error Rate (WER)	.024%	.006%
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**TABLE 3** Comparison of G2P conversion accuracy of 80-20 approach with previous related research of word-based approach

	Testing data	
	Phoneme level (%)	Word level (%)
Our Approach	99.97	99.70
[2]	99.216	94.105
[3]	99.057	92.927
[4]	98.354	86.629

Table3 shows the comparison among previous state-of-the-art related work performances tested on same Korean database. Lee and Lee [2] had proposed rule based system for Korean G2P TTS. They experimented the corpus on rule-based data-driven model. They measured their performances based on phoneme level and word level accuracy with full rules and rule pruning procedures. They obtained 99.22 percent phoneme-level accuracy with full rules and only a small performance degradation (0.1percent) by using reduced rule approach. With reduced rules, they obtained 99.11 percent phoneme level accuracy [2]. The downside part of rule-based data-driven model[2] was that it had limited context length feature which varies up to maximum ten. However, Lee et.al[2] had compared other data driven methods like decision trees [3] and Hidden Markov model (HMM) [4] on the same Korean corpus. They applied graphemes contexts ( five letters both left and right side) for decision trees and 5-gram grammar for HMM based methods. The final consequences of Korean corpus based on word-level accuracy of decision trees and HMM models are 92.927 percent and 86.629 percent respectively. It is evident from results that joint sequence model[1] performs much better than rule-based data-driven model[2] better than decision trees algorithm better than HMM. The results illustrate that our method surpassed other data-driven methods on the same corpus.

In this paper, we discussed an competent and robust statistical approach for G2P conversion for Korean language. The system has been implemented in python. Our Sentence-by-sentence learning approach was not restricted to length of sentence. This

approach has ability to learn a sentence with endless words in single line. This is most profitable fixation of grapheme to phoneme conversion. Moreover, 1-to-1 alignment scheme has been opted for alignment of each grapheme to phoneme conversion. Therefore, it reduced the error prospect and increases the precision of results. In English, there are 1-to-n and n-to-1 alignment as well as 1-to-1 alignment. Moreover, since the Korean writing system is more or less phonetic, most graphemes are enunciated as they are referred from pronunciation-varying verbalization database. At the last, the size of Korean database have an adequate amount of words which cover most of the pronunciation changes. This approach can be used in various speech recognition and speech synthesis application.

### **Conclusion and Future work**

This paper introduced a sentence-by-sentence learning approach for G2P conversion. Aforementioned approach reduced the processing time of building the models from training corpus and fetching results from testing data. During experimentation, we had also tested our corpus on word-by-word learning approach and from the end result of both approaches, it is explicitly suggested that sentence learning furnished more precise outcome than word learning approach for G2P conversion. The noteworthy parameter was phoneme error rate (PER) and word error rate (WER) , which were almost negligible. This concluded our paper that with high transcription rate of G2P, our sentence-by-sentence learning approach was more efficient, methodical and robust.

### **Acknowledgement**

We would like to thank Sogang University, Seoul for providing Korean corpus used in this exp.

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## PERFORMANCE OF MIMO-OFDM TRANSMISSION SYSTEM ON WIRELESS NETWORKS

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### Abstract

A detailed study of the performance of MIMO-OFDM transmission on WLAN physical layer specified in IEEE 802.11n, Wi-MAX (IEEE 802.16-2009) physical layer specified in 802.16 and LTE downlink physical channel (PDSCH) has been carried out using MATLAB Simulink. The WLAN and Wi-MAX system incorporates Convolution coding with 1/2 and 2/3 rated codes. The LTE incorporates Turbo coding with 1/2 and 2/3 rated codes. Orthogonal Frequency Division Multiple (OFDM) accesses uses adaptive modulation technique such as QPSK, 16-QAM and 64-QAM, on the physical layer of WLAN, Wi-MAX and LTE and the concept of cyclic prefix that adds additional bits at the transmitter end. The Error Rate (BER) derived from simulation results show that the implementation with interleaved Convolution coding and Turbo coding under QPSK modulation technique is found to be highly efficient for WLAN, Wi-MAX and LTE wireless network system. The Implementation of MIMO-OFDM multiplexing on WLAN networks with QPSK modulation at BER  $\sim 10^{-3}$  dB, exhibits significant improvement in SNR  $\sim 2.75$  dB, Wi-MAX network SNR  $\sim 3.75$  dB and LTE network SNR  $\sim 7.55$  dB. The improvement of SNR  $\sim 4.8$  dB displayed between the MIMO-OFDM implementation on WLAN and LTE

network can be attributed to the Turbo coding techniques adopted in LTE networks.

### Keywords

Multiple Input Multiple Output (MIMO), Orthogonal Frequency Division Multiplexing (OFDM), Phase Shift Keying (PSK), Quadrature Amplitude modulation (QAM), Bit Error Rate (BER), Signal to Noise Ratio (SNR), Line-of-Sight (LoS), Forward Error Correction (FEC), Wireless Local Area Network (WLAN), Worldwide interoperability for Microwave Access (Wi-MAX), Long Term Evaluation (LTE), Subscriber Station (SS), Base Station (BS).

### Introduction

In this new information age, high data rate and strong reliability features out wire-less communication systems and is becoming the dominant factor for a successful deployment of commercial networks. MIMO technology is one among being used in broadband systems that exhibit frequency-selective fading and Inter-Symbol Interference (ISI). MIMO system realize the spatial diversity and spatial multiplexing at the same time and consequently obtain both the spatial diversity gain and spatial multiplexing gain leading to an enormous capacity enlargement. The improvement can be even greater by combination with other technology such as OFDM. Effectively, OFDM transforms a frequency selective channel into parallel flat-fading sub channels i.e., the signals on the



subcarriers undergo narrowband fading. Hence by performing MIMO transmission and detection per subcarrier, MIMO can be applied in broadband communication. Multiple Input Multiple Output-Orthogonal Frequency Division Multiplexing (MIMO-OFDM), a new wireless broadband technology, has gained great popularity for its capability of high rate transmission and its robustness against multi-path fading and other channel impairments [14]. In radio, MIMO is the use of multiple antennas at both the transmitter and receiver to improve communication performance. It is one of several forms of smart antenna technology. MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without additional bandwidth or increased transmit power. It achieves this goal by spreading the same total transmit power over the antennas to achieve an array gain that improves the spectral efficiency or to achieve a diversity gain that improves the link reliability and reduced fading. Because of these properties, MIMO is an important part of modern wireless communication standards such as IEEE 802.11n (Wi-Fi), 4G, 3GPP Long Term Evolution, Wi-MAX and HSPA+ [2].

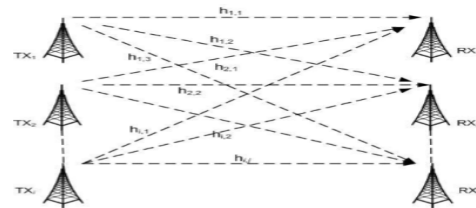
Conventional high-speed broadband solutions are based on wired-access technologies such as Digital Subscriber Line (DSL). This type of solution is difficult to deploy in remote rural areas, and furthermore it lacks support for terminal mobility. Mobile Broadband Wireless Access (BWA) offers a flexible and cost-effective solution to these problems. The goal of LTE was to increase the capacity and speed of wireless data networks using new DSP (digital signal processing) techniques and modulations that were developed around the turn of the millennium. A further goal was the redesign and simplification of the network architecture to an IP-based system with significantly reduced transfer latency compared to the 3G architecture. The LTE wireless interface is incompatible with 2G and 3G networks, so that it must be operated on a separate wireless spectrum [19].

The present study involves implementation of MIMO system with OFDM multiplexing and

modulation techniques for digital signal transmission on WLAN, Wi-MAX and LTE networks. For WLAN, IEEE 802.11n standard is considered, for Wi-MAX IEEE 802.16-2009 is considered. The performance of the WLAN, Wi-MAX and LTE combined with MIMO-OFDM is determined by computing the Signal to Noise Ratio (SNR), Bit Error Rate (BER) for a given data rate in a communication system using MATLAB Simulink.

## Multiple Input Multiple Output (MIMO)

The multiple input multiple output channel technology is aimed to increase the capacity in the wireless communication network. With the invention of MIMO, the technology seems to gain popularity as it is being implemented in the current commercial wireless products and networks such as broadband wireless access systems, Wi-MAX, 3G networks, etc. Figure 1 shows a line of sight (LOS) antenna setup of a MIMO system.



**Figure 1 A generalized MIMO wireless communication system**

The main idea behind MIMO is that, the sampled signals in spatial domain at both the transmitter and receiver end are combined so that they form effective multiple parallel spatial data streams which increase the data rate. The occurrence of diversity also improves the quality that is the bit-error rate of the communication [6, 13].

To derive the channel characteristics, MIMO system transmits specified and known training signals regularly from all transmitters of the system and these transmitted signals are received at the receiver. Based on the received signals, the receiver calculates the characteristics of all channel paths from each transmitted antenna to each receiving antenna. In order to prove that MIMO work, the transmitted signal  $X$  has to be solved from the group of equations in equation (1),

assuming that the system is noise free and line of sight (LOS). If the transmitted signal is represented to be  $X$ , the received signal  $Y$  and the channel characteristics matrix is  $W_c$ , then  $Y = X W_c$  (1).

If the channel matrix has  $N$  rows as many as there are transmitting antennas with index  $i$ , then transmitted signal vector is written as  $X = [x_1, x_2, \dots, x_N]$ . Also if the channel matrix has  $M$  columns, as there are receiving antennas with index  $j$ , then the received signal vector is  $Y = [y_1, y_2, \dots, y_M]$ . These vectors are extended later to matrixes by inserting  $K$  samples into each column. The channel matrix contains path characteristics  $h_{ij}$  as

$$W_c = \begin{pmatrix} h_{1,1} & h_{1,2} & \dots & h_{1,M} \\ h_{2,1} & h_{2,2} & \dots & h_{2,M} \\ \vdots & \vdots & \ddots & \vdots \\ h_{N,1} & h_{N,2} & \dots & h_{N,M} \end{pmatrix}$$

### Orthogonal Frequency Division Multiplexing (OFDM)

OFDM is a Multi-Carrier Modulation technique in which a single high rate data-stream is divided into multiple low rate data-streams and is modulated using sub-carriers which are orthogonal to each other and can be thought of as a large number of low bit rate carriers transmitting in parallel. All these carriers transmitted using synchronized time and frequency, forming a single block of spectrum, to ensure that the orthogonal nature of the structure is maintained. As a modulation format, OFDM is very flexible in that it can be easily scaled to meet the needs of a particular application. For applications like VOFDM, the lack of ISI also greatly simplifies the implementation of diversity reception. BWIF (uplink), 802.11a and Hyperlan/II are unique in that the OFDM is

pulse modulated. While the specifics of BWIF are proprietary, the impact on WLAN products is the need for special synchronization techniques [5, 10].

### Implementation of MIMO-OFDM on WLAN Network (IEEE 802.11n)

The model shown in figure 2 represents an end-to-end baseband model of the physical layer of a WLAN according to the IEEE 802.11n standard. This model contains various components that model the essential features of the WLAN 802.11n standard. The top row of blocks contains the transmitter components while the bottom row contains the receiver components. The model supports data rates of 6, 9, 12, 18, 24, 36, 48, and 54 Mb/s. The model also illustrates adaptive modulation and coding over a dispersive multipath fading channel, whereby the simulation varies the data rate dynamically [9, 11].

Random binary data is generated by Random Integer block (variable rate data source). This randomly generated data is then modulated by modulator bank (QPSK, 16-QAM and 64-QAM modulations are incorporated). This modulated data is converted to OFDM symbols and again modulated by OFDM modulator. Pilot signals and training symbols (preambles) are used for time synchronization (to avoid ISI) and frequency synchronization (to avoid inter-carrier interference, ICI, caused by Doppler shift). Zero padding blocks append zeros to the specified dimension if it is not available at the input of IFFT block. The cyclic prefix, which is transmitted during the guard interval, consists of the end of the OFDM symbol copied into the guard interval, and the guard interval is transmitted followed by the OFDM symbol. Ultimately it decides the number of subcarriers to be used [12, 15].

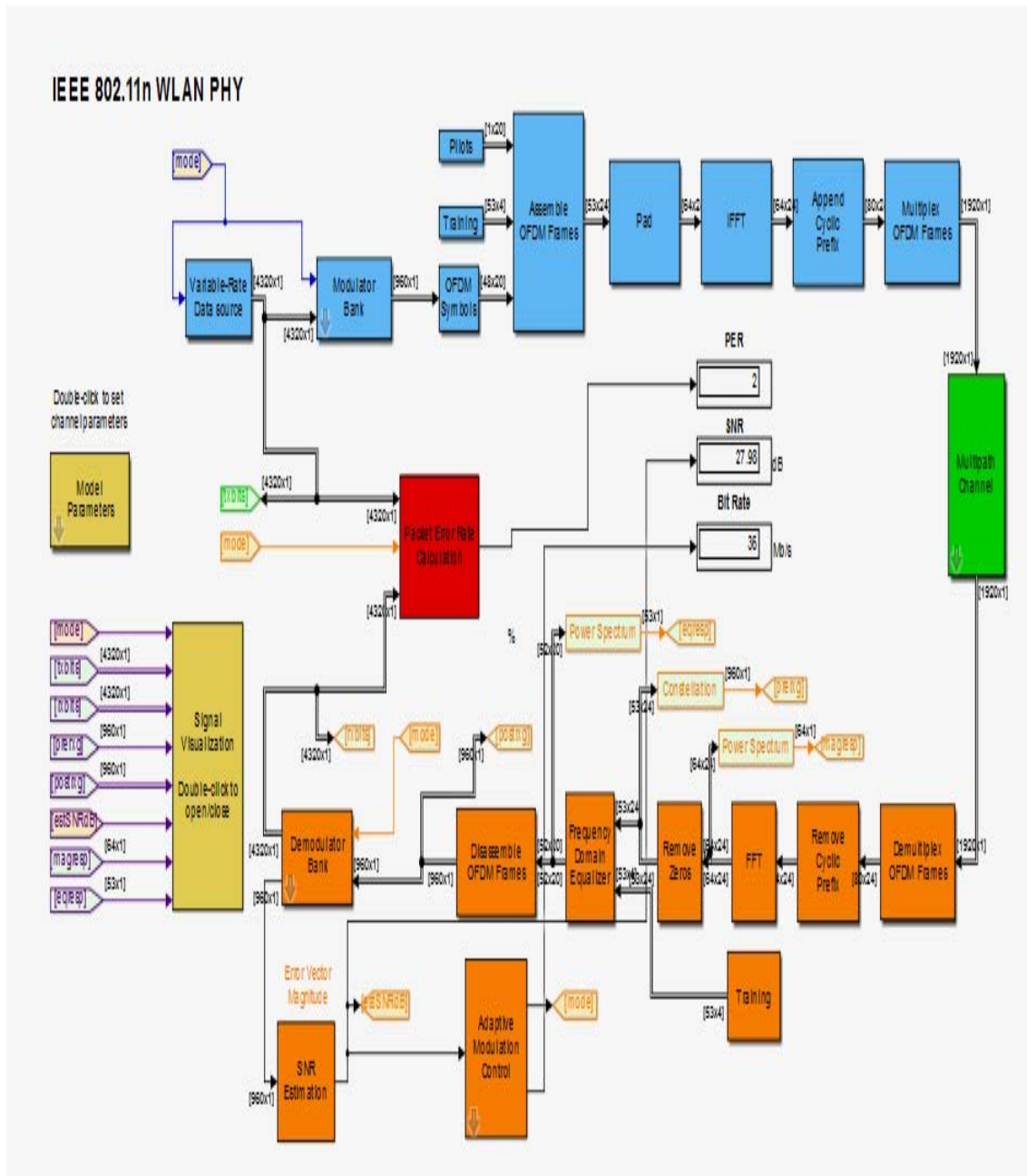


Figure 2 IEEE 802.11n WLAN PHY

Now OFDM frames are multiplexed and transmitted through the multipath channel. After passing through the channel the data first demultiplex the OFDM frames and then demodulated by the OFDM demodulator which consists of remove Cyclic Prefix, FFT, remove Zero Pad blocks in sequence. Cyclic prefix which is attached to OFDM signal

before transmission is to be removed by removing Cyclic Prefix block. Then FFT will process the data to get the data same as that of input given to the IFFT block. After this, zero padding is removed. Now demodulator is used to demodulate this data to obtain random binary data transmitted by the random integer generator block [18, 20].

## Implementation of MIMO-OFDM on Wi-MAX Network (IEEE 802.16-2009)

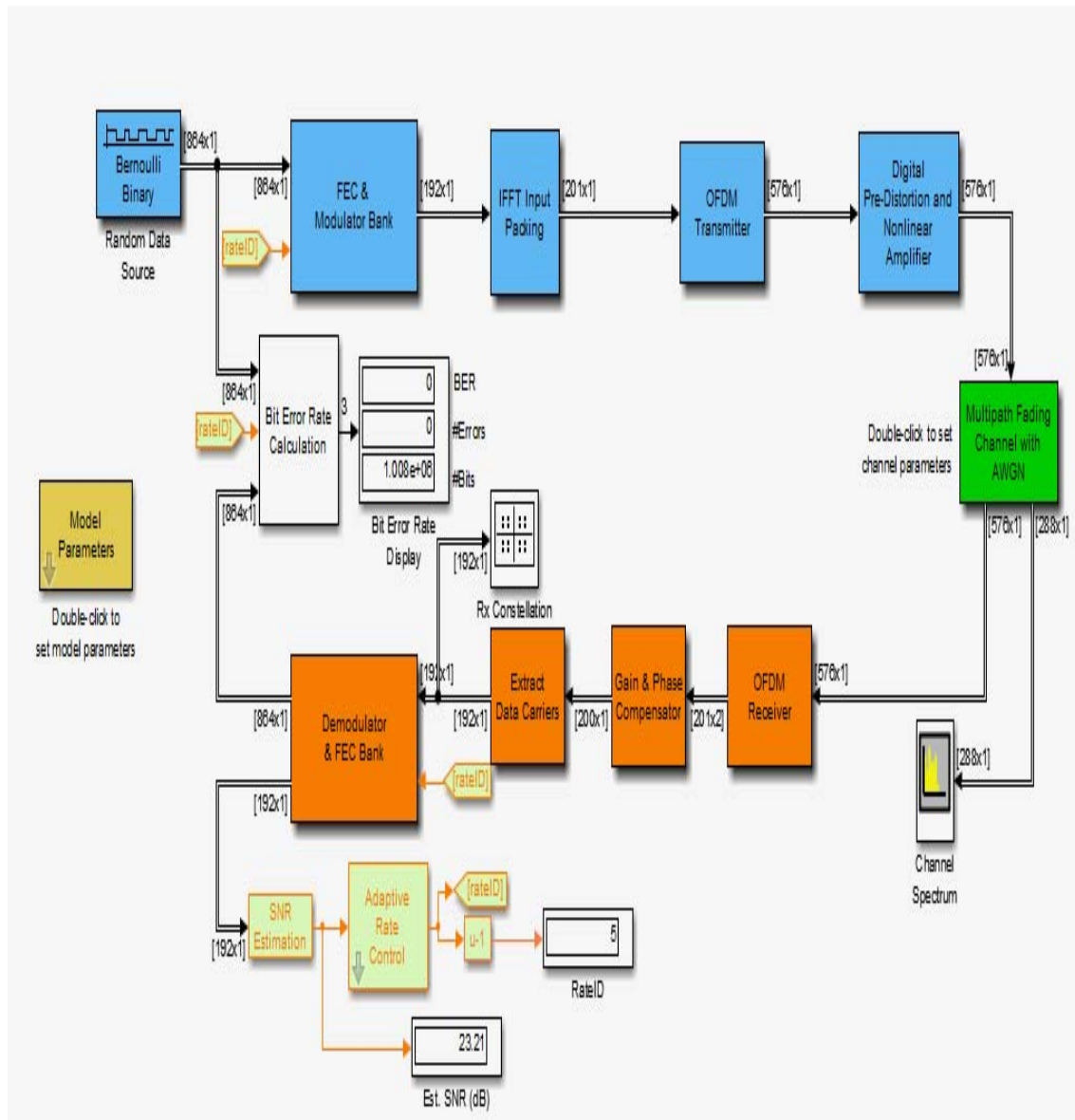
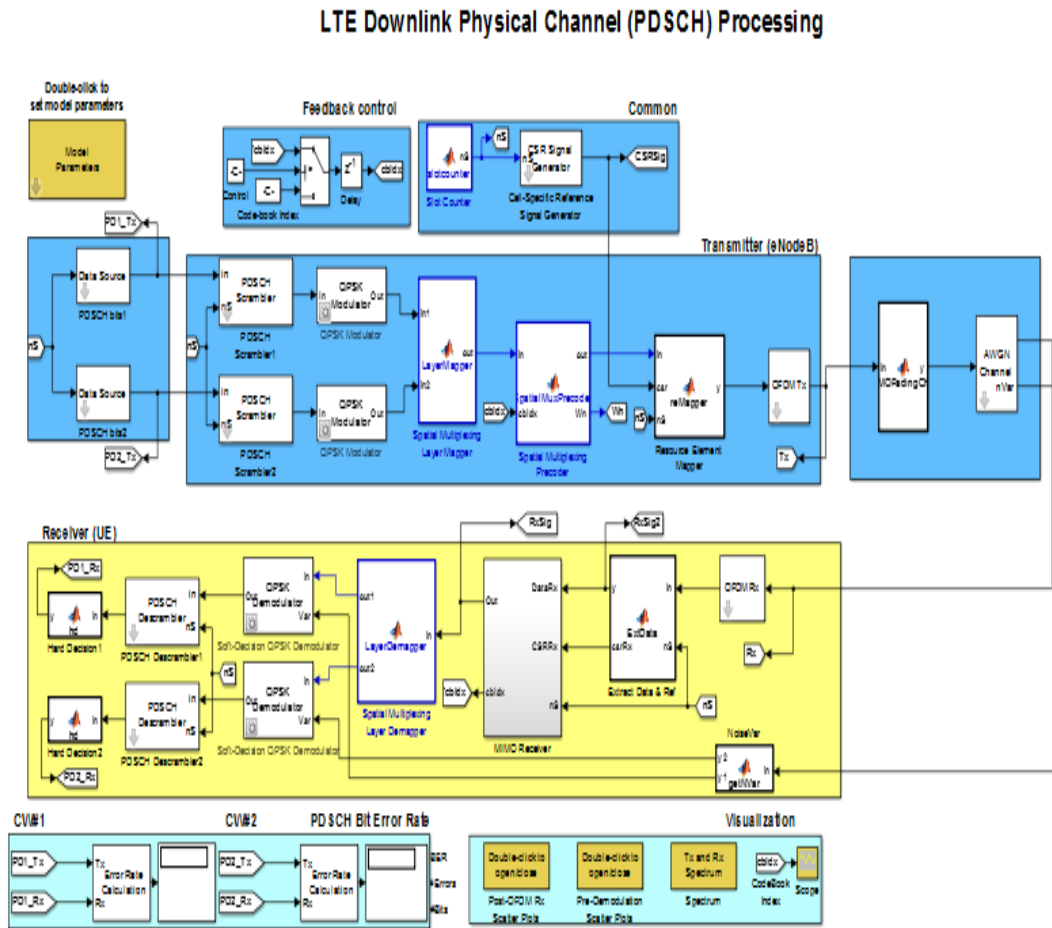


Figure 3 IEEE 802.16 Wi-MAX

### IEEE 802.16 Wi-MAX NETWORK

The simulation model shown in figure 3 is an end-to-end baseband model of the physical layer of a wireless metropolitan area network (Wi-MAX), according to the IEEE 802.16-2009 standard. More specifically, it models the OFDM-based physical layer, called Wireless MAN-OFDM, supporting all of the

mandatory coding and modulation options. It also illustrates Space-Time Block Coding (STBC), an optional transmit diversity scheme specified for use on the downlink. Finally, it illustrates the use of digital pre-distortion, a technique for extending the linear range of a nonlinear amplifier [1, 7, 17



### Implementation of MIMO-OFDM on LTE Network

Figure 4 LTE Downlink Physical Channel

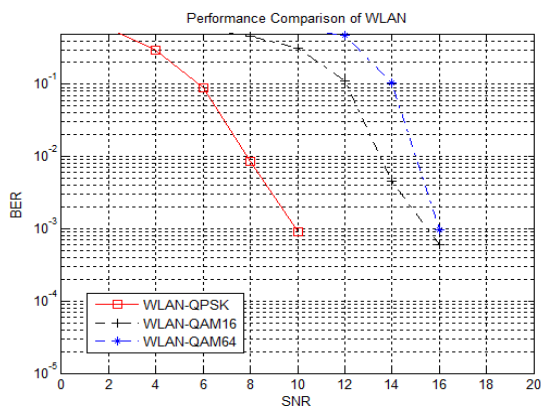
The simulation model of LTE is as shown in figure 4. A physical channel corresponds to a set of time-frequency resources used for transmission of a particular transport channel. The source data bits (transport channel encoded bits) are scrambled by a bit-level scrambling sequence. Downlink data modulation converts the scrambled bits into complex modulated symbols. The set of modulation schemes supported include QPSK, 16QAM and 64QAM, corresponding to two, four, and six bits per modulation symbol respectively. We can select the different modulation schemes using the PDSCH modulation type parameter in the simulation. The LTE Encode function

combines the transmit diversity layer mapping and precoding as per the LTE Standard. This function uses complex notation for signals and employs the OSTBC Encoder System to implement the space-frequency block coding specified for LTE. The complex-valued time-domain OFDM signal per antenna is generated from the fully populated resource grid, via using the OFDM Modulator System. The simulator uses the MIMO Channel to model the Rayleigh fading over multiple links. OFDM receiver undoes the unequal cyclic prefix lengths per OFDM symbol in a slot and converts back to the time- and frequency-domain grid structure, using the OFDM Demodulator System. Channel

Estimation when selected, employs least-squares estimation using averaging over a subframe for noise reduction for the reference signals, and linear interpolation over the subcarriers for the data elements. Transmit Diversity (TD) combining for the multiple transmitted signals are folded into the TD Combine function which, similar to the encoder, uses complex notation for signals and employs the OSTBC Combiner. The combined data stream is further demodulated and descrambled to get the received data bits [3, 19].

## Results and Discussions

The simulation results of the performance of 2x2 MIMO-OFDM system on WLAN physical layer, Wi-MAX physical layer and LTE for different digital modulation techniques namely QPSK, 16-QAM and 64-QAM are derived using MATLAB Simulink. The BER values as a function of SNR are determined for WLAN network for different modulation schemes to study their relative performances with digital modulation. The SNR values are determined as a function of BER for QPSK, 16-QAM and 64-QAM modulation schemes. Figure 5 shows the BER performance of WLAN network derived as a function of SNR for 2x2 MIMO-OFDM multiplexing system for different modulation schemes.

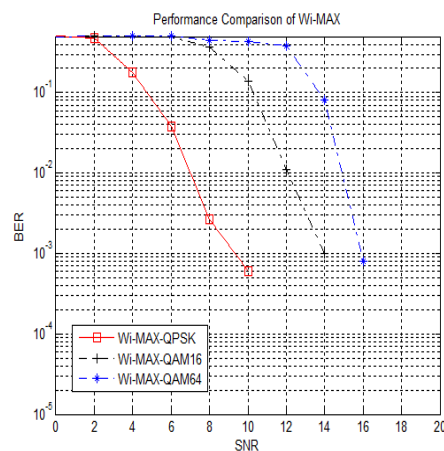


**Figure 5 SNR Vs BER performance analysis on WLAN network for different modulation schemes**

It is evident in figure 5 that the BER values decrease as SNR increases for different modulation schemes. The figure indicates that

implementation of MIMO-OFDM system on the WLAN network for QPSK modulation at BER  $\sim 10^{-3}$  dB, depicts an SNR  $\sim 10$  dB, 16-QAM modulation SNR  $\sim 15.5$  dB and 64-QAM modulation SNR  $\sim 16$  dB is achievable. The simulation results of 2x2 MIMO-OFDM system at BER  $\sim 10^{-3}$  dB for QPSK modulation, the SNR is found to be lowest  $\sim 10$  dB and between QPSK and 64-QAM modulation there is a large improvement in SNR  $\sim 6$  dB. The results suggest that, the 2x2 MIMO-OFDM implementation with QPSK modulation is very efficient on WLAN networks.

The BER values as a function of SNR are determined for Wi-MAX network for different modulation schemes to study their relative performances for digital modulation. The SNR values are determined as a function of BER for QPSK, 16-QAM and 64-QAM modulation schemes. Figure 6 shows the BER performance of Wi-MAX network derived as a function of SNR for 2x2 MIMO-OFDM multiplexing system for different modulation schemes.

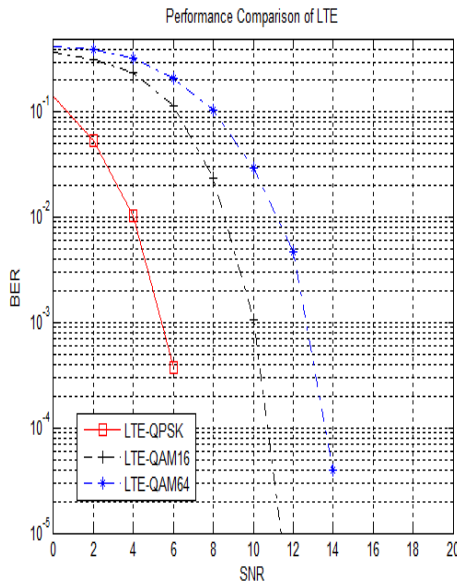


**Figure 6 SNR Vs BER performance analysis on Wi-MAX network for different modulation schemes**

It can be seen in figure 6 that the BER values decrease as SNR increases for different modulation schemes. The figure indicates that for MIMO-OFDM system at BER  $\sim 10^{-3}$ , the Wi-MAX network depicts that for QPSK modulation SNR  $\sim 9.1$  dB, 16-QAM modulation SNR  $\sim 14$  dB and 64-QAM modulation SNR  $\sim 15.7$  dB is achievable. The

simulation results of 2x2 MIMO-OFDM system at BER  $\sim 10^{-3}$  dB for QPSK modulation, the SNR is found to be lowest  $\sim 9.1$  dB and between QPSK and 64 QAM modulation there is a large improvement in SNR  $\sim 6.6$  dB. The results of the simulation studies suggest that, the 2x2 MIMO-OFDM implementation with QPSK modulation is more efficient on Wi-MAX networks.

The BER values as a function of SNR are determined for LTE network for different modulation schemes to study their relative performances for digital modulation. The SNR values are determined as a function of BER for QPSK, 16-QAM and 64-QAM modulation schemes. Figure 7 shows the BER performance of LTE network derived as a function of SNR for 2x2 MIMO-OFDM multiplexing system for different modulation schemes.

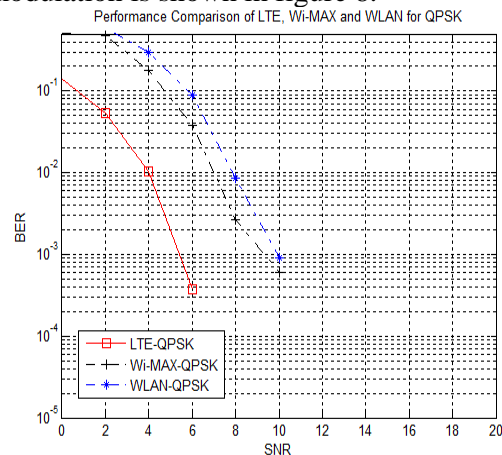


**Figure 7 SNR Vs BER performance analysis on Wi-MAX network for different modulation schemes**

It can be seen in figure 7 shows that the BER values decreases as SNR increases for different modulation schemes. The figure indicates that for MIMO-OFDM system at BER  $\sim 10^{-3}$ dB, the Wi-MAX network depicts that for QPSK modulation SNR  $\sim 5.2$  dB, 16-QAM modulation SNR  $\sim 10$  dB and 64-QAM modulation SNR  $\sim 12.8$  dB achievable. The simulation results of 2x2 MIMO-OFDM system at BER  $\sim 10^{-3}$  dB for QPSK

modulation, the SNR is found to be lowest  $\sim 5.2$  dB and between QPSK and 64-QAM modulation, there is a large improvement in SNR  $\sim 7.6$  dB. The results of the analysis suggest that, the 2x2 MIMO-OFDM implementation with QPSK modulation is very efficient on LTE networks.

A detailed comparison of the SNR performance of 2x2 MIMO-OFDM system implementation on WLAN, Wi-MAX and LTE networks as a function of BER for QPSK modulation is shown in figure 8.



**Figure 8 SNR Vs BER performance analysis for QPSK on different networks**

It is evident from figure 8 that the BER values decreases as SNR increases for all the three networks. The figure indicates that at BER  $\sim 10^{-3}$  dB, the WLAN shows that the SNR  $\sim 10$  dB, Wi-MAX shows SNR  $\sim 9.1$  dB and LTE shows the SNR  $\sim 5.2$  dB are achievable for QPSK modulation. Further the figure shows that there is a large improvement in SNR  $\sim 4.8$  dB between WLAN to LTE networks. The SNR values are being lowest  $\sim 5.2$  dB for 2x2 MIMO-OFDM system implemented on LTE network suggest that, the LTE networks are most efficient for MIMO-OFDM implementation with QPSK modulation.

The SNR performance of 2x2 MIMO-OFDM without and with implementation on the WLAN, Wi-MAX and LTE networks for QPSK modulation at BER  $\sim 10^{-3}$ dB has been compared in table 1

**Table-1- Comparison of MIMO Systems with and without implementation network, SNR Values for QPSK modulation technique for BER  $\sim 10^{-3}$ dB**

NETWORK	WLAN SNR(dB)	Wi-MAX SNR(dB)	LTE SNR(dB)
WITHOUT MIMO-OFDM ON NETWORK IMPLEMENTATION	12.75	12.75	12.75
WITH MIMO-OFDM ON	10	9.1	5.2
DIFFERENCE	2.75	3.75	7.55

It is clearly evident from the Table 1 that at BER  $\sim 10^{-3}$  dB the simulation results show that implementation of MIMO-OFDM transmission on WLAN networks for QPSK modulation there is significant improvement in SNR  $\sim 2.75$  dB. Similarly the implementation on Wi-MAX networks shows an improvement in SNR  $\sim 3.65$  dB. The implementation on LTE networks shows an improvement in SNR  $\sim 7.55$  dB. The result of the analysis indicates that the 2x2 MIMO-OFDM system implementation on WLAN, Wi-MAX and LTE networks offers better SNR performance for higher data rate transmission.

The SNR values derived at BER  $\sim 10^{-3}$  dB for the 2x2 MIMO-OFDM implementation on the WLAN, Wi-MAX and LTE networks for different coding schemes and modulation techniques are summarized in table 2.

**Table-2 Comparison of SNR values for WLAN, Wi-MAX and LTE for different modulation techniques at BER  $\sim 10^{-3}$**

CODING TECHNIQUE USED	NETWORKS / MODULATION	QPSK SNR (dB)	16-QAM SNR (dB)	64-QAM SNR (dB)
Convolution coding	WLAN (IEEE 802.11n)	10	15.5	16
Reed-Solomon	Wi-MAX (IEEE	9.1	14	15.7

with Convolution coding	802.16-2009)			
Turbo coding	LTE	5.2	10	12.8

It is clearly evident from the Table 2 that at BER  $\sim 10^{-3}$  dB, the SNR values increase with increasing modulation from QPSK to 64-QAM modulation are consistent with theoretical considerations. Further the table shows that implementation of the MIMO-OFDM transmission on LTE networks for QPSK modulation shows lowest SNR  $\sim 5.2$  dB compared to other networks. The LTE implementation of MIMO-OFDM network indicates a large improvement in SNR  $\sim 4.8$  dB compared to WLAN network. The MIMO-OFDM implementation on the three networks indicates that the SNR values are very sensitive to the coding techniques. The lowest SNR  $\sim 5.2$  dB values and the better SNR performance displayed by LTE network compared to WLAN and Wi-MAX networks can be attributed to the efficient Turbo coding schemes adopted by LTE networks.

## Conclusions

It can be concluded from the results presented that,

1. The simulation results of MIMO-OFDM implementation on network indicates that the SNR at BER  $10^{-3}$  dB increases from QPSK to 64-QAM modulation in accordance with the modulation theory. The results depicts that QPSK modulation exhibits lowest SNR values.
2. The MIMO-OFDM system implementation on WLAN network for QPSK modulation shows that at BER  $\sim 10^{-3}$  dB, the lowest SNR values  $\sim 10$  dB and improvement in SNR  $\sim 2.75$  dB.
3. The MIMO-OFDM system implementation on Wi-MAX network for QPSK modulation show that at BER  $\sim 10^{-3}$  dB, the lowest SNR values  $\sim 9.1$  dB and improvement in SNR  $\sim 3.65$  dB.
4. The MIMO-OFDM system implementation on LTE network for QPSK modulation shows that at BER



$\sim 10^{-3}$ dB, the lowest SNR values  $\sim 5.2$  dB and improvement in SNR  $\sim 7.55$  dB.

5. The implementation of 2x2 MIMO system on LTE networks QPSK modulation at BER  $10^{-3}$ dB shows an improvement of SNR  $\sim 4.8$  dB compared to WLAN networks.
6. The larger improvement seen in SNR  $\sim 4.8$  dB for LTE networks can be attributed to the Turbo coding adopted in LTE networks.

### Acknowledgement

We wish to acknowledge the support given by Principal, RV College of Engineering, Bangalore for carrying out the present research work and HoD Department of Telecommunication for constant encouragement.

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# SMART TRANSLATOR: TEXT TO SPEECH CONVERSION SYSTEM ENHANCED WITH MULTILINGUAL ENABLEMENT AND OPTICAL CHARACTER RECOGNITION

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## Abstract

**Understanding regional languages in a country like India has been very difficult for foreigners. When there are many regional languages no one would be able to study all these languages, but it is necessary to understand the meaning of the text in that regional language when a person visit that region. This application focuses on eliminating this difficulty. Through this application a user will be able to understand a regional language. This application translates the regional language to a person's native language and read out the text in native language. For translation a user has to take a picture of the text to be translated and this application will then extract the text data from that image and translate it to the user's native language.**

## I. INTRODUCTION

When there are many regional languages no one would be able to study all these languages, but it is necessary to understand the meaning of the text in that regional language when a person visit that region. This application focuses on eliminating this difficulty. Through this application a user will be able to understand a regional language. This application translates the regional language to a

person's native language and read out the text in native language.

Optical Character Recognition (OCR) is the mechanical or electronic conversion of scanned or photographed images of typewritten or printed text into machine-encoded or computer-readable text. It is widely used as a form of data entry from some sort of original paper data source, whether passport documents, invoices, bank statements, receipts, business card, mail, or any number of printed records. It is a common method of digitizing printed texts so that they can be electronically edited, searched, stored more compactly, displayed on-line, and used in machine processes such as machine translation, text-to-speech, key data extraction and text mining. OCR is a field of research in pattern recognition, artificial intelligence and computer vision.

### A. PURPOSE

Through this application a user will be able to understand a regional language. This application translates the regional language to a person's native language and read out the text in native language. For translation a user has to take a picture of the text to be translated and this application will then extract the text data from that image and translate it to the user's native language.

## B. OBJECTIVES

The motivation, envision a cheap and convenient mobile device that is able to capture an image of the text to be translated, extract the text from that image, translate the extracted text using a translator and to speak out the text that is translated.

## C. EXPECTED OUTCOME

We observed that using this application, it helps in understanding a regional or foreign language to a person who doesn't know that language. This application also doesn't require any other hardware other than a smartphone with internet facility. This application doesn't require an assistance from a third party for most users. This application can even be used by blind people with proper assistance.

## II. RELATED WORKS

Research aiming to develop a text-to-speech converter (TSC) for Spanish, that accepts a continuous source of alphanumeric characters (up to 250 words per minute) and produces good quality, natural Spanish output, is described. Four sets of problems are considered in this work: the hardware structure adopted for real time operation; the complex control software needed to handle the orthographic input and linguistic programs; the linguistic, processing rules, and the parameterization of the Spanish language matched to a TSC. Emphasis is made on the problems of adapting a general hardware structure to a specific language.

## III. WORKING

- First taking the image of the text to be translated using a camera
- Captured image will be send to the server using internet.
- In the server text will be extracted from the image using an OCR
- Then by using translator, converting the text to native language.
- Send the native language text back to the phone.
- Then by using a text to speech converter convert the text to speech and speak out the text using a microphone.

## IV. CONCLUSION

The project translates the regional language to a person's native language and read out the text in native language. For translation a user has to take a picture of the text to be translated and this application will then extract the text data from that image and translate it to the user's native language. This application also doesn't require any other hardware other than a smartphone with internet facility. This application doesn't require an assistance from a third party for most users. This application can even be used by blind people with proper assistance.

## V. FUTURE WORKS

There are many researches going on in the field of optical character recognition which gives better accuracy for the optical character recognition. This will lead to the increase in the accuracy of the project proposed in this paper.

There are also researches going on in the field of the translation which will enhance the accuracy of translation api's. This will also lead to the accuracy of the translation in this application..

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## VTDS: VEHICLE THEFT DETECTION SYSTEM

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### Abstract

**Now a days the cases of vehicle theft detection increases very much especially in developing country's like India .security for vehicle is available only in costly editions. This project deals with a sensor based vehicle theft detection system along with some other features like fire detection which can be implemented in any vehicle. The sensors in the system identifies any anomalies occurred in the system and inform the owner using some messages. The owner can control the vehicle from a distant location based on the messages received using an android application in his mobile device.**

security mechanisms provided by the manufacturer in addition to the extra technologies available in the market, but there exist some problems for all of this technologies and have a high cost too.

The available security systems in the market contain either a locking system or a GPS based tracking system. The problem with the normal locking system is that an expert can easily unlock the vehicle if he have the necessary tools. The GPS only tracking system also face some vulnerabilities like jamming devices and network coverage problems. These systems also come with a high implementation and maintenance cost. Most of these systems need further updates which cost more money. Currently the inbuilt security system is provided only for higher editions by most of the manufactures. The implementation of additional security system cost a large amount of money which cannot afforded by a normal user.

### I. INTRODUCTION

The project deals with a novel method for vehicle tracking and locking system used to track the vehicle by using GPS and providing an alert to the owner of the vehicle by communication between android devices in occurrence of a theft. The development of satellite communication technology helps in easily identifying the vehicle location. Vehicle tracking and theft detection systems have brought this technology to the common people all around the world.

Due to fact that the cases of vehicle theft increases day by day, an efficient security mechanism is needed for our vehicle in order to protect it from robbery. There exist a lot of

### II. SYSTEM OVERVIEW

In VTDS we propose a combination of GSM and sensor based anti-theft detection system. This system is used to provide security for a number of vehicles. Each vehicle has an android device with in it which will help to uniquely identify the vehicle. Every android device has an IMEI number which will identify the vehicle.

The main problem with the existing theft detection systems is that there is limited user

interactive methods. Our system overcome this problem by providing an efficient user interface. Through any mobile android device, we can control and track the vehicle very easily. Communication can be established between the two android devices- one which is placed inside the vehicle and the other which is with the owner.

Our system consists of four main components:

- Theft Detection System
- Realtime Tracking System
- Fire Detection System
- User End Application

**III.SYSTEM DESIGN**

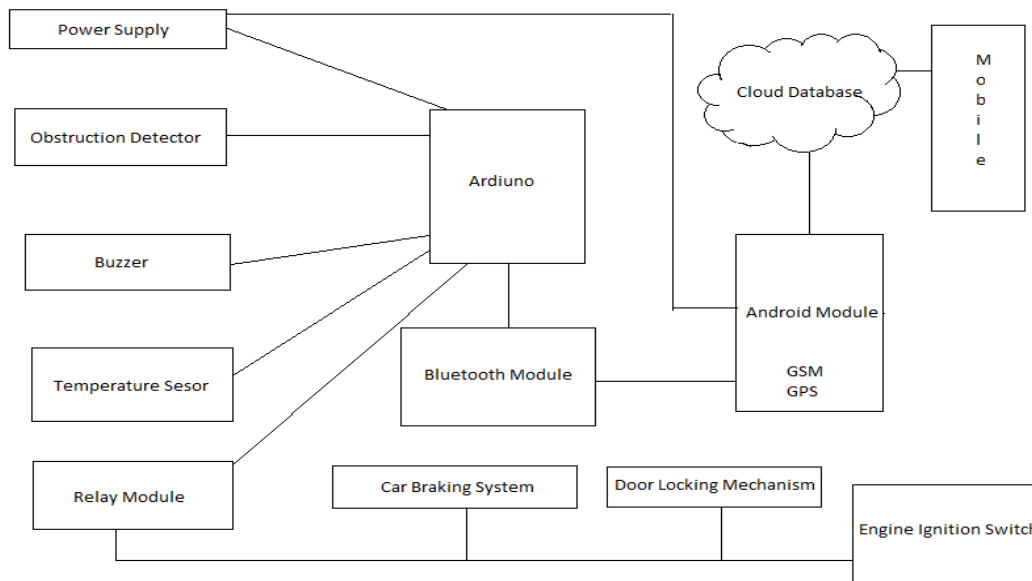


Fig 1: Block Diagram for vehicle theft detection

**BLOCK DIAGRAM DESCRIPTION**

The block diagram of Vehicle Theft Detection System is shown in the figure 1. It consists of a power supply section, Obstruction detection system, Relay Module, Buzzer, temperature sensor, Android Module. The power supply gives 5v DC to the circuit. Obstruction detection Sensor consists of an IR Transmitter receiver pair for detecting an intrusion. Relay block which is a 3 channel relay act as a digital switch for braking system, door locking mechanism and engine ignition switch. Buzzer is used to make an alarm when theft occurs. Bluetooth Module connects the Arduino which is the main controller to the Android Module. Arduino sends/receives messages to the android module for an action to occur. Android Module containing GSM and GPS technologies allows to

retrieve location and also to communicate with Cloud Server.

**THEFT DETECTION SYSTEM**

The detection system includes an obstruction detection system combined with user authentication. The android module in the car needs to be setup the first time with the username and password obtained from registration on manufacturers server. On a successful login system asks to set up a password, which is used for authentication of Car. The owner has the ability to reset both the passwords ie, one in the server and the other stored in the car.

The theft detection system consists of an obstruction detection sensor which is a IR sensor placed inside the vehicle. It is placed across the driver seat. When door is locked with the key/UserEnd Application the IR sensor is enabled and if an attempt of intrusion occurred at the door the sensor detects it and the system sends an alert to the Users Mobile through the User end Application. Then user can control his

vehicle using this Application on their handheld device. On entry into the car user goes through the second stage of the verification, i.e.; The password authentication. The driver needs to enter the password in the screen placed on the car to start the vehicle. The display is a part of the android device placed in the car and if someone incorrectly type the password three times or if he try to damage the system, an alert message is send to the user device.

#### REALTIME TRACKING SYSTEM

Realtime tracking system consists of a satellite based GPS receiver which is present in the android module in the car. The car notifies its location to the manufacturers server whenever there is change location. The car owner can track his car's location using the user end application on his device. The car's location is calculated accurately by using measurements from both network and GPS receiver, So on locations where GPS service is not available, data from network is used or viceversa. User End Application uses Google Maps Service to precisely point the location on the device. Then using Maps service user can navigate to car's location.

#### FIRE DETECTION SYSTEM

Fire detection system consists of series of temperature sensors which is placed in appropriate positions in the car both inside and outside. The android module checks the temperature reported by these sensors and do necessary actions required. A threshold temperature value is calculated on base of location where sensor is placed and other conditions that affect the temperature values. Whenever there is a temperature increase than the threshold values, an alert is sent to the user. The system also sends alert to the fire & safety department to do recovery actions.

#### USER END APPLICATION

User end application consists of a notification system and a remote control panel to control car features such as to shutdown the car's engine, track the car, to fully lock/unlock the car and car door lock/unlock. Using this panel to user can remotely control car. The manufacturers server acts as a communication medium between the system and the user end application. The notification system in the App notifies user

whenever there is one to notify and make sure user sees it. The remote control panel can be accessed only after successful login which need the username and password of the owner obtained after registration of the product to the manufacturers server. This password can be changed by the owner through the application.

#### IV. CONCLUSION

In this paper, we have proposed a novel method of vehicle tracking and locking systems used to track the theft vehicle by using GPS and GSM technology. This system is in active mode whenever the user leave the vehicle and in any case of intrusion the system will detect it and inform the owner. Owner can control his vehicle remotely using is android device. When the theft identified, the owner can send SMS to the micro controller, then issue the control signals to stop the engine motor. After that all the doors locked. To open the doors or to restart the engine authorized person needs to enter the passwords. In this method, easily track the vehicle place and doors locked.

#### V. ACKNOWLEDGEMENT

The authors are sincerely thankful to the support given by our guide Mr. Shijin.P.V and our project coordinator Mrs.P.Reshma.

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## ROAD ANOMALY DETECTION USING SMARTPHONE

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**Abstract-** To ensure the quality of road is a major challenge faced by the government all over the world. In particular, poor road surfaces pose a significant safety threat to motorists. This project explores utilizing a mobile phone with a tri-axial accelerometer to collect acceleration data while riding a vehicle. The monitoring of road surface conditions plays a key role in ensuring safety and comfort to the various road users, from pedestrians to drivers. Furthermore, having information on infrastructure quality allows road managers to guarantee an adequate maintenance. We are describing a mobile sensing system for road irregularity detection using Android OS based smart-phones. The main aim of this project is to realize a simple application, which can be installed on several devices (smartphone/tablet) that allows using sensors piggybacked on them in order to monitor road surface quality

**Keywords—** Sensors Accelerometer, Mobile, Android.

### I. INTRODUCTION

Road is a vital part of people's day-to-day lives. When road is put into use after construction, it will lead to develop various anomalies due to continuous rolling under the wheels, and snow, rain and other natural factors. This will affect the quality of driving. With the availability of information regarding the road conditions, road

users can be cautious about or avoid the bad roads. It is desirable to have a mechanism for detecting the condition of roads and get them repaired as soon as possible. As a result, working on monitoring road conditions has gained significant attention in recent time. The traffic conditions in developing countries, like India, are more complex owing to varied road conditions, heterogeneous mix of vehicles and chaotic traffic. Since India is a developing country there is a constant requirement for good quality transportation, infrastructure and services. This problem has not been totally addressed in India as it is a huge nation with pretty a sizable population. Potholes, speed breakers, mud pits, grains, cow dung, garbage and shards of glass are just a number of the things that may be found on the road while driving in India. Bad riding quality, insufficient pavement thickness and poor geometrics are other problems faced by Indian roads. India is also a home of rural population which has to face tough time during monsoon season. Consequently, it is of great significance to continuously observe the traffic and road conditions in real time to make transportation system more comfortable and efficient.

Many of the proposed techniques require dedicated hardware deployed in vehicle or at various road junctions. These methods have mostly focused on developed world, with its comparatively simple road and traffic flow pattern. These methods are expensive. Furthermore, installing sensors in large



number of vehicles and at various junctions is impractical due to large monetary cost and human effort required. Several methods are proposed to detect road conditions using mobile phone sensors. The Smartphone based method eliminates the need to deploying special sensors in vehicle. This method also has the advantage of high scalability as the number of mobile users is increasing rapidly.

**A. PURPOSE**

Our application will ensure safety and comfort to various road users. Smooth roads will lead to less vehicle damage and government Investment. The availability of low cost sensors in Smart phones and the rapid increase in the rate of Smartphone users invoked the necessity to develop systems which are able to detect road conditions using sensors present in Smartphone.

**B. OBJECTIVES**

The motivation, envision a cheap and convenient mobile device that is able to analyze and advise the driver on sudden and harmful situations that arise from vehicle maneuvers and environmental factors. This type of driver assist is only meant to complement the driver but not to take full control of the vehicle. Providing constructive feedback to the driver is crucial in correcting bad driving behaviors. Given the sensing capability of smart phones, using the internal accelerometer and GPS of the phone in place of the expensive hardware installed in vehicles to assist active features provided in newer ADAS vehicles.

**C. EXPECTED OUTCOME**

We observed that using a multiple-axis classification method for bumps increased the bump and pothole classification accuracy, resulting in a better road anomaly detection system. Being fueled by demand, future advancements in embedded hardware will yield the smartphone and its sensors to be more powerful devices in terms of processing, sensitivity, and accuracy, paving the way for many more innovative applications. Unlocking its potential in intelligent transportation systems seems only logical as there are conceivably numerous of applications that can help reduce safety concerns on the road. Furthermore, our evaluations of the

proposed approach in applications show that it has the potential to speed up the computer inspection process.

**D. ORGANIZATION OF THE PAPER**

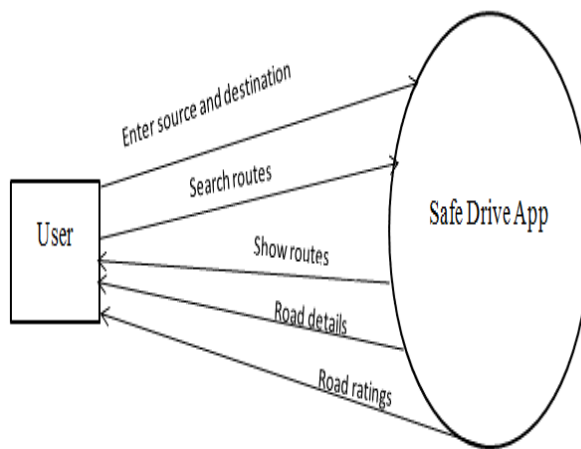
The paper is organized as follows: Section II explains system design. Section III provides related works. Section IV technologies used. Section V covers experimental setup. Section VI covers the details of the testing results and Section VII the conclusion.

**II.SYSTEM DESIGN**

This section deals with data flow diagram requirement analysis and the design process of the front and back end design of the “Android and Web based Student Appraisal System”.

**A. DATA FLOW DIAGRAMs**

A Data Flow Diagram (DFD) is a graphical representation of the “flow” of “Road Anomaly Detection Using Smartphone”. A data flow diagram can also be used for the visualization of Data processing .DFD shows the interaction between the system and users. This context-level DFD is then “expanded” to show more detail of the system being modelled. A DFD represents flow of data through a system. It views a system as function that transforms the given input into required output. Movement of data through the different transformations or processes in the system are shown in Data Flow Diagram of Fig. 1.



DFD-LEVEL 1

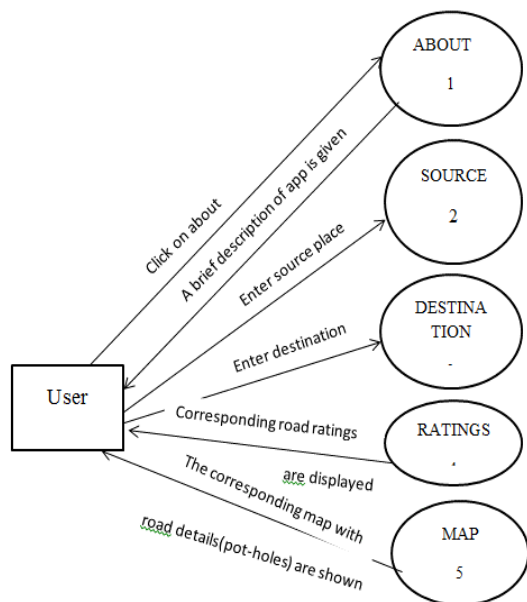


Fig1.Data Flow Diagram-Context-0 and Level-1

**B. USECASE DIAGRAM**

The use case diagram shows the user interaction with our system “Road Anomaly Detection Using Smartphone” from the user point of view. It’s a UML model which is easy to understand by common users as it is very clear the interactions. The user can view map of his journey, manage the destination at any point of journey, can view the previous journey logs, can get a rating about his driving and can get a review on road quality etc.

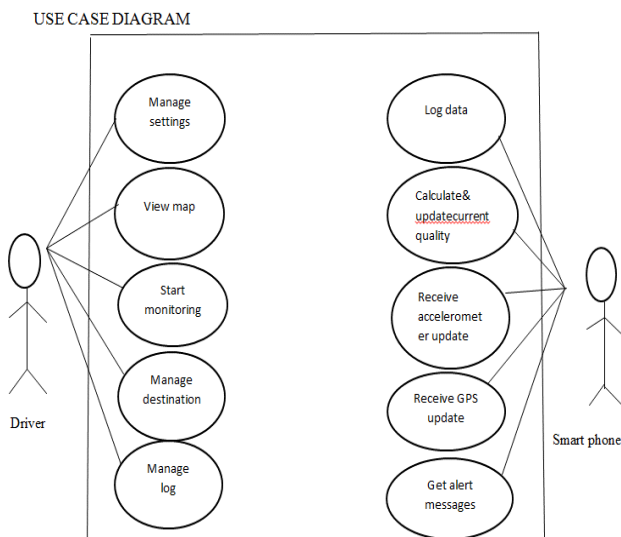


Fig2.Usecase Diagram

**III.RELATED WORKS**

The Pothole Patrol paper [2] investigates an application of mobile sensing: detecting and reporting the surface conditions of roads. We describe a system and associated algorithms to monitor this important civil infrastructure using a collection of sensor-equipped vehicles. This system, which we call the Pothole Patrol (P2), uses the inherent mobility of the participating vehicles, opportunistically gathering data from vibration and GPS sensors, and processing the data to assess road surface conditions. We have deployed P2 on 7 taxis running in the Boston area. Using a simple machine-learning approach, we show that we are able to identify potholes and other severe road surface anomalies from accelerometer data. Via careful selection of training data and signal features, we have been able to build a detector that misidentifies good road segments as having potholes less than 0.2% of the time.

**IV.TECHNOLOGIES USED**

**Accelerometer:** An accelerometer measures proper acceleration along the three axes in the smartphone. When accelerometer experiences acceleration, the mass is displaced to the point of at which the spring can accelerate the mass at the same rate as the casing. The displacement is then measured in order to give the acceleration. In semiconductor devices, piezo-resistive, piezo-electric and capacitive components are commonly used in order to convert the mechanical motion into an electrical signal.

**Android:** Android is a mobile operating system (OS) based on the Linux kernel and currently developed by Google. With a user interface based on direct manipulation, Android is designed primarily for touchscreen mobile devices such as smartphones and tablet computers, with specialized user interfaces for televisions (Android TV), cars (Android Auto), and wrist watches (Android Wear). The OS uses touch inputs that loosely correspond to real-world actions, like swiping, tapping, pinching, and reverse pinching to manipulate on-screen objects, and a virtual keyboard. Despite being primarily designed for touchscreen input, it also has been used in game consoles, digital cameras, regular PCs (e.g. the HP Slate 21) and other electronics [7].

**Android Studio:** Android Studio is an integrated development environment (IDE) for developing on the Android platform. It was announced on May 16, 2013 at the Google I/O conference by Google's Product Manager, Ellie Powers. Android Studio is freely available under the Apache License 2.0[citation needed]. Android Studio was in early access preview stage starting from version 0.1 in May 2013, then entered beta stage starting from version 0.8 which was released in June 2014. The first stable build was released in December 2014, starting from version 1.0. Based on JetBrains' IntelliJ IDEA software, the Studio is designed specifically for Android development. [5] It is available for download on Windows, Mac OS X and Linux, and replaced Eclipse as Google's primary IDE for native Android application development. [7]

**OSM Map:** OpenStreetMap (OSM) is a collaborative project to create a free editable map of the world. Two major driving forces behind the establishment and growth of OSM have been restrictions on use or availability of map information across much of the world and the advent of inexpensive portable satellite navigation devices. [7]. This is similar to Google maps but much easier to add and hence in our project we use OSM.

**XML:** Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format which is both human-readable and machine-readable. It is defined by the W3C's XML 1.0 Specification and by several other related specifications, all of which are free open standards.

The design goals of XML emphasize simplicity, generality and usability across the Internet. It is a textual data format with strong support via Unicode for different human languages. Although the design of XML focuses on documents, it is widely used for the representation of arbitrary data structures [7] such as those used in web services.

**Java Script:** JavaScript is considered to be one of the most famous scripting languages of all time. JavaScript, by definition, is a Scripting Language of the World Wide Web. The main usage of JavaScript is to add various Web functionalities, Web form validations, browser detections, creation of cookies and so on. JavaScript is one of the most

popular scripting languages and that is why it is supported by almost all web browsers available today like Firefox, We used the browser Opera or Internet Explorer. JavaScript is considered to be one of the most powerful scripting languages in use today. It is often used for the development of client-side web development. JavaScript is used to make web pages more interactive and dynamic. JavaScript is a light weight programming language and it is embedded directly into the HTML code. JavaScript, as the name suggests, was influenced by many languages, especially Java

## V. EXPERIMENTAL SETUP

Using a mobile phone for detecting the road anomaly creates numerous variables that can be used as measurements can be misleading in certain situations. Firstly the phone should be calibrated inside the car by fixing the phone in a location and keeping it still till the device is being calibrated. This process resets the previous values in the accelerometer and initialises it to zero. The device measures the reading with respect to the location the device has been kept for calibrating. The smartphone uses three axis of the accelerometer which is x-axis, y-axis and z-axis. It will measure values corresponding to acceleration applied on car, sudden breaks, uneven road conditions etc. The x-axis measures the lateral movements and the lane changes that is a decrease in x-axis represents lane changes. The y-axis measures the acceleration or breaking and the z-axis detects the values that are occurred by road conditions like potholes, bump or rough road. We will compare the values with a previous value or a pre-set value and finds the change in values and conclude the corresponding road conditions. At high speeds the change in z-axis is very prominent whereas in low speeds this is not obvious. To detect bumps at low speeds, we compensate it with the x-axis and a threshold which is dynamic based on the speed. A bump can be assumed if the consecutive difference between the acceleration values of z-axis and x-axis exceeds its corresponding threshold.

## VI. TESTING AND RESULTS

The result is a map of your journey. In the map there are 3 colours of lines which are red, green and blue. Red indicates road with anomalies, green

indicates good conditioned road and blue indicates conditions like bump etc. Also we will get a graph which is generated from the accelerometer reading and which is also tri colour. Then we have an “info” section which gives a brief description about your driving and give a rating for the road.

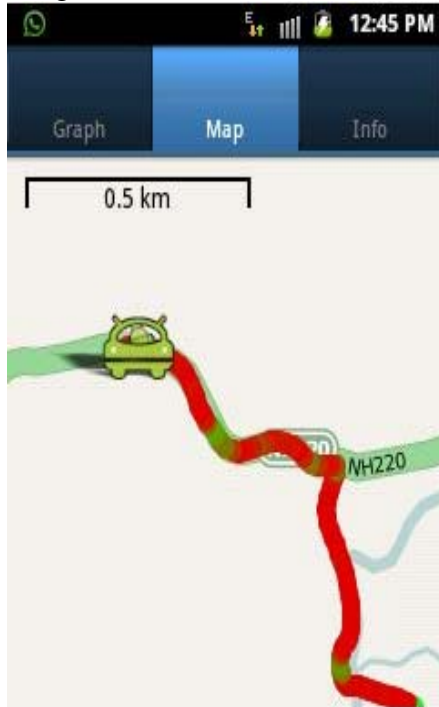


Fig 3. Map View

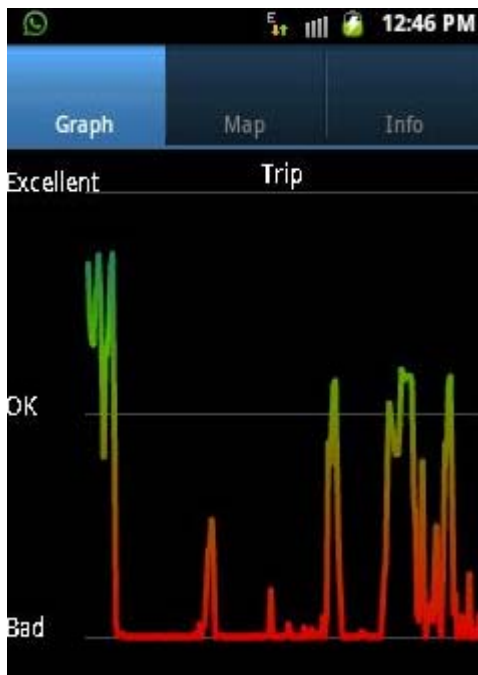


Fig4.Graph View



Fig5. Information

## VII. CONCLUSION

The project aims at improving the driving conditions by improving the road conditions. This project can be viewed as a research project rather than a daily use application. This can be used by surveyors to check the road conditions for a specific period of time and it aids the road authority to take appropriate measures to correct the road conditions. Roads are needed to be monitored continuously for roughness and other anomalies to avoid inconvenience to the road users. Mobile phones today are equipped with inbuilt sensors that give safety enhancement to the drivers on road. Using a smart phone, some innovative applications that are integrated inside an automobile can evaluate the overall road conditions including bumps, potholes, rough road and uneven road. The three axis accelerometer of an Android based smart phone is used to record and analyse various and external road conditions that could be hazardous to the health of the driver and the automobile. With analysis and alerts of these factors, we can increase a driver’s overall awareness to maximize safety. Google map is used to create road condition using GPS coordinates. Android operating system in smart phone is used for analysing the road

conditions for safety. Once the data is available to the user, he can efficiently and safely drive the vehicle.

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## **THREE WAY MECHANISM TO ENHANCE THE DATA SECURITY ON CLOUD**

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**Abstract – The cloud computing is one of the developing segmenting of IT industry as well as a promising concept to the end users. Cloud computing is an internet based service which allows its consumers to store large amount of data on the cloud in multitenant environment and use as and when required, from any part of the world via any terminal equipments. As Cloud computing is a shared facility and is accessed remotely, the data stored in it is vulnerable to various attacks by hackers or crackers and becomes difficult to maintain its security and privacy. As a solution to these problems our research paper provides a “Three Way Mechanism” system as it ensures all the three protection scheme of authentication, data security and verification, at the same time. In this paper, we make use of digital signatures and Diffie Hellman key exchange melded with (AES) Advanced Encryption Standard encryption algorithm to protect confidentiality of data stored in cloud. Even if the key in transmission is hacked by untrusted party, the facility of Diffie Hellman key exchange make it useless, since key in transit is of no use without user’s private key, which only belonged to the legitimate user. The model we have implemented makes it tough for hackers to crack the security system, thereby protecting data stored in cloud.**

**Index Terms– Cloud Computing, Security,**

**Authentication, AES, Digital Signatures.**

### **I. INTRODUCTION**

Clouds provide a powerful computing platform that enables individuals and organizations to perform variety levels of tasks such as: use of online storage space, adoption of business applications, development of customized computer software, and creation of a “realistic” network environment. Cloud computing virtually and dynamically distributes the computing and data resources to a variety of users, based on their needs, with the use of virtualization technologies and uses public and private APIs (Application Programming Interface) to provide services to its consumers. It provides better utilization of resources and hence results in reduced service access cost. Cloud is used as the medium to store massive data of users. Data outsourcing user can get the information from anywhere more efficiently and has no burden on data storage and avoid extra expense on software, hardware and information resources and the maintenances and usage will be more efficient. The data storage is made public by sharing it on cloud. Cloud services are provided by different cloud providers like Google, Microsoft, IBM, Amazon etc. cloud storage is used as a core technology of many online services [2]. The data stored in the cloud are accessible anywhere and therefore there are some security requirements are [3] :

- **Authentication:** It is used for identification of intended user.
- **Privacy/ Confidentiality:** Only legitimate users can view the data during transmission.
- **Integrity:** Data is protected from any kind of alteration.
- **Non-repudiation:** Assurance that someone cannot deny something or we can say that the communication between two parties cannot be denied and ensure the authenticity of their signature on a document or the sending of a message that they originated.

Cryptography is the science of enciphering and deciphering of messages that is the art of hiding and transforming information into scrambled format [4]. Encryption is the main aspect of cryptography for the secure transmission of data over the internet and also data can be stored in the same format on the cloud storage to enhance its security[3].

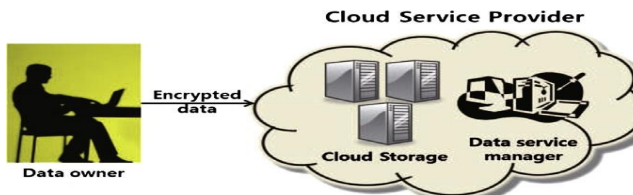


Fig. 1. Data Stored in Encrypted Format on Cloud [5]

Our paper focus on three security control mechanism viz authentication Encryption and data verification technique in to a single system wherein digital signature provides authentication, encryption algorithm provides session encryption key and is used to encrypt user data file , which is to be saved in cloud and lastly trusted computing to verify integrity of user data.

## II. LITERATURE REVIEW

Dan Boneh<sup>1</sup>, Craig Gentry<sup>2</sup>, and Brent Waters<sup>1</sup>[6] has described two public key broadcast encryption systems for stateless receivers. Broadcast encryption so defined , a scheme in which broadcaster encrypts a message for some subset of users listening on a broadcaster channel . Any user other than of S cannot receive any information about the contents of the

broadcast. In the paper, they have constructed fully collusion secure broadcast encryption systems with short ciphertexts and private keys for arbitrary receiver sets. Their first construction provided a system in which both the broadcast message and user private keys are of constant size and broadcast ciphertext contains only two group elements. Each user's private key is just a single group element. Thus, when broadcasting to small sets, generates far shorter ciphertexts than the trivial solution and in the second system both the public key and the ciphertext are of size  $O(\sqrt{n})$ . This means that user can attach the public key to the encrypted broadcast and still achieve ciphertext size of  $O(\sqrt{n})$  [6].

*Dongyoung Koo<sup>a</sup>, Junbeom Hur<sup>b</sup>, Hyunsoo Yoon<sup>a</sup> [7]*

have proposed a scheme for data retrieval using attribute-based encryption(ABE). This proposed scheme was best suited for cloud storage systems with massive amount of data.

In this paper, they have proposed a new searchable encryption scheme that exploited ABE with scrambled attributes to handle the security problems specifically, the presence of redundant encrypted data for the same message, poor expressiveness regarding access policy, and the concentration of computational overhead on the searching entity. In ABE, the access policy can be represented as Boolean expressions which consist of logical operators such as AND or OR with various attributes describing who is eligible to access the data content. Under this approach, the retriever makes index terms from its private key satisfying the access policy made up of keywords associated with the content, where these index terms are only used for data accessing in the cloud storage system. Therefore, the Cloud Service Provider cannot learn which keywords are associated to the retriever's query. This scheme was suitable for one-to-many content distribution without a sacrifice of the nature of ABE. The main advantage of this was in case of one-upload-many-download situation [7]. According to Parvez khan Pathan, Basant Verma[3], Encryption is the main aspect of cryptography for the secure transformation over the cloud storage system and also Avalanche

effect is the phenomenon that describes the effect in the output cipher text if a single or few bits are changed in the plain text. This change that occurs at the output should be sufficient if we want to create a secure algorithm. In this Paper, they are showing a new encryption key model and there decryption part which will improve avalanche effect as well as execution time as compared with various encryption algorithms. The model so proposed will secure information from all the anomalies which constantly follow-up over public network. In this paper they have defined the study of TEA encryption and MTEA encryption algorithms with their weaknesses and also comparing both these algorithms with their proposed model which will improve the avalanche effect of data thereby improving data security[3].

*Authors Kamlesh Kumar Hingwe , S.Mary Saira Bhanu[10],* has described about Database as a service (DBaaS) security of Cloud Computing. According to this paper, in DbaaS cloud service providers provide services for storing customers data. As the data are managed by an un-trusted storage server, the service is not fully trustworthy. So, the proposed framework performed database encryption, query encryption and also supports range query over encrypted databases. The proposed framework focused on securing database as well as storing sensitive information without any leaks or alteration. A double layered encryption is used for sensitive data and a single layer encryption is used for non-sensitive data. Order Preserving Encryption (OPE) is used for single layer encryption. OPE maintains the order in encrypted database and so range query can be performed over encrypted database using encrypted query. OPE has a drawback of revealing a person information and so for sensitive data, a double layered encryption using Format Preserving Encryption (FPE) followed by OPE, symmetric key encryption algorithm is proposed. Symmetric key is used for both OPE and FPE [10].

*Authors R.Sivaranjani, R.Radhika[8],* have proposed Cloud Security Framework (CSF), been structured to provide complete security to the data throughout the process of cloud computing. In system, multiple mechanisms and available

techniques are applied to shield the critical information from unauthorized parties. The proposed Cloud Security Framework (CSF) is divided into two phases. First phase deals with process of transmitting and storing data securely into the cloud. Second phase deals with the retrieval of data from cloud and shows the generation of requests for data access, double authentication, verification of digital signature and integrity, thereby providing authorized user with data on satisfying all security mechanisms[8].

From the literature review, it is observed that there are some limitations and constraints in the security of data stored on the cloud. So, our work is trying to overcome these security issues and is providing the three way protection scheme in the form of authentication, encryption and data verification in single architecture or system.

### III. SYSTEM OVERVIEW

A new “Three Way Security Mechanism “ system that was proposed by *Mr.Prashant Rewagad,Ms. Yogita Pawar[1]*, is now designed and implemented in our paper to enhance the security of data stored on cloud. Firstly, Diffie Hellman algorithm is used to generate keys for key exchange between client and server. Then digital signature is used for authentication, thereafter AES encryption algorithm is used to encrypt or decrypt user’s data file. All this is implemented to provide trusted and secure computing environment in order to avoid data alteration at the server end to preserve data integrity. For the same reason two separate servers are maintained, one for encryption process known as (secure/trusted) computing platform and another known as storage server for storing user data text files [1].

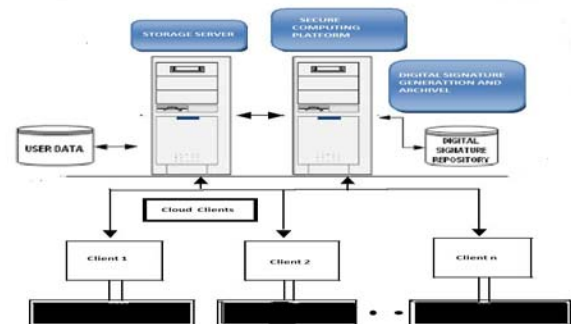


Fig.2. System Architecture [1]



Execution Steps during the process [1] :

- Sign up by the user on the cloud .
- Login from client on the cloud storage  
Key Exchange – Diffie Hellman  
Digital Signature –SHA-I
- Uploading / Downloading Data  
Encryption- AES
- Data is stored / retrieved from Storage server
- . Logout.

When a user wants to upload a file to the cloud server, first keys are exchanged among client and server using Diffie Hellman key exchange algorithm at the time of login, then the client is authenticated using digital signature. Finally user's data file is encrypted using AES and only then it is uploaded to another cloud Storage server. Now when client is in need of same file, it is to be downloaded from cloud server and for that when user login, first encryption keys are exchanged, file to be downloaded is selected, authentication takes place using digital signature and then the same algorithm, AES is used to decrypt the saved file and client can access that text file [1].

#### IV. DETAILED INSIGHT INTO THE SYSTEM

Our paper focus on protecting the data of client stored on cloud storage at robust places from any modification or malfunctioning by the third untrusted parties by proper authentication of legitimate user using key exchange process and digital signatures. To secure the data from hackers it has been stored in encrypted format on cloud side that further increases its security to great extend.

##### A. Diffie Hellman : Key Exchange Algorithm

Diffie Hellman was the first public key algorithm ever invented, in 1976. Client and server want to generate a key to use for subsequent message exchange to avoid any attack on data so the steps followed in this algorithm are[11] :

*Step1:* Two numbers are set: p, large prime and g, a primitive element of  $Z_n$ . These two numbers do

not need to be kept secret that is client and server can exchange these two numbers in open.

*Step2:* Client choses a large random integer x and sends to server

$$X=g^x \text{ mod } p$$

*Step3:* Server choses a large random integer y and sends Client

$$Y=g^y \text{ mod } p$$

*Step 4:* Client computes

$$k=Y^x \text{ mod } p$$

*Step5:* Server computes

$$k=X^y \text{ mod } p$$

k is the final key and need to be same. Therefore, k should be same with server and client and is equal to  $g^{xy} \text{ mod } p$ . In order to attack this scheme, an intruder would need to know how to calculate x from X or y from Y [11].

##### B. AES (Advanced Encryption Standard): Encryption Algorithm

AES has also been called Rijndael on its inventors' names Joan Daemen and Vincent Rijmen. The AES encryption and AES decryption occurs in blocks of 128 bits . The maximum block size can be 256 bits however the key size has no maximum limit. The AES cryptography uses the same key to encrypt and decrypt data. The user simply need to select AES encrypt or AES decrypt and the encryptor will do the rest. It is one of the perfect cryptography algorithms to protect personal data. The encrypt AES tool converts the input plain text to cipher text in a number of repetitions based on the encryption key. The AES decrypt method uses the same process to transform the cipher text back to the original plain text using the same encryption key [9].

Process of AES algorithm shown below:

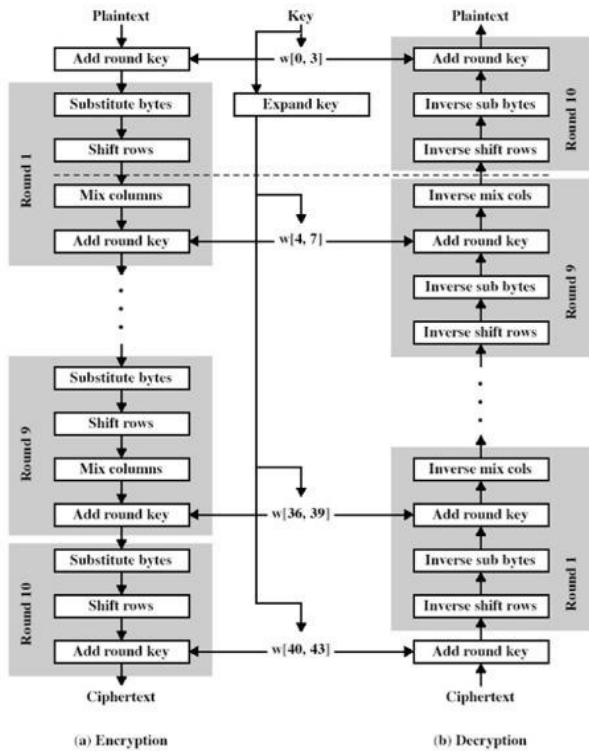


Fig.3. AES Algorithm[9]

### V. EXPERIMENTAL SETUP

CloudSim is the simulator tool that is used to carry out experiment. Other minimum requirements that need to be specified are :

#### A. Hardware Specifications :

- Pentium Core.
- RAM Size 128mb.
- Processor 1.2GHz

#### B. Software Specifications :

- Supporting OS: Windows XP, VISTA, LINUX: Red Hat, Ubuntu, Fedora.
- Java Development Kit - jdk1.6.0\_02.
- Java Runtime Environment - jre1.6.0\_06.
- Netbeans
- Web Browser like Google chrome with Java Plug-in installed.
- Wireless connectivity driver.

- SOAP
- Glassfish Server

### VI. RESULT ANALYSIS

1. Firstly, the client or user registers himself with username / id and password on the cloud inorder to use it as data storage medium.

```

Thesibase (run) x1 Thesibase (run) #1 x1
run:
Enter UserName/Id : sbs
Enter Password : cse
Starting the Cloud Service for Registration of User
Initialising...
Starting CloudSim version 3.0
Datacenter_0 is starting...
Broker is starting...
Entities started.
0.0: Broker: Cloud Resource List received with 1 resource(s)
0.0: Broker: Trying to Create VM #0 in Datacenter_0
0.1: Broker: VM #0 has been created in Datacenter #2, Host #0
0.1: Broker: Sending cloudlet 0 to VM #0
160.1: Broker: Cloudlet 0 received
160.1: Broker: All Cloudlets executed. Finishing...
160.1: Broker: Destroying VM #0
Broker is shutting down...
Simulation: No more future events
CloudInformationService: Notify all CloudSim entities for shutting down.
Datacenter_0 is shutting down...
Broker is shutting down...
Simulation completed.
Simulation completed.

===== OUTPUT =====
Cloudlet ID STATUS Data center ID VM ID Time Start Time Finish Time
0 SUCCESS 2 0 160 0.1 160.1
Registration finished at Cloud Provider
Registered Successfully
    
```

Fig.4. Registration by the Client on Cloud

2. After Registration the client will login on to the cloud with valid username and password. Diffie Hellman Key Exchange Algorithm will run to produce Cloud and client secret and public keys and Login will be finished.

```

Output
Thesibase (run) x Thesibase (run) #2 x
run:
Enter UserName : sbs
Enter Password : cse
Prime No for Diffie hellman is : 5147
Value of G is : 2456
Client generated Private key : 948
Client Generated Public Key : 3140
Starting the Cloud for Login
Initialising...
Starting CloudSim version 3.0
Datacenter_0 is starting...
Broker is starting...
Entities started.
0.0: Broker: Cloud Resource List received with 1 resource(s)
0.0: Broker: Trying to Create VM #0 in Datacenter_0
0.1: Broker: VM #0 has been created in Datacenter #2, Host #0
0.1: Broker: Sending cloudlet 0 to VM #0
160.1: Broker: Cloudlet 0 received
160.1: Broker: All Cloudlets executed. Finishing...
160.1: Broker: Destroying VM #0
Broker is shutting down...
Simulation: No more future events
CloudInformationService: Notify all CloudSim entities for shutting down.
Datacenter_0 is shutting down...
Broker is shutting down...
Simulation completed.
Cloud Secret Key is : 862
Cloud Public Key is : 528
Cloud Final Key is : 3819
Simulation completed.
    
```

Fig.5. Login on the cloud by the client

- When the userid and password is correct then client's identity will be verified and this will be done by generation of Digital Signatures at cloud and client side.

```

Output
Thesisbase (run) x Thesisbase (run) #2 x
Login finished!
Welcome User.. Id and Password Correct
Client Generated Key is : 3819
SHA1 generated signature is : ae6f29007306a30a4e36a0024d704d6c776973e6
Starting the Cloud Service for Signature Verification
Initialising...
Starting CloudSim version 3.0
Datacenter_0 is starting...
Broker is starting...
Entities started.
0.0: Broker: Cloud Resource List received with 1 resource(s)
0.0: Broker: Trying to Create VM #0 in Datacenter_0
0.1: Broker: VM #0 has been created in Datacenter #2, Host #0
0.1: Broker: Sending cloudlet 0 to VM #0
160.1: Broker: Cloudlet 0 received
160.1: Broker: All Cloudlets executed. Finishing...
160.1: Broker: Destroying VM #0
Broker is shutting down...
Simulation: No more future events
CloudInformationService: Notify all CloudSim entities for shutting down.
Datacenter_0 is shutting down...
Broker is shutting down...
Simulation completed.
Simulation completed.

----- OUTPUT -----
Cloudlet ID   STATUS   Data center ID   VM ID   Time   Start Time   Fi
0             SUCCESS  2                 0       160    0.1          160.1
SHA1 generated signature at cloud: ae6f29007306a30a4e36a0024d704d6c776973e6
Verification finished at Cloud Provider
Signature Verified
    
```

Fig. 6. Digital Signature Generation for verification

- After the verification and authentication of legitimate user on the cloud is done if the client want to upload the data file then the path will be specified and data will be uploaded in encrypted form on cloud storage by AES Algorithm and also files can be retrieved from cloud in decrypted manner on client machine using the same.

```

Enter Choice :
1
Enter the fileName with path to be uploaded :
C:\Users\chawla\Desktop\chawla.txt
file Data is : ishachawla
Encrypted by AES : XTIUazpujMBS0GDYHf/rfA==
Cloud Storage Service Activated
Initialising...
Starting CloudSim version 3.0
Datacenter_0 is starting...
Broker is starting...
Entities started.
0.0: Broker: Cloud Resource List received with 1 resource(s)
0.0: Broker: Trying to Create VM #0 in Datacenter_0
0.1: Broker: VM #0 has been created in Datacenter #2, Host #0
0.1: Broker: Sending cloudlet 0 to VM #0
160.1: Broker: Cloudlet 0 received
160.1: Broker: All Cloudlets executed. Finishing...
160.1: Broker: Destroying VM #0
Broker is shutting down...
Simulation: No more future events
CloudInformationService: Notify all CloudSim entities for shutting down.
Datacenter_0 is shutting down...
Broker is shutting down...
Simulation completed.
Simulation completed.

----- OUTPUT -----
    
```

Fig.7. Encryption of data by AES

```

Enter Choice :
2
Enter the fileName that has to be downloaded from the Cloud :
chawla.txt
Cloud Storage Service Activated for Decryption
Initialising...
Starting CloudSim version 3.0
Datacenter_0 is starting...
Broker is starting...
Entities started.
0.0: Broker: Cloud Resource List received with 1 resource(s)
0.0: Broker: Trying to Create VM #0 in Datacenter_0
0.1: Broker: VM #0 has been created in Datacenter #2, Host #0
0.1: Broker: Sending cloudlet 0 to VM #0
160.1: Broker: Cloudlet 0 received
160.1: Broker: All Cloudlets executed. Finishing...
160.1: Broker: Destroying VM #0
Broker is shutting down...
Simulation: No more future events
CloudInformationService: Notify all CloudSim entities for shutting down.
Datacenter_0 is shutting down...
Broker is shutting down...
Simulation completed.
Simulation completed.

----- OUTPUT -----
Cloudlet ID   STATUS   Data center ID   VM ID   Time   Start Time   Finish Time
0             SUCCESS  2                 0       160    0.1          160.1
Storage finished!
File Decrypted !!! Done
    
```

Fig.8. Decryption of data by AE

## VII. CONCLUSION AND FUTURE WORK

In this paper, we have implemented a new three way mechanism security architecture that enhances the security of data stored at robust places on the cloud. It has incorporated the authentication, encryption and verification in a single standalone system which allows only intended users to use that data, thereby preserving its availability, confidentiality and integrity.

In Future, we can extend our system by different algorithms to generate keys and also “One Time Password” can be applied in addition to key exchange algorithm for authentication so as its security further gets increased.

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## SECURITY STORAGE MODEL OF DATA IN CLOUD

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**Abstract—** For IT Enterprise cloud computing has become the new generation architecture. Comparing with traditional computing designs, it provides large data centers to move the application softwares and databases. Cloud computing has attained huge recognition from industries but it still facing many challenges at initial stage which obstructs the growth of cloud. One of the major issue is security of data stored in cloud service provider as cloud has only single security structure but demands of customers are increasing. Therefore this paper focus more on data storage security model of cloud. The data model of default gateway proposed in this paper is focused on providing more security to the platform. This gateway is used to encrypt the data completely with best encryption techniques before sending the data on cloud storage. Maintaining the security during transmission is the major concern, therefore secure OTP is proposed and various hashing techniques are used to sustain the integrity of data.

**Index Terms—** Cloud Computing, One Time Password, Encryption, Hashing, Integrity

### I. INTRODUCTION

Cloud computing is achieving popularity nowadays that aims to provide dynamic scalable resources in computing over the internet as services [1]. The self-service, on-demand, pay per-use, and scalable computing services provided by cloud which reduce capital and operative overheads for hardware and software[2], the concern of securing the data at

cloud will also be expand with this. Security issues increases because the data user and the resources to be used by the user are all on the internet and at the remote locations, so the customers cannot have full control on services provided by the service provider. Issues arise when unauthorized person disturbs the data. While moving services to cloud, the data safety at provider's site and data in transmission between host and server must be ensured.

For this to be ascertained, the authentication mechanism on the cloud must be very secure and proper encryption method or algorithm is to be followed to encrypt the data. Also the integrity of data should be sustained using proper hashing method and with all these techniques we can maintain the data security.

Cloud is a means to provide the services to the customers with the least effort from the shared pool of resources. In cloud, the various services available are:

- **Software as a service(SaaS):** Provide the consumers the Applications or Services created by Cloud Service Provider(CSP) and which are running on Cloud infrastructure.
- **Platform as a service(PaaS):** Provide the consumers with the ability to deploy their applications onto the cloud infrastructure. These applications are created by the consumers using the tools and programming languages provided by the cloud provider. Thus, consumers have control over the deployed applications and possibly environment configurations of applications but not on the underlying cloud infrastructure including server machines(physical or

virtual), storage drives, networks, or operating systems. [3]

- **Infrastructure as a service(Iaas):**  
Consumers are provided with the capability to provision storage, networks, processing and other computing resources, also allow the consumer to run arbitrary software, which include operating systems and applications on it.

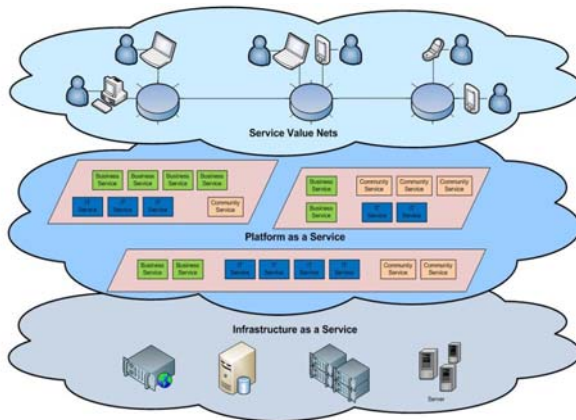


Fig. 1: Services in cloud

Various organizations will have to trust third party to keep their data safe. As cloud is located outside the domain of data owner's, therefore issues of trust between the cloud service provider and data owner will always be there. As data stored in cloud is very confidential and sensitive and it should not be disclosed to unauthorized member [4].

Therefore to maintain trust between cloud service provider and customers, third party auditor act as default gateway which is involved to check the clients data and will enhance more data security to it.

The main objective of this paper is to increase security of data on cloud, discussing the major flaws which were found while maintaining authenticity and integrity of data. The improved data security model and software is implemented to enhance the work in data security of cloud computing based on the study of cloud architecture.

## II. RELATED WORK

This section emphasize recent researches in cloud data storage. Kamara et al. [5] discussed

about a model for securely storage of data without concerning the components involved for architecture. Wei et al. [6] proposd a SecCloud to achieve security goals. As it jointly considers data storage security and auditing services in cloud, which is very effective and improve efficiency to achieve secure cloud computing. But it is need to be implemented in real platform like EC2 or openstack, also it should focus more on privacy preserving issues. Chow et al. [7] here it more focused on providing secure cloud data storage for dynamic users. It verifies the design with group signature and identity based encryption with constant size cipher texts. It includes confidentiality traceability .

Choudhury et al. [8] proposes a new authentication system for cloud. As in this technique one time password is encrypted using public key of user to obtain encrypted onetime password. It removes dependency on third party but limit is its key size. Fred et al. [9] proposes the Rubbing Encryption Algorithm (REAL) to implement a Mobile-based and a Cloud based OTP Token as design examples which can easily resists the security attacks.

Sood et al. [10] proposed a framework to provide data security to the data. It composed of two phases. Firstly it deals with secure transmission and storage of data in cloud. Second it deals with retrieval of data from cloud. Message authentication code and double authentication with verification of digital signatures are combined to achieve reliability, integrity and availability of data. Patel et al. [11] proposed a model to maintain the computation and communication cost while achieving storage correctness with provision to consider dynamic nature of cloud. Its main role is to develop client application for cloud customer which proved functionalities like encryption-decryption, key management, encoding, decoding, integrity checking functions like MAC, Hash.

Manjusha et al. [12] proposed a multi authority hierarchical attribute based encryption technique which is gives highest security in NIST statistical test compared to key policy and cipher text attribute based encryption techniques. As it preserve major issue of cloud computing which is confidentiality and integrity of data in cloud.

### III. SECURITY ISSUES IN CLOUD

Various security concerns are discussed:

- **Data integrity and Reliability**

In cloud computing, anyone from any location can access the data. Cloud does not differentiate between common and sensitive data. Thus, the reliable availability of users data is an important aspect of cloud service.

- **Data Confidentiality**

Confidentiality refers to having the ability to access protected data only by authorized systems or users. As the number of users, devices and applications involved increases, the threat of data compromise on the cloud also increases because number of accessibility increases day by day [13].

- **Multitenancy**

Cloud computing is based on a computing model where resources are shared at host, application and network level. As in multi-tenancy multiple tasks, or processes are shared, this presents a number of privacy and confidentiality issues. [14].

- **Loss of user identity/password**

For an authorized access, authentication is required to be there in the cloud computing security structure. Thus, if the identity and password of the user is lost or is revealed by mistake to any unauthorized person, the data can be at risk [10].

- **Data Tampering**

There is always a concern for data being tampered by unauthorized party. Tampering refers to the data which is entered by user are changed without user's authorization. This is employed by criminals or thieves to intentionally obtain personal or business information about the user.

In Table 1 this shows that there are three types of data in cloud computing. Firstly data in storage, then in transmission, lastly in processing the data.

TABLE I: Data Storage in cloud Computing [15]

Storage	Transmission	Processing
Symmetric encryption	Secret socket layer SSL encryption	Homomorphic encryption
AES-DES-3DES- Blowfish- MARS	SSL 1.0-SSL 3.0- SSL 3.1-SSL 3.2	Unpadded RSA- ElGamal ...

### IV. METHODOLOGY

Security and trust problem has always been the challenging issue in cloud. Therefore this proposal provides data security model to strengthen security using OTP authentication, encrypting data automatically and checks integrity by using hashing algorithms.

#### A. Proposed Model

In this model, single default gateway is introduced as a platform to secure sensitive data across multiple cloud applications. In this gateway three phases are implemented as shown in Figure 2.

Proposed data security model is implemented using cloudsim 3.0 using Java language, Mysql-server for storing data in database. It is built in Eclipse IDE 3.8 using Ubuntu 14.04 (32 bit).

#### B. Implementation Details

1) Phase1(OTP Authentication): Starting with the authentication details:

- Cloud authentication starts with user registration and account is created for particular company.
- Cloud confirms user's registration and user login with his/her username and password.

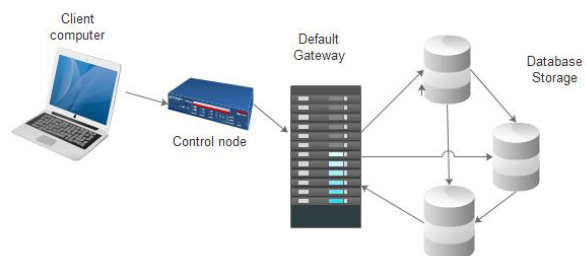


Fig. 2: Default gateway security model

- Checking of valid username and password is performed by cloud provider by searching in DB in cloud storage.
- Cloud provider generates OTP based on information of the client which is stored in OTP temporary DB using MD5 algorithm.
- User of cloud will receive valid OTP through email which will be entered. Validation of OTP is checked by searching in OTP temporary DB. If not valid will display error message.

Flowchart of Login phase with authentication is described in Figure 3.

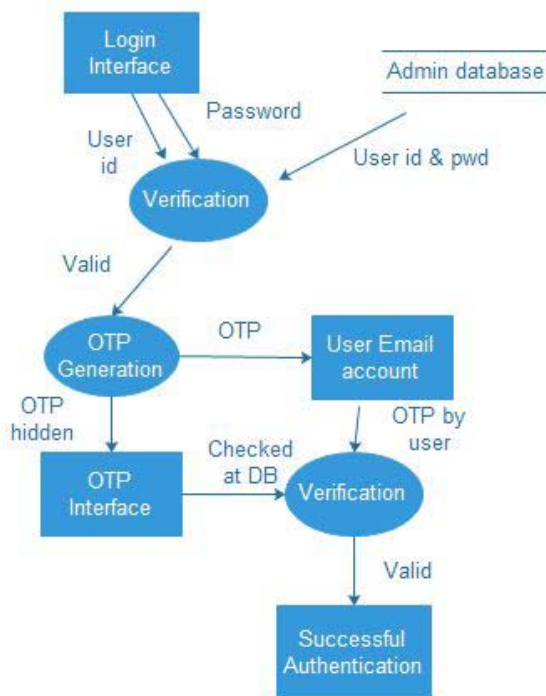


Fig. 3: Login phase with OTP authentication

2) Phase2(Encryption): After login to the cloud, client need to upload the file in cloud but it have to pass through gateway where randomly one algorithm will be chosen from eight algorithms which are RC6, RC4, Blowfish, AES, DES,MARS, Two-Fish,3DES to encrypt the file and then transfer to cloud.

3) Phase3(To check integrity):

- Hash files will be generated in cloud server using MD4, MD5, SHA-1, SHA-2 algorithms.

- Integrity of the data is checked using these hash values.
- Cloud user requests the data, then cloud server decrypts data automatically and will checked the integrity.



Fig. 4: Encryption at default gateway

- If all files of hash codes are matched then file is downloaded at client side, else file is accessed by someone.

## V. SIMULATION & RESULTS

This section provides the simulation and results of the proposed structure.

### A. Authentication

OTP steps are described in figure 6.

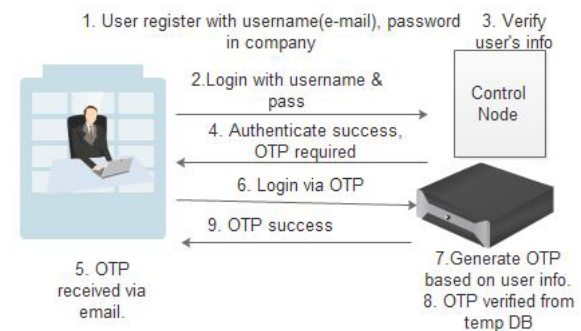


Fig. 5: OTP Authentication steps

The cloud controller generates 1000 OTP using MD5 algorithm based on user's information. Controller saves 1000 OTP in temporary OTP database. Figure 6 shows the Login screen of the proposed software.

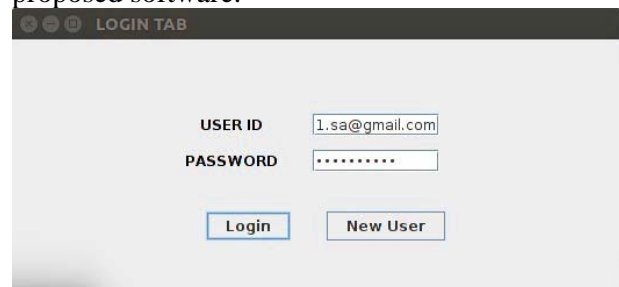


Fig. 6: Login screen



User login to cloud website with OTP which is received via e-mail, verifies with the temporary OTP database. If OTP login is valid, login success [16]. If failed then attempt again.

Figure 7. shows the OTP authentication screen of the proposed software.

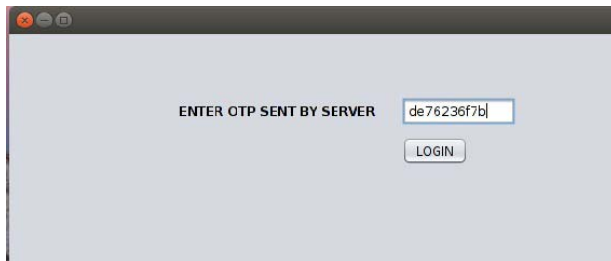


Fig. 7: Proposed OTP screen

1) Benefits of OTP:

- It offers much higher security than static passwords[17].
- OTP's are immune against password sniffing attacks[18].
- Low cost to deploy authentication strongly.
- Protected from unauthorized access.
- It offers two-factor authentication which makes it harder to steal or crack a user information.

B. File Encryption

In proposed software gateway will encrypt the uploaded file with randomly choosing NIST eight modern encryption algorithms namely: RC4, RC6, MARS, AES, DES, 3DES, Two-Fish and Blowfish. Figure 8 shows the Uploading screen:



Fig. 8: Proposed Upload screen

Experiment results shows comparison to indicate the best encryption techniques which enhance security.

Figure 9 indicates time taken by a file in different slots. The results shows the superiority of AES, RC4 followed with Blowfish as they always take less time in encryption/decryption than other algorithms.

C. Ensure Integrity

Integrity is to ensure the data presents are valid and true source of data which also guards against improper modification of information to sustain the authenticity and non-repudiation of information [19].

To solve the trust problem between cloud storage and customer, a simple solution of integrity is proposed to check the integrity of data by producing hash values of the file using MD4, MD5, SHA-1 and SHA-2 algorithms.

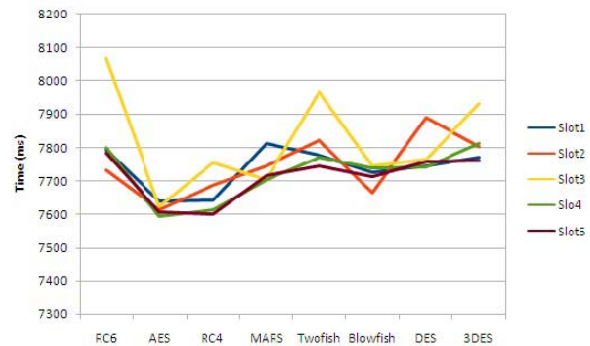


Fig. 9: Encryption/Decryption time of different algorithms

Figure 10 shows that hash values which are produced after uploading the file. When users store data in cloud, server also store four hash values with them.



Fig. 10: Calculate hash values to check integrity

To retrieve the file, server generates new hash values where integrity is checked by comparing the new hash values with the stored hash values.

If hash values not matched then software give message of hash values change like in figure 11:

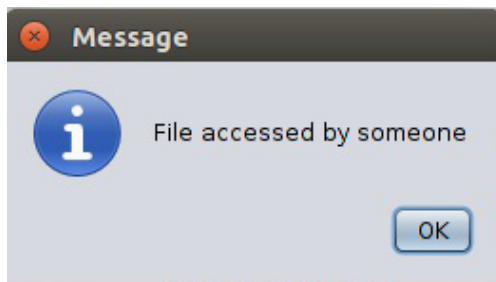


Fig. 11: File accessed

Following are benefits of using this efficacy:

- Not much effort required in implementation.
- Time required to compute the hash values is not much.
- Security level can be change flexibly.
- Space required to store hash values is not much.

## VI. CONCLUSION

Security and trust has always been the major issue in cloud computing. This paper points the security constraints and how to overcome these issues. Here the security model is proposed which attempts to focus on providing security at cloud side.

In this OTP (One-Time Password) is provided which shows two-factor authentication software. Default gateway is proposed where randomly encryption algorithms is chosen, results shows that the AES, RC4 and followed by Blowfish are best algorithms as they always take less time to encrypt/decrypt.

In addition to this data integrity is ensured by using hash algorithms. The summarized results of proposed security model of data is in Table 2:

TABLE II: Summarized Results of proposed data security model

Features	Description
Authentication	Mathematically generated OTP authentication
Provide Encryption	File is encrypted randomly chosing one algorithm from eight algorithms.
Best Encryption algorithm	AES, RC4 and Blowfish are best among them.
Data integrity	Hashing- MD5- MD4-SHA-1-SHA-2

## ACKNOWLEDGMENT

The authors would like to thank the editors and the anonymous referees for their valuable comments and suggestions.

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# GENETIC ALGORITHM BASED NEURAL NETWORK MODEL FOR PREDICTING THE DURABILITY OF HIGH PERFORMANCE CONCRETE

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**Abstract—** This paper presents the effectiveness of two distinct nature inspired computational intelligence techniques viz., Artificial Neural Networks (ANN) and Genetic Algorithms (GA) to generate a model for predicting the durability of High performance concrete with distinct water cement ratios (0.3, 0.35, 0.4, 0.45, 0.5) and aggregate binder ratios (2,2.5,3) with various percentage replacement of Fly ash, silica fume, Metakaolin (0,10,20,30) and different acids i.e. HCL, Mg<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub>SO<sub>4</sub> as input parameters. The test results obtained from the research was used to train the data; the artificial neural network erudite the correlation for predicting the durability of high performance concrete elements. The developed GA/ANN model will function as more logical and computationally efficient model in predicting the durability of high performance concrete.

**KEYWORDS:** Artificial Neural Network (ANN), Back Propagation (BP), Genetic Algorithm (GA), Root Mean Square Error (RMSE)

## I. INTRODUCTION

Concrete is a basic building block of our everyday world. It's used in almost every type of structure that we build today. Concrete is a well-known building material and has occupied an indispensable place in construction works. It is economical in the long run as compared to other engineering materials. In recent times, the traditional concrete production has been replaced

with concrete of admixture, also technically known as concrete production or high performance concrete (HPC). The high performance concrete achieved the improvements involving an improved compaction, improved paste characteristics, aggregate matrix bond and reduced porosity. The researchers have done significant effort in replacing the cement with Flyash, Silicafume, Metakaolin, blast furnace slag and chemical admixtures such as super plasticizers without affecting the strength of characteristics. These mineral admixtures help in obtain both high performance and economy. These mineral admixtures increase the long-term performance of the HPC through reduced permeability resulting in improved durability. Addition of such material has indicated the enhancements in strength properties of HPC. Babu.V., Mullick, A., (2014) examined on the strength and durability characteristics of high-strength concrete with recycled aggregate-influence of processing. It is worth mentioning that the permeability of cement based concrete plays an important role in the performance and service life of concrete constructions. A highly permeable concrete helps to place excessive water inside it (Bahia and Benson 2001). The mechanical and durability properties of high performance Metakaolin and Silicafume concretes to their microstructure characteristics related by Poon et. al [2006]. Development of models using analytical approach to predict the strength parameters of HPC is difficult because of the complex multi parametric interaction

between the various constituents of HPC. Very recently, it is established that neural networks and genetic algorithms have the ability to map this type of multi parametric interaction.

Artificial Neural Network (ANN) is a black box computing system whose architecture and operation is inspired from neurons in the human being's brain. Neurons are simple elements operating in parallel. ANN can be considered of some interconnected neurons as computational units which can take inputs and transform them into outputs. ANN can be trained to perform a particular function by adjusting the values of the connections (weights) between elements. Generally, artificial neural network is adjusted, or trained, so that particular inputs lead to some target outputs. Artificial neural network is good at approximating functions. In fact, there is proof that a fairly simple artificial neural network can fit any practical function. One of the distinct characteristics of the ANN is its ability to learn from experience and examples and then to adapt with changing situations. Another advantage of ANN is that it can provide rapid meaningful answers even when the data to be processed include errors or is incomplete.

The ANN modeling process involves of the following steps: (a) data acquisition, analysis and problem representation (b) architecture determination (c) learning process determination (d) training of the networks (e) testing of the trained network for generalization evaluation.

The aim of this study is to build models which have architectures in ANN system to evaluate the effect of Metakaolin, Silicafume and Fly ash on durability of concrete. For purpose of constructing these model, different mixtures with 315 specimens of the 30, 60 and 90 days durability results of concretes containing Metakaolin, Silicafume and Fly ash is used in training and testing. In training and testing of the models constituted with the architecture of type of mineral admixture (type of MA), aggregate-binder ratio (A/B), water –binder ratio (W/B), type of acids (TA), percentage replacement of cement (% replacement) and age of specimen (AS). The model were trained with 80% data of experimental results and then remainders were used as only experimental input values for testing and values similar to the experimental

results were obtained.

## II. ARTIFICIAL NEURAL NETWORKS

Artificial neural networks (ANNs) are data processing systems consisting of a large number of simple, highly interconnected processing elements (artificial neurons) in an architecture inspired by the structure of the central cortex of the brain. They have the ability to learn from experience in order to improve their performance and to adapt themselves to changes in the environment (Holla and Schabowicz, 2005; Mansour et al., 2004). ANNs can provide meaningful answers even when the data to be processed include errors or are incomplete and can process information extremely rapidly when applied to solve real world problems.

As shown in Figure 1, a typical neural network has three layers: The input layer, the hidden layer and the output layer. The MFNN model is one of the most commonly used ANN models, whose application stretches to almost every field. Each neuron in the input layer represents the value of one independent variable. The neurons in the hidden layer are only for computation purpose. Each of the output neurons computes one dependent variable. Signals are received at the input layer, pass through the hidden layer, and reach the output layer.

Artificial neuron models are at their core simplified models based on biological neurons. This allows them to capture the essence of how a biological neuron functions. We usually refer to these artificial neurons as 'perceptrons'. Now let's take a look at what a perceptron looks like .As shown in the diagram above a typical perceptron will have many inputs and these inputs are all individually weighted. The perceptron weights can either amplify or deamplify the original input signal. For example, if the input is 1 and the input's weight is 0.2 the input will be decreased to 0.2. These weighted signals are then added together and passed into the activation function. The activation function is used to convert the input into a more useful output. There are many different types of activation function but one of the simplest would be step function

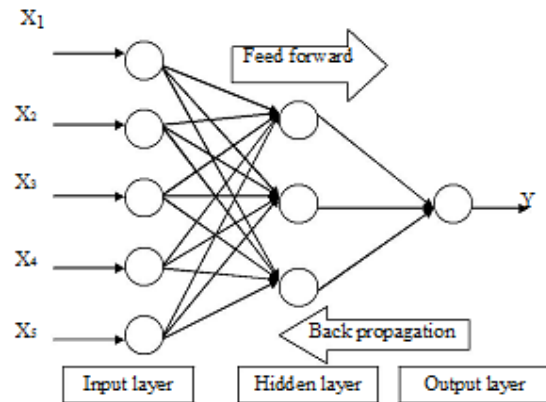


Figure 1. Architecture of a typical multilayer feedforward neural network

### III. LITERATURE SURVEY

Several authors have used ANNs in structural engineering. For example, Yeh (1998), Kasperkiewicz et al. (1995), Lai and Sera (1997) and Lee (2003) applied the NN for predicting properties of conventional concrete and high performance concretes. Bai et al. (2003) developed neural network models that provide effective predictive capability with respect to the workability of concrete incorporating metakaolin (MK) and fly ash (FA). Guang and Zong (2000) proposed a method to predict 28-day compressive strength of concrete by using multilayer feed forward neural networks. Dias and Pooliyadda (2001) used back propagation neural networks to predict the strength and slump of ready mixed concrete and high strength concrete, in which chemical admixtures and mineral additives were used. Cengiz Toklu [2005] formulated an aggregate blending as a multi-objective optimization problem and solved by using genetic algorithms. Noor Zaii and Hakim [2007] focused on development of ANN in prediction of compressive strength of concrete after 28 days Agarwal [2011] presented an ANN model for predicting compressive strength of self compacting concrete with Fuzzy logic. Mohammed Iqbal Khan [2012] developed an ANN model for predicting properties of high performance concrete composite cementitious material system.

### IV. EXPERIMENTAL WORK

#### 1. MATERIALS USED

(i) Cement: The cement used in the experimentation was 53-grade ordinary port land cement and having a specific gravity of 3.15 which satisfies the requirements of IS: 12269-1987 specifications

(ii) Coarse aggregates: The crushed granite aggregate were collected from the local quarry. The quarry aggregate was used in the experimentation were of 20MM and downsize aggregate and tested as per IS: 2386-1963 (I, II, and III) specifications.

(iii) Fine aggregates: Locally available sand collected from the bed of river Pandumeru was used as fine aggregate. The sand used was having fineness modulus of 2.96 and conformed to grading zone-III as per IS: 383-1970 specification.

(iv) Metakaolin: The mineral admixture Metakaolin was obtained from the 20 MICRON LIMITED company at Vadodara in Gujarat. The Metakaolin was in conformity with the general requirements of pozzolana.

(v) Silica Fume: The Silica fume used in the present study was obtained from the Elkem India Pvt Limited, Mumbai in Maharashtra.

(vi) Fly Ash: Fly ash belonging to class-F obtained from Rayalaseema Thermal Power station (RTPS), Muddanuru was used in the present investigation.

(vii) Type of acids: HCL, H<sub>2</sub>SO<sub>4</sub>, and Mgso<sub>4</sub>

(vii) Water: Ordinary portable water free from organic content turbidity and salts was used for mixing and for curing throughout the investigation.

(viii) Super Plasticizer: To impart the additional desired properties, a super plasticizer (Conplast SP-337) was used.

The main objective of this experimental investigation is to develop a neural network models for predicting the workability and strength of high performance concrete. Experiments was conducted to determine the workability and strength of High performance concrete after 28 days curing with various parameters like water-cement ratio (0.3, 0.35, 0.4, 0.45 & 0.5), aggregate binder ratio (2, 2.5 & 3) and percentage replacement of mineral admixtures (0, 10, 20 & 30%). A total of 315 HPC mixes were cast in the laboratory for durability purpose.

Out of these 315 data sets, 290 data sets (80% total data) for each for these models was used for training and the remaining 25 data sets were used for validation in both the models. A part of the training data sets is presented in the Table 1, 2 &

3. The following input vectors were selected to predict the values of durability. However, the same input vectors were selected to predict the values of durability.

- a. Water-binder ratio (W/B)
- b. Aggregate binder ratio (A/B)
- c. Type of mineral admixture (Type of MA) and
- d. Percentage replacement of cement by admixture (% replacement)
- e. Type of acids (TA)
- f. Age of the specimen (AS)

Based on the input vectors selected, the network model was formulated as

$$IP = [W/B, A/B, \text{Type of MA}, \% \text{ replacement}, \text{type of acid}, \text{age of specimen}]$$

The following output vectors were selected to predict from the network model of durability such as.

Durability (D)

Based on the output vectors selected the network model was formulated as

$$OP = \{D\}$$

**Table No.1: Durability test results of high performance concrete for various input vectors (HCL)**

Sl. No	Input Vectors				Output Vectors (Durability)		
	W/B	A/B	Type of MA	%	30days	60days	90 days
1	0.3	2.0	1	2	4.7	5.2	6.1
2	0.35	2.0	1	0	6.4	7.5	8.6
3	0.4	2.0	1	3	6.4	7.5	8.8
4	0.45	2.0	1	1	4.5	5.3	6.0
5	0.5	2.0	1	2	5.1	6.0	6.9
6	0.3	2.5	1	3	6.1	7.2	8.3
7	0.35	2.5	1	1	4.5	5.3	6.0
8	0.4	2.5	1	0	6.7	7.9	9.0
9	0.45	2.5	1	2	4.9	5.8	6.6
10	0.5	2.5	2	1	4.8	5.7	6.5
11	0.3	3.0	2	3	6.2	7.3	8.4
12	0.35	3.0	2	0	6.1	7.2	8.3
13	0.4	3.0	2	1	5.2	6.0	6.9
14	0.45	3.0	2	3	7.2	8.3	9.6
15	0.5	3.0	2	2	5.4	6.0	7.0
16	0.3	2.0	2	1	4.7	5.5	6.4
17	0.35	2.0	2	2	5.4	6.0	7.0
18	0.4	2.0	2	3	6.5	7.6	8.8
19	0.45	2.0	3	0	6.4	7.6	8.7
20	0.5	2.0	3	2	5.6	6.3	7.3
21	0.3	2.5	3	3	6.3	7.3	8.5
22	0.35	2.5	3	1	4.9	5.7	6.7
23	0.4	2.5	3	0	6.7	7.9	9.0
24	0.45	2.5	3	1	5.2	6.0	6.9

**Genetic Algorithm Based Neural Network Model For Predicting The Durability Of High Performance Concrete**

25	0.5	2.5	1	2	5.7	6.7	7.7
26	0.3	3.0	1	0	6.1	7.2	8.3
27	0.35	3.0	1	1	4.2	5.1	5.8
28	0.4	3.0	1	2	4.9	5.8	6.6
29	0.45	3.0	1	3	6.7	7.9	9.1
30	0.5	3.0	1	1	7.3	8.2	9.5

Table No 2: Durability test results of high performance concrete for various input vectors (H<sub>2</sub>SO<sub>4</sub>)

Sl. No	Input Vectors				Output Vectors (Durability)		
	W/B	A/B	Type of MA	%	30days	60days	90 days
1	0.3	2.0	1	2	4.8	5.7	6.5
2	0.35	2.0	1	0	6.9	8.1	9.3
3	0.4	2.0	1	3	7.3	8.5	9.9
4	0.45	2.0	1	1	5.3	6.3	7.2
5	0.5	2.0	1	2	5.2	6.3	7.2
6	0.3	2.5	1	3	6.6	7.8	9.0
7	0.35	2.5	1	1	4.7	5.5	6.7
8	0.4	2.5	1	0	7.2	8.5	9.8
9	0.45	2.5	1	2	5.2	6.3	7.2
10	0.5	2.5	2	1	5.8	6.8	7.9
11	0.3	3.0	2	3	6.7	7.8	9.0
12	0.35	3.0	2	0	6.9	8.1	9.3
13	0.4	3.0	2	1	5.3	6.2	7.2
14	0.45	3.0	2	3	7.3	8.6	9.9
15	0.5	3.0	2	2	5.8	6.8	7.9
16	0.3	2.0	2	1	4.8	5.7	6.6
17	0.35	2.0	2	2	5.3	6.3	7.2
18	0.4	2.0	2	3	7.3	8.6	9.9
19	0.45	2.0	3	0	7.5	8.9	10.1
20	0.5	2.0	3	2	6.1	7.3	8.3
21	0.3	2.5	3	3	6.7	7.9	9.1
22	0.35	2.5	3	1	5.1	6.0	6.7
23	0.4	2.5	3	0	6.9	8.1	9.3
24	0.45	2.5	3	1	5.6	6.5	7.6
25	0.5	2.5	1	2	6.1	7.3	8.3
26	0.3	3.0	2	0	6.6	7.7	8.9
27	0.35	3.0	2	1	5.1	5.9	6.9
28	0.4	3.0	2	2	5.3	6.3	7.2
29	0.45	3.0	2	3	7.6	9.0	10.4
30	0.5	3.0	2	1	5.5	6.5	7.5

Table No 3: Durability test results of high performance concrete for various input vectors (MgSO<sub>4</sub>)

Sl. No	Input Vectors				Output Vectors (Durability)		
	W/B	A/B	Type of MA	%	30days	60days	90 days
1	0.3	2.0	1	2	5.2	6.0	6.9
2	0.35	2.0	1	0	7.3	8.6	9.8
3	0.4	2.0	1	3	7.7	9.1	10.5
4	0.45	2.0	1	1	5.6	6.5	7.7



**Genetic Algorithm Based Neural Network Model For Predicting The Durability Of High Performance Concrete**

5	0.5	2.0	1	2	5.7	6.6	7.7
6	0.3	2.5	1	3	6.9	8.2	9.6
7	0.35	2.5	1	1	5.3	6.1	6.7
8	0.4	2.5	1	0	7.6	9.0	10.4
9	0.45	2.5	1	2	5.7	6.6	7.7
10	0.5	2.5	2	1	5.3	6.3	7.2
11	0.3	3.0	2	3	7.1	8.3	9.6
12	0.35	3.0	2	0	6.9	8.1	9.3
13	0.4	3.0	2	1	5.7	6.6	7.7
14	0.45	3.0	2	3	7.8	9.1	10.6
15	0.5	3.0	2	2	6.2	7.3	8.4
16	0.3	2.0	2	1	5.1	6.0	6.9
17	0.35	2.0	2	2	5.7	6.7	7.7
18	0.4	2.0	2	3	7.8	9.1	10.6
19	0.45	2.0	3	0	8.0	9.5	10.9
20	0.5	2.0	3	2	6.5	7.6	8.8
21	0.3	2.5	3	3	7.2	8.5	9.7
22	0.35	2.5	3	1	5.5	6.4	7.2
23	0.4	2.5	3	0	7.3	8.6	9.8
24	0.45	2.5	3	1	5.9	6.9	8.1
25	0.5	2.5	3	2	6.5	7.6	8.8
26	0.3	3.0	2	0	5.4	6.4	7.3
27	0.35	3.0	2	1	5.9	6.9	8.1
28	0.4	3.0	2	2	6.3	7.3	8.4
29	0.45	3.0	2	3	7.9	9.3	10.5
30	0.5	3.0	2	1	6.2	7.2	8.4

The input and output vectors have been normalized in the range (0, +1) using suitable normalization factors or scaling factors. The following Table No.4 gives the scaling factors for input and output vectors.

Table No. 4: Details of scaling factors

Nature of vector	Parameter	Minimum Value	Maximum Value	Scale Factor
Input Vector	Water binder ratio (W/B)	0.3	0.5	0.7
	Aggregate binder ratio (A/B)	2	3	4
	Type of mineral admixture (MA)	1	3	4
	Percentage replacement of admixture (% replacement)	0	30	35
	Type of acid (TA)	1	3	4
	Age of specimen (AS)	30	90	120
Output Vector	Durability (D)	4.1	11.3	11.5

The network configuration is defined in terms of number, size, nodal properties, etc. of the input/output vectors and the intermediate hidden layers. Once the input and output vectors are

decided to cater the present investigation requirements, the task of selecting a suitable configuration has been taken up. There is no direct method to select number of nodes in

hidden layer. Generally a trial and error method is adopted for arriving at the network configuration. After doing a few trials, it is observed that the network with 20 neurons in two

hidden layer is behaving well. Accordingly a configuration of (6-20-1) has been selected for this network model. The architecture is depicted in Figure No 2

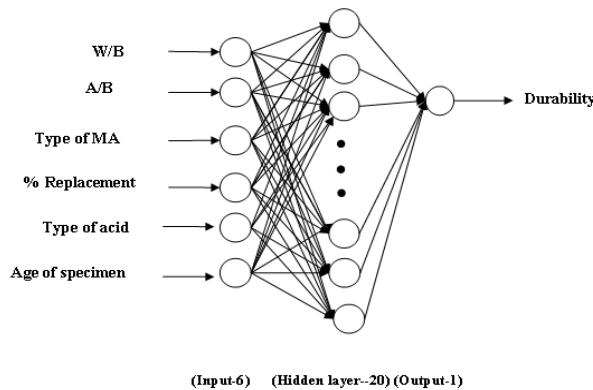


Fig No.2 Configuration of GA/ANN model

Conventionally, a BPN determines its weights based on gradient search techniques and hence runs the risk of encountering local – minima. GA on the other hand is found to be good at finding ‘acceptably good’ solutions. The idea to hybridize the two networks has been successful to enhance the speed of training [Rajasekaran and Vijayalakshmi Pai, 2003]. In the present work, the weights for the BPN have been obtained by using GA. genetic Algorithms (GAs) which use a direct analogy of natural behavior, work with a population of individual strings, each representing a possible solution to the problem considered. Each individual string is assigned a fitness value which is an assessment of how good a solution is to a problem. The high-fit individuals participate in “reproduction” by cross-breeding with other individuals in the population. This yields new individual strings as offspring which share some features with each parent. The least-fit individuals are kept out from reproduction and so they “die out”. A whole new population of possible solutions to the problem is generated by selecting the high-fit individuals from the current generation. This new generation contains characteristics which are better than their ancestors. The parameters which represent a potential solution to the problem, genes, are joined together to form a string of values referred to as a Chromosome. A decimal

coding system has been adopted for coding the chromosomes in the present work. The network configuration chosen for the present work is 6 – 20 – 1. Therefore, the numbers of weights (genes) those are to be determined are  $6 \times 20 + 20 \times 1 = 180$ . With each gene being a real number, and taking the gene length as 5, the string representing the chromosomes of weights will have a length of  $180 \times 5 = 900$ . This string represents the weight matrices of the input hidden layer-output layers. An initial population of chromosomes is randomly generated. Weights from each chromosome have been extracted then using the procedure suggested by Rajasekaran & Vijayalakshmi Pai [2003]. The fitness function has been devised using FITGEN algorithm [Rajasekaran & Vijayalakshmi Pai, 2003]. A constant learning rate of 0.6 and a momentum factor of 0.9 have been adopted during the training. Satisfactory training has been obtained after just 2000 training cycles. The progress of the learning of the network is presented in Table No.5. It can be seen from Table No.5, that the RMS error after 2000 cycles is only 0.001172. Accordingly the performance of the network is acceptable. At this stage the training of the network is terminated to avoid over training. Such an overtraining may hamper the generalization capabilities of the network. The training of the network accepted at this stage is presented in Figure No.2 & 3. The figure is

drawn only for twenty training examples selected at random. Though the figure is drawn for only twenty four examples the author has verified all the three hundred training examples and it is found that the network has predicted all the values to the good satisfaction. Thus it can be concluded that at this stage the network has learnt the relationship between input and output parameters successfully.

This network has been chosen as the most suitable network for generalization due to its small root mean square error (RMSE) and a high percentage in good patterns as compared to other different architecture networks. Furthermore, the

sigmoid of activation function in this architecture network has effectively limited the amplitude of the output neurons. This 6-20-1-architecture network is shown in Figure 2. After selecting the best possible architecture, the network was trained to reduce the error between the neural network output and the target output. The aim of training is to find a set of connection weights that will minimize the mean squared error forecasting error in the shortest possible training time (Kim et al., 2004). Training data is a process to minimize the RMSE between actual and estimated output values with a set of suitable connection weights.

Table 5: Learning progress of the network

Sl.No	No of Epochs	RMS Value
1	100	0.068024
2	200	0.001276
3	300	0.001234
4	400	0.001189
5	500	0.001189
6	600	0.001172
7	700	0.001172
8	800	0.001172
9	900	0.001175
10	1000	0.001175
11	1100	0.001175
12	1200	0.001175
13	1300	0.001173
14	1400	0.001173
15	1500	0.001173
16	1600	0.001173
17	1700	0.001172
18	1800	0.001172
19	1900	0.001172
20	2000	0.001172

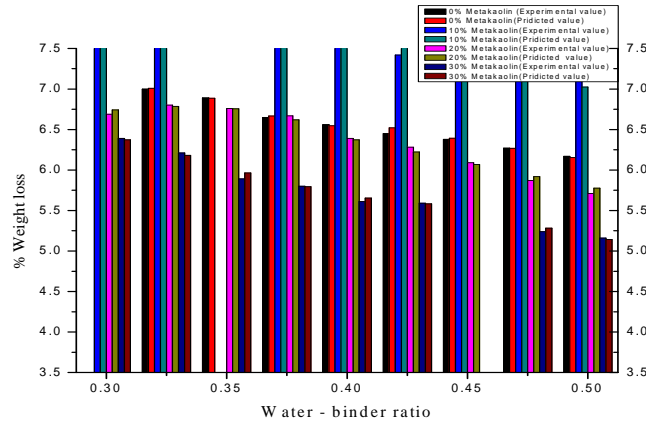


Fig.3. Learning of GA/ANN of % Weight Loss vs. W/B Ratio at 30 days HCL acid Immersion

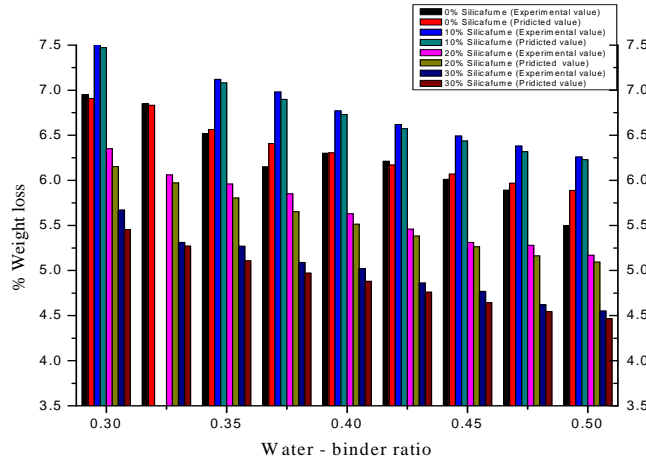


Fig.4. Learning of GA/ANN of % Weight Loss vs. W/B Ratio at 60 days H<sub>2</sub>SO<sub>4</sub> acid Immersion

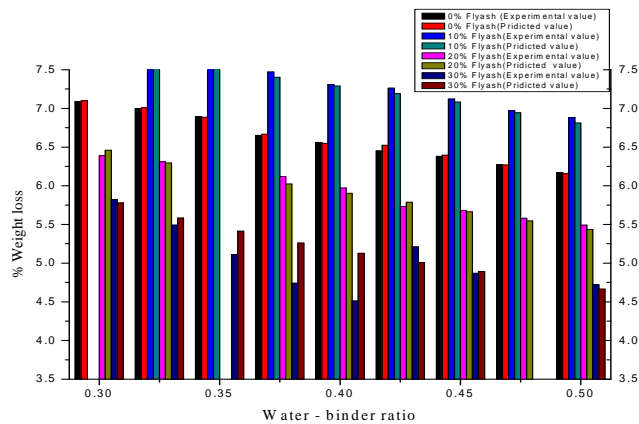


Fig.5 Learning of GA/ANN of % Weight Loss vs. W/B Ratio at 90 days MgSO<sub>4</sub> acid Immersion

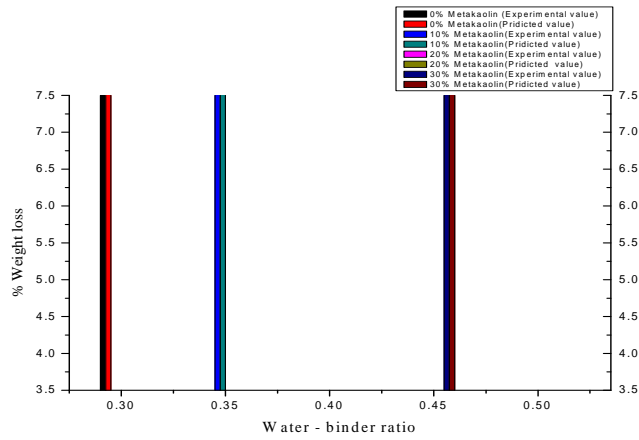


Figure No.6 Validation of GA/ANN Model for Durability (HCL)

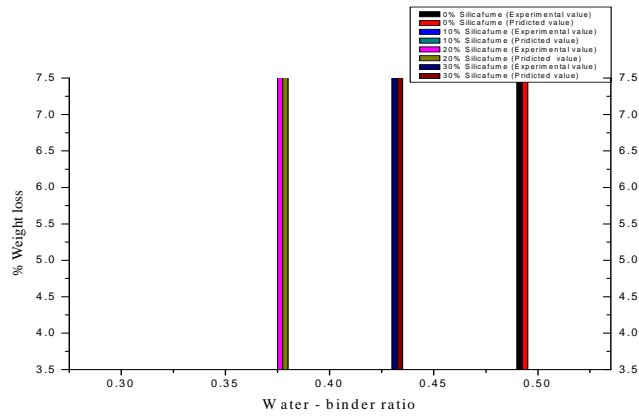


Figure No.7 Validation of GA/ANN Model for Durability (H2so4)

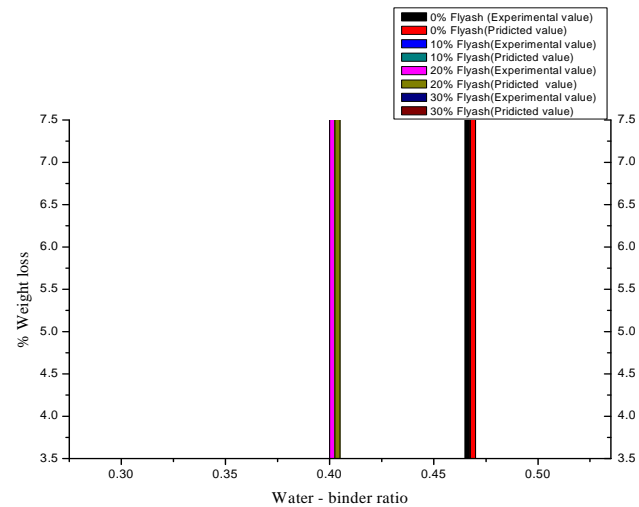


Figure No.8 Validation of GA/ANN Model for Durability (Mgso4)

Artificial neural networks are capable of learning and generalizing from examples and experiences. This makes artificial neural networks a powerful tool for solving some of the complicated civil engineering problems. In this paper, the application of Genetic Algorithm based neural network model for predicting the durability of High performance concrete has been demonstrated. The neural network model has been trained using 290 examples obtained from experimental results. The training examples are so chosen that they will cover all the variables involved in the problem. The weights for the

network have been obtained using a genetic algorithm. The network could learn the strength prediction problem with just 2000 training cycles. The models were trained with input and output data. After successful training, the GA based neural network model is able to predict the weight of High performance concrete satisfactorily for new problems with an accuracy of about 95%. Thus, it is concluded that the developed neural network model can serve as a macro-mechanical model for predicting the durability of high performance concrete

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## ANALYSIS OF SMART METER DATA USING HADOOP

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### Abstract

The government agencies and the large multinational companies across the world focuses on energy conservation and efficient usage of energy. The need of using energy in a efficient way is the need of developing countries like India and China .The emergence of smart grid meters gave us access to huge amount of energy consumption data. This data provided by smart meters can be used efficiently to provide insights into energy conservation measures and initiatives. Various energy distribution companies harness this data and get unpredictable results about customer's usage pattern; they then after performing analysis predict the demand and consumption of users. This analysis helps them to decide the tariff at different point of time. The companies are trying to overcome the bottleneck in capital investment cost of data .Further, processing Big Data for chart generation and analytics is a slow process and is not fast enough to support real-time decision making. Our paper showcases a Business Intelligence tool which uses Apache Hadoop to efficiently handle the existing problems. Taking the advantage of this tool, energy distribution companies can reduce the investment by using community hardware that runs Hadoop. The usage of distributed computing tools also reduces the processing time significantly to enable real-time monitoring and decision making .This tool will also reduce carbon footprint and other related

**problems in energy distribution including loses and theft .In future this same analysis**

**can be done on other utility resources such as gas and water.**

**Index Terms—About four key words or phrases in alphabetical order, separated by commas.**

### I. INTRODUCTION

Analytics of energy consumption data to gain insights into customer usage patterns is what energy distributors are trying to achieve for several target applications such as time-of use tariff, demand response management and billing accuracy. This smart meter collects data every minute which results in generating large amount of data while the old mechanical meter collects data by hourly or monthly. This huge data storage capabilities and the complexity of data processing intelligence varies significantly with different applications. Traditional RDBMS of utility companies is a bottleneck in executing this approach. As a result, for the industry to truly benefit from the smart grid investment, it is critical that the massive amount of data made available by smart meters be handled efficiently in an organized manner that helps grid operators make timely decisions to operate grid safely, economically and reliably. Apache Hadoop is the solution available to tackle above problems which runs on commodity machines only. It is distributed computing tool which have large storage as well as processing capability.

We are using Apache Hadoop framework that allows for the distributed processing of large data sets across clusters of computers. Hadoop MapReduce is a system for parallel processing



of large data sets. Traditional RDBMS or other applications are much slower and inefficient in handling big data generated by smart meters as compared to Hadoop framework. So for the industry and customers to gain benefits like billing accuracy, energy theft detection, analyzing customer usage patterns and demand response management etc. It is always profitable to use Hadoop which runs on cheap commodity hardware.

With the evolution of smart meters for smart distribution and efficient use of energy, electricity, the generated power should be utilized properly with fair economy gains to distributors and the consumers. Thus with this focus of energy distribution in the domain of energy consumption, which will result in reduction of carbon prints, the analytics for the data received from the smart meters should be done. This massive size of analytics will need large computation which can be done with the help of distributed processing framework, Hadoop. The framework's use will provide multipurpose beneficial outputs which include: billing accuracy, time-of-use tariff plans etc. Thus this concept, smart meter data analytics, is implemented with a view of future use.

## II. HADOOP

Smart meters send energy consumption data to the server at regular intervals of time which results in generating big amount of data and existing tools were not capable of handling such large amounts of data. Apache Hadoop is an open source framework for developing distributed applications that can process very large amounts of data. It is a platform that provides both distributed storage and computational capabilities.

Hadoop has two main layers:

1. Computation layer: The computation tier uses a framework called MapReduce.
2. Distributed storage layer: A distributed file system called HDFS provides storage.

### Hadoop Advantages:

- Hadoop is an open source, versatile tool that provides the power of distributed computing.
- By using distributed storage & transferring code instead of data, Hadoop reduces the costly transmission step when working with large data sets to a great extent.

- Redundancy, hadoop can recover from a situation when a single node fails.
- Ease to create programs with Hadoop As it uses the MapReduce framework. You did not have to do worry about partitioning the data, determining which nodes will perform which tasks, or handling communication between nodes as it is all done by Hadoop for you.
- Hadoop leaving you free to focus on what is most important to you and your data and what you want to do with it.

### Hadoop Key Features:

Distributed computing is the very vast field but following key features has made Hadoop very distinctive and attractive.

#### A.Accessible:

Hadoop runs on large clusters of commodity machines or on cloud computing services such as Amazon's Elastic Compute Cloud (EC2).

#### B.Robust:

As Hadoop is intended to run on commodity hardware, it is architected with the assumption of frequent hardware malfunctions. It can gracefully handle most such failures.

#### C.Scalable:

Hadoop scales linearly to handle larger data by adding more nodes to the cluster.

## III. SYSTEM ARCHITECHTURE

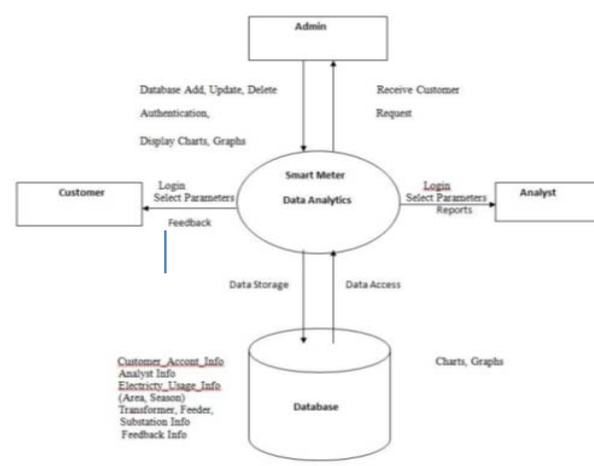


Fig. 1 System Architecture

## IV. SMART METER DATA ANALYSIS

Electricity generation in India majorly depends upon the non-renewable sources [1]. Though India is rich in these resources but these

resources are depleting at an alarming rate such that they will be exhausted very soon whereas the renewable resources are not utilized to their capacity. Thus India needs to concentrate more on the renewable sources of energy such as wind energy harvesting in southern and western India where wind velocity is high.

Poor metering, power theft, lack of proper planning, overload on the resources are the few reasons to the present poor grid conditions in India. The transmission and distribution costs are so high that the government loses a lot of money on every unit of electricity sold.

Keeping all the above factors in mind the government of India has taken many steps towards the betterment and improvement of the electricity grid. Smart metering, Variable tariffs, the Electricity act 2003, etc. are some of the initiatives taken.

The Smart grid concept presented in this paper is a step by step process specially tailored to Indian conditions which when followed will lead to a very effective and well managed smart electricity grid by 2024. This will include well established production and transmission devices, smart metering, transparency in the working of the management, visual analytics for both the provider and the consumer.

Various hurdles will have to be jumped over to reach this stage the biggest one will be that of corruption, once that is overcome then rest of the problems can be collectively solved by heuristic methods. Secondly government should try and involve the IT companies into this so that experts from these companies can make necessary amendments. The top ranked colleges can be involved in this process where the students might provide some valuable insights.

To save energy, reduce cost, and increase reliability, billions of dollars are being invested by the U.S. government and private industries to build the smart grid infrastructure [2]. Higher resolution measurements are made available to more equipment at wider areas by the wide deployment of modern information technology into power grid control and communication networks.

Consider Fig.2 for example. According to this figure, data is collected by a smart meter by the minute while the data is collected hourly or monthly by an old mechanical meter; 30-60 data points are collected by a phasor measurement

unit (PMU) per second which is much faster than the sampling rate of the traditional mechanical system named supervisory control and data acquisition (SCADA) system, which is 1 data point per 1-2 second.

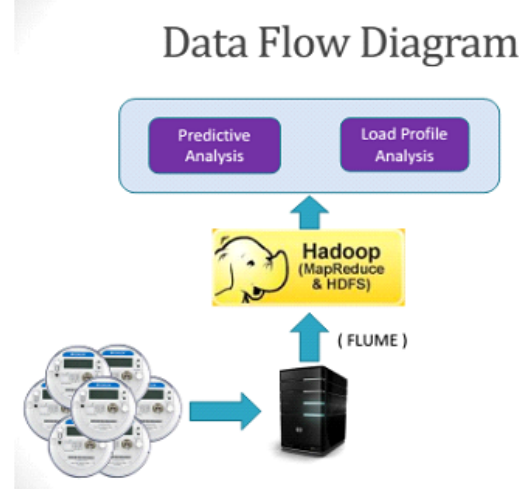


Fig.2: Data Flow Diagram

## V. IMPLEMENTATION AND RESULTS

The system that we implemented is useful for both electricity providers and customers in terms of cost efficiency and analysis. Smart meters collect and send electricity consumption data at particular intervals which results in generating large amount of data. The best software that we can use for handling such big data is Hadoop. Hadoop is infrastructure developed by Apache and leading distributed computing platform. Hadoop was derived from Google's MapReduce and Google File System (GFS). Hadoop is open-source platform and works on master-slave configuration. Hadoop runs on commodity hardware.

In our implementation HDFS (Hadoop Distributed File System) acts as our database where we are going to store all the data which includes electricity consumption data, user account information.

### GUI (Graphical User Interface):

Our main module is the GUI which tells entirely about the project that we have implemented. It describes different functionalities provided to user of the system. Here two types of user can gain access to the system, one is the analyst and another is consumer. Only authenticated users can be allowed to use the system. Both users can view electricity consumption data of their choice based on different given parameters (week,

month etc.) available in the system. Then depending upon their selected choice, graph is generated so that they can analyze the consumption of electricity and further achieve various objectives mentioned. Main aim of GUI is to provide flexible and efficient system to users.

**ANALYSIS MODEL 1:**

Module Name	Energy Consumption Prediction
Functionality	Following functionality is provided in this module 1. Can access different parameters (week, season etc.) 2. Can access graph of choice
General Workflow	Following steps are included in general workflow of module 1. Login 2. Select Parameters 3. Select Graph
Dependency	Following module on which this module is dependent Login for username and password

**Table I Analysis Model 1**

**ANALYSIS MODEL 2:**

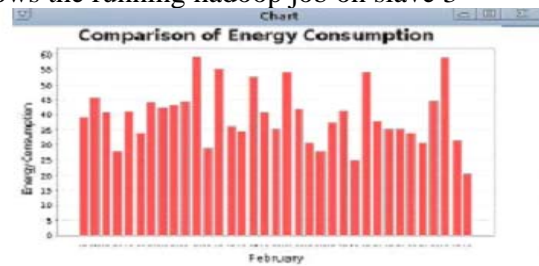
Module Name	Drill Down
Functionality	Following functionality is provided in this module 1. Can access different parameters (week, season etc.) 2. Can access graph of choice
General Workflow	Following steps are included in general workflow of module 1. Login 2. Select Parameters 3. Select Graph
Dependency	Following module on which this module is dependent Login for username and password

**Table II Analysis Model 2  
CONSUMER MODEL:**

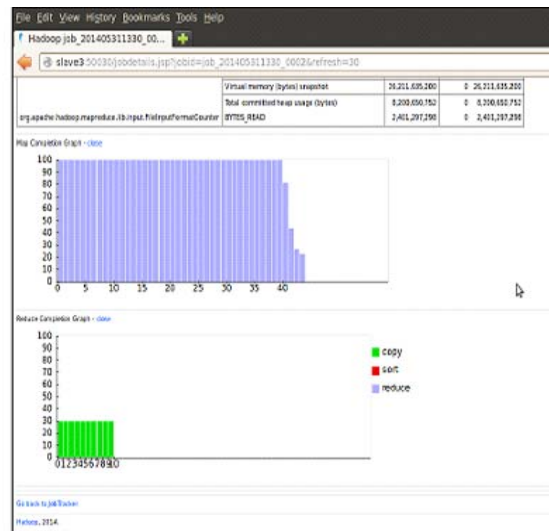
Module Name	Customer
Functionality	Following functionality is provided in this module 1. Can access different parameters (week, season etc.) 2. Can access graph of choice
General Workflow	Following steps are included in general workflow of module 3. Login 4. Select Parameters 5. Select Graph
Dependency	Following module on which this module is dependent Login for username and password

**Table III Customer Model**

The fig 4 shows the comparison of energy consumption in the month of February and fig 5 shows the running hadoop job on slave 3



**Fig. 4: Comparison of energy consumption**



**Fig. 5: Ongoing Hadoop Jobs of Slave 3**

## VI. CONCLUSION

To reach the 2020 energy efficiency as well as renewable energy targets and also for the future smart grids, effective use of smart metering technology is crucial. Rational energy use is a must for a larger group of companies, municipalities and public organizations because of the gain in importance of the energy costs and environmental issues. Hence proper information about their consumption is needed by them along with and its distribution between different activities. A total picture of their energy use, potential for savings, along with costs can be given to them by smart meter data analytics, enabling effective energy management. Smart meter sends energy consumption data at small intervals resulting in generating big data. Time and storage are two important factors that affect a lot on building any application. The solution for handling such big data is Hadoop.

## VII. FUTURE SCOPE

For a good understanding of how customer, environmental and structural features affect the usage, the techniques for the analysis of energy consumption data by using smart meters will be helpful. Analysis of customer behavior can be performed easily by analyzing this data which will be helpful to reduce energy consumption. A utility for better management of power outages and restoration events as well as reduction in outage duration and costs is allowed by Outage Management System (OMS). Reduced CO<sub>2</sub> emission is resulted by demand response because of avoided use of polluting power plant. Also, as a result, reduced peak prices are found because of avoided use of expensive peak load production. Because of customers' awareness, reduced consumption is found as a result of feedback as well as load management regarding energy consumption. Analysis of smart meter data in accordance with weather can also be performed. In India, main challenge is to install the smart meter all over the country as internet facility is still not present in most of the regions.

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# POWER UPGRADING OF TRANSMISSION LINE BY COMBINING AC-DC TRANSMISSION

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## Abstract

**Long extra high voltage (EHV) ac lines cannot be loaded to their thermal limits in order to keep sufficient margin against transient instability. With the scheme proposed in this project, it is possible to load these lines very close to their thermal limits. The conductors are allowed to carry usual ac along with dc superimposed on it.**

**The added dc power flow does not cause any transient instability. This paper gives the feasibility of converting a double circuit ac line into composite ac–dc power transmission line to get the advantages of parallel ac–dc transmission to improve stability and damping out oscillations. Simulation and experimental studies are carried out for the coordinated control as well as independent control of ac and dc power transmissions. No alterations of conductors, insulator strings, and towers of the original line are needed. Substantial gain in the load ability of the line is obtained. Master current controller senses ac current and regulates the dc current orders for converters online such that conductor current never exceeds its thermal limit.**

**Keywords: Flexible ac transmission system (FACTS), Extra high voltage (EHV)transmission, power system computer-aided design(PSCAD),Simultaneous ac-dc power transmission.**

## I. INTRODUCTION

In recent years, environmental, right-of-way, and cost concerns have delayed the construction of a new transmission line, while demand of

electric power has shown steady but geographically uneven growth. The power is often available at locations not close to the growing load centers but at remote locations. These locations are largely determined by regulatory policies, environmental acceptability, and the cost of available energy. The wheeling of this available energy through existing long ac lines to load centers has a certain upper limit due to stability considerations. Thus, these lines are not loaded to their thermal limit to keep sufficient margin against transient instability.

The present situation demands the review of traditional power transmission theory and practice, on the basis of new concepts that allow full utilization of existing transmission facilities without decreasing system availability and security. The flexible ac transmission system (FACTS) concepts, based on applying state-of-the-art power electronic technology to existing ac transmission system, improve stability to achieve power transmission close to its thermal limit.

The basic proof justifying the simultaneous ac–dc power transmission is explained in an IEEE paper “Simultaneous ac-dc power transmission,” by K. P. Basu and B. H. Khan. In the above reference, simultaneous ac–dc power transmission was first proposed through a single circuit ac transmission line. In these proposals Mono-polar dc transmission with ground as return path was used. There were certain limitations due to use of ground as return path. Moreover, the instantaneous value of each conductor voltage with respect to ground becomes higher by the amount of the dc voltage,

and more discs are to be added in each insulator string to withstand this increased voltage. However, there was no change in the conductor separation distance, as the line-to-line voltage remains unchanged. In this paper, the feasibility study of conversion of a double circuit ac line to composite ac-dc line without altering the original line conductors, tower structures, and insulator strings has been presented.

### 2 Problem Definition:-

The main object of my paper is to show that by superimposing DC in AC transmission, the capacity of the transmission line can be increased by nearly 70 % of that if only AC is transmitted. In our existing transmission system, long extra high voltage (EHV) ac lines cannot be loaded to their thermal limits in order to keep sufficient margin against transient instability. With the scheme proposed in this project, it is possible to load these lines very close to their thermal limits. The conductors are allowed to carry usual ac along with dc superimposed on it.

### 3 Literature Survey:-

This report presents the Power Upgrading of Transmission line by combining AC and DC transmission.

The flexible ac transmission system (FACTS) concepts, based on applying state-of-the-art power electronic technology to existing ac transmission system, improve stability to achieve power transmission close to its thermal limit [1]–[4]. Another way to achieve the same goal is simultaneous ac-dc power transmission in which the conductors are allowed to carry superimposed dc current along with ac current. Ac and dc power flow independently, and the added dc power flow does not cause any transient instability.

The authors, H. Rahman and B. H. Khan, of this paper have earlier shown that extra high voltage (EHV) ac line may be loaded to a very high level by using it for simultaneous ac-dc power transmission as reported in references [5] and [6]. The basic proof justifying the simultaneous ac-dc power transmission is explained in reference [6]. In the above references, simultaneous ac-dc power transmission was first proposed through a single circuit ac transmission line. In these proposals Mono-polar dc transmission with ground as return path was used. There were certain limitations due to use of ground as return path. Moreover, the

instantaneous value of each conductor voltage with respect to ground becomes higher by the amount of the dc voltage, and more discs are to be added in each insulator string to withstand this increased voltage. However, there was no change in the conductor separation distance, as the line-to-line voltage remains unchanged.

In this paper, the feasibility study of conversion of a double circuit ac line to composite ac-dc line without altering the original line conductors, tower structures, and insulator strings has been presented. In this scheme, the dc power flow is point-to point bipolar transmission system. Clerici *et al.* [7] suggested the conversion of ac line to dc line for substantial power upgrading of existing ac line. However, this would require major changes in the tower structure as well as replacement of ac insulator strings with high creepage dc insulators. The novelty of our proposed scheme is that the power transfer enhancement is achieved without any alteration in the existing EHV ac line. The main object is to gain the advantage of parallel ac-dc transmission and to load the line close to its thermal limit.

### 4 Existing Transmission Issues and Solution

#### 4.1 High Voltage DC Transmission:

##### 4.1.1 Introduction:-

It has been widely documented in the history of the electricity industry, that the first commercial electricity generated (by Thomas Alva Edison) was direct current (DC) electrical power. The first electricity transmission systems were also direct current systems. However, DC power at low voltage could not be transmitted over long distances, thus giving rise to high voltage alternating current (AC) electrical systems. Nevertheless, with the development of high voltage valves, it was possible to once again transmit DC power at high voltages and over long distances, giving rise to HVDC transmission systems. Since the first commercial installation in 1954 a huge amount of HVDC transmission systems have been installed around the world.

In today electricity industry, in view of the liberalization and increased effects to conserve the environment, HVDC solutions have become more desirable for the following reasons:

1. Environmental advantages
2. Economical (cheapest solution)

3. Asynchronous interconnections
4. Power flow control
5. Added benefits to transformers.

#### 4.1.2 Inherent problems associated with HVDC:

(a) Expensive converters:

Expensive Converter Stations are required at each end of a D.C. transmission link, whereas only transformer stations are required in an A.C. link.

(b) Reactive power requirement:

Converters require much reactive power, both in rectification as well as in inversion. At each converter the reactive power consumed may be as much as 50% of the active power rating of the D.C. link. The reactive power requirement is partly supplied by the filter capacitance, and partly by synchronous or static capacitors that need to be installed for the purpose.

(c) Generation of harmonics:

Converters generate a lot of harmonics both on the D.C. side and on the A.C. side. Filters are used on the A.C. side to reduce the amount of harmonics transferred to the A.C. system. On the D.C. system, smoothing reactors are used. These components add to the cost of the converter.

(d) Difficulty of circuit breaking:

Due to the absence of a natural current zero with D.C., circuit breaking is difficult. This is not a major problem in single HVDC link systems, as circuit breaking can be accomplished by a very rapid absorbing of the energy back into the A.C. system. (The blocking action of thyristors is faster than the operation of mechanical circuit breakers). However the lack of HVDC circuit breakers hampers multi-terminal operation.

(e) Difficulty of voltage transformation:

Power is generally used at low voltage, but for reasons of efficiency must be transmitted at high voltage. The absence of the equivalent of D.C. transformers makes it necessary for voltage transformation to be carried out on the A.C. side of the system and prevents a purely D.C. system being used.

(f) Difficulty of high power generation:

Due to the problems of commutation with D.C. machines, voltage, speed and size are limited. Thus comparatively lower power can be generated with D.C.

(g) Absence of overload capacity:

Converters have very little overload capacity unlike the transmission (stability, power quality etc.)

## 4.2 High Voltage AC Transmission

### 4.2.1 Introduction:-

Industrial-minded countries of the world require a vast amount of energy of which electrical energy forms a major fraction. The world has already consumed major portion of its natural resources and is looking for sources of energy other than Hydro and Thermal to cater for the rapid rate of consumption which is outpacing the discovery of new resources. This will not slow down with time and therefore there exists a need to reduce the rate of annual increase in energy consumption by any intelligent society if resources have to be preserved for posterity. This requires very high voltages for transmission. The very rapid stride taken by development of dc transmission since 1950 is playing a major role in extra-long-distance transmission, complementing or supplementing E.H.V. ac transmission. They have their roles to play and a country must make intelligent assessment of both in order to decide which is best suited for the country's economy.

### 4.2.2 Problems posed in using such HVAC are encountered as:-

(a) Increased Current Density because of increase in line loading by using series capacitors.

(b) Use of bundled conductors.

(c) High surface voltage gradient on conductors.

(d) Corona problems: Audible Noise, Radio Interference, Corona Energy Loss, Carrier Interference, and TV Interference.

(e) High electrostatic field under the

line. (f) Switching Surge Over voltage's which

cause more havoc to air-gap insulation than lightning or power frequency voltages.

(g) Increased Short-Circuit currents and possibility of Ferro resonance conditions.

(h) Use of gapless metal-oxide arresters replacing the conventional gap-type Silicon Carbide arresters, for both lightning and switching-surge duty.

(i) Shunt reactor compensation and use of series capacitors, resulting in possible sub synchronous resonance conditions and high short circuit currents.

(j) Insulation coordination based upon switching impulse levels.

(k) Single-pole reclosing to improve stability, but causing problems with arcing.

### 4.3 Proposed System (Simultaneous AC-DC Power Transmission):-

With the scheme proposed in this thesis, it is possible to load the transmission lines very close to their thermal limits. The conductors are allowed to carry usual ac along with dc superimposed on it. The added dc power flow does not cause any transient instability. This thesis gives the feasibility of converting a double circuit ac line into composite ac-dc power transmission line to get the advantages of parallel ac-dc transmission to improve stability and damping out oscillations. No alterations of conductors, insulator strings, and towers of the original line are needed. Substantial gain in the load ability of the line is obtained. In this thesis, the feasibility study of conversion of a single circuit ac line to composite ac-dc line without altering the original line conductors and tower structures has been presented.

#### 4.3.1 Introduction:-

Fig. 1 depicts the basic scheme for simultaneous ac-dc power flow through a double circuit ac transmission line. The dc power is obtained through line commutated 12-pulse rectifier bridge used in conventional HVDC and injected to the neutral point of the zigzag connected secondary of sending end transformer and is reconverted to ac again by the conventional line commutated 12-pulse bridge inverter at the receiving end. The inverter bridge is again connected to the neutral of zig-zag connected winding of the receiving end transformer.

The double circuit ac transmission line carries both three-phase ac and dc power. Each conductor of each line carries one third of the total dc current along with ac current. Resistance being equal in all the three phases of secondary winding of zig-zag transformer as well as the three conductors of the line, the dc current is equally divided among all the three phases.

The three conductors of the second line provide return path for the dc current. Zig-zag connected winding is used at both ends to avoid saturation of transformer due to dc current. Two fluxes produced by the dc current ( $I_d / 3$ ) flowing through each of a winding in each limb of the core of a zig-zag transformer are equal in magnitude and opposite in direction. So the net dc flux at any instant of time becomes zero in each limb of the core. Thus, the dc saturation of the core is avoided. A high value of reactor  $X_d$  is used to reduce harmonics in dc current. In the

absence of zero sequence and third harmonics or its multiple harmonic voltages, under normal operating conditions, the ac current flow through each transmission line will be restricted between the zig-zag connected windings and the three conductors of the transmission line. Even the presence of these components of voltages may only be able to produce negligible current through the ground due to high value of  $X_d$ .

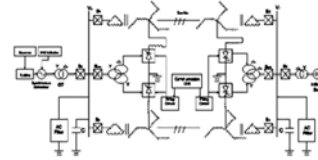


Figure: 4.1 Basic scheme for composite ac-dc transmission

Assuming the usual constant current control of rectifier and constant extinction angle control of inverter as mentioned later, the equivalent circuit of the scheme under normal steady-state operating condition is given in Fig. 2. The dotted lines in the figure show the path of ac return current only. The second transmission line carries the return dc current, and each conductor of the line carries ( $I_d / 3$ ) along with the ac current per phase and  $V_{dro}$  and  $V_{dio}$  are the maximum values of rectifier and inverter

side dc voltages and are equal to  $3\sqrt{2}$  times

converter ac input line-to-line voltage.  $R$ ,  $L$  and  $C$  are the line parameters per phase of each line.  $R_{cr}$  and  $R_{ci}$  are commutating resistances, and,  $\alpha$ ,  $\gamma$  are firing and extinction angles of rectifier and inverter, respectively.

#### 4.3.2 Proof with Equations:-

Neglecting the resistive drops in the line conductors and transformer windings due to dc current, expressions for ac voltage and current, and for active and reactive powers in terms of  $A$ ,  $B$ ,  $C$ , and  $D$  parameters of each line may be written as

$$E_S = A E_R + B I_R \quad [4.1]$$

$$I_S = C E_R + D I_R \quad [4.2]$$

$$P_S + j Q_S = -E_S E_R^* / B^* + [D^* E_S^2 / B^*] \quad [4.3]$$

$$P_R + j Q_R = E_R E_S^* / B^* - [A^* E_R^2 / B^*] \quad [4.4]$$

Neglecting ac resistance drop in the line and transformer, the dc power  $P_{dr}$  and  $P_{di}$  of each rectifier and inverter are given by

$$P_{dr} = V_{dr} I_d \quad [4.5]$$

$$P_{di} = V_{di} I_d \quad [4.6]$$



Reactive powers required by the converters are

$$Q_{dr} = P_{dr} \tan \theta_r \quad [4.7]$$

$$Q_{di} = P_{di} \tan \theta_i \quad [4.8]$$

$$\cos \theta_r = [\cos \alpha + \cos(\alpha + \mu_r)]/2 \quad [4.9]$$

$$\cos \theta_i = [\cos \gamma + \cos(\gamma + \mu_i)]/2 \quad [4.10]$$

where  $X_i$  and  $X_r$  are commutation angles of inverter and rectifier, respectively, and total active and reactive powers at the two ends are

$$P_{s1} = P_s + P_{dr} \text{ and } P_{s2} = P_s + P_{di} \quad [4.11]$$

$$P_{r1} = P_r + P_{dr} \text{ and } P_{r2} = P_r + P_{di} \quad [4.12]$$

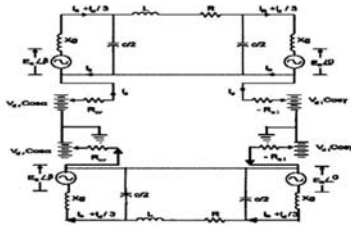


Figure: 4.2 Equivalent Circuit

Transmission loss for each line is

$$P_L = (P_S + P_{dr}) - (P_R + P_{di})$$

$$[4.13]$$

$I_a$  being the rms ac current per conductor at any point of the line, the total rms current per conductor becomes

$$I = [I_a^2 + (I_d/3)^2]^{1/2}$$

$$\text{Power loss for each line} = P_L \approx 3I^2 R$$

The net current 'I' in any conductor is offsetted from zero. In case of a fault in the transmission system, gate signals to all the SCRs are blocked and that to the bypass SCRs are released to protect rectifier and inverter bridges. The current in any conductor is no more offsetted. Circuit breakers (CBs) are then tripped at both ends to isolate the faulty line. CBs connected at the two ends of transmission line interrupt current at natural current zeroes, and no special dc CB is required. Now, allowing the net current through the conductor equal to its thermal limit  $I_{th}$ .

$$I_{th} = [I_a^2 + (I_d/3)^2]^{1/2} \quad [4.14]$$

Let  $V_{ph}$  be per-phase rms voltage of original ac line. Let also  $V_a$  be the per-phase voltage of ac component of composite ac-dc line with dc voltage  $V_d$  superimposed on it. As insulators remain unchanged, the peak voltage in both cases should be equal to

$$V_{max} = \sqrt{2}V_{ph} = V_d + \sqrt{2}V_a$$

$$[4.15]$$

Electric field produced by any conductor possesses a dc component superimpose on it a sinusoidal varying ac component. However, the instantaneous electric field polarity changes its sign twice in a

cycle if  $(V_d/V_a) < \sqrt{2}$  is insured.

Therefore,

higher creepage distance requirement for insulator discs used for HVDC lines are not required. Each

conductor is to be insulated for  $V_{max}$ , but the line-to-line voltage has no dc component and

Therefore, conductor-to-

$$V_{LLmax} = \sqrt{6}V_a \text{ to-}$$

conductor separation distance of each line is determined only by rated ac voltage of the line. Allowing maximum permissible voltage offset such that the composite voltage wave just touches zero in each every cycle;

The total power transfer through the double circuit line before conversion is as follows

$$P'_{total} \approx 3V_{ph}^2 \sin \delta_1 / X$$

$$[4.17]$$

where 'X' is the transfer reactance per phase of the single circuit line, and  $\delta_1$  is the power angle between the voltages at the two ends. To keep sufficient stability margin,  $\delta_1$  is generally kept low for long lines and seldom exceeds  $30^\circ$ . With the increasing length of line, the load ability of the line is decreased. An approximate value of  $\delta_1$  may be computed from the loadability curve by knowing the values of surge impedance loading (SIL) and transfer reactance of the line

$$P'_{total} = 2. M. SIL$$

$$[4.18]$$

Where M is the multiplying factor and its magnitude decreases with the length of line. The value of M can be obtained from the loadability curve.

The total power transfer through the composite line

$$P_{total} = P_{ac} + P_{dc}$$

$$P_{total} = 3; V_{ph}^2 \sin \delta_1 / X + 2; V_a V_d L \quad [4.19]$$

The power angle  $\delta_1$  between the ac voltages at the two ends of the composite line may be increased to a high value due to fast

controllability of dc component of power. For a constant value of total power,  $P_{total}$  may be modulated by fast control of the current controller of dc power converters. Approximate value of ac current per phase per circuit of the double circuit line may be computed as

$$I_a = V(\sin \delta/2)/X$$

[4.20]

The rectifier dc current order is adjusted online as

$$I_d = 3 \sqrt{I_{th}^2 - I_a^2}$$

[4.21]

Preliminary qualitative analysis suggests that commonly used techniques in HVDC/AC system may be adopted for the purpose of the design of protective scheme, filter, and instrumentation network to be used with the composite line for simultaneous ac–dc power flow. In case of a fault in the transmission system, gate signals to all the SCRs are blocked and that to the bypass SCRs are released to protect rectifier and inverter bridges. CBs are then tripped at both ends to isolate the complete system.

A surge diverter connected between the zig-zag neutral and the ground protects the converter bridge against any over voltage.

## 5 Simulation:-

### 5.1 Simulink Model Using AC Transmission:-

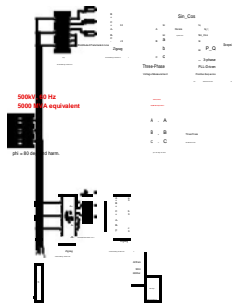


Figure: 6.1 Simulink model using AC Transmission

### 5.2 Simulink Model Using AC –DC Transmission:-



Using (17)–(20), the computed power at receiving end and conductor current is  $P_{total} = 1124.2 \text{ MW}$   
 $I_{ph/ckt} = 0.803 \text{ kA}$ .

### 6.2 Both AC-DC Configuration:-

TABLE I  
COMPUTED RESULTS

Power Angle (δ) Degree	30°	45°	60°	75°	90°
ac power(MW) $=3V_s I_a \sin \delta/2$	290	410	502.61	560.6	571.55
ac current $I_a$ (kA) $I_a = V(\sin \delta/2)/X$	0.4166	0.6122	0.805	0.98	1.033
dc Current (kA) $I_d$	5.253	5.078	4.829	4.529	4.418
$3 \sqrt{I_{th}^2 - I_a^2}$					
Dc Power $P_{dc} = 2V_d I_d$ (MW)	1084.8	1024.9	1545.3	1149.44	1413.76
$P_{total} = P_{ac} + P_{dc}$ (MW)	1971	2034	2048	2010	1985

## 6.2 Simulated Results

TABLE II  
SIMULATED RESULTS

Power Angle	30°	45°	60°	75°	90°
Power (MW)	2306	2379.0	2383.7	2342.0	2318.260
Power (kVA)	294.89	411.60	495.3	541.36	548.43
Power (kVA)	1915.5	1637.0	1385.8	1406.3	1467.0
Power (kVA)	11.34	30.30	54.08	81.34	91.73
Power (kVA)	280.31	281.88	241.17	217.81	206.53
Power (kVA)	292.85	246.18	205.25	206.35	206.26
Power (kVA)	1988.8	2088.14	2062.8	2019.24	1988.88
Total Power (MW)	117.76	48.08	183.54	335.73	375.37
Power (kVA)	39.88	140.84	280.83	431.38	484.38
Power (kVA)	883.0	894.34	885.29	876.1	869.48
Power (kVA)	841.3	823.8	797.43	764.64	753.04
Power (kVA)	841.339	843.733	879.684	940.892	1003.883
Power (kVA)	824.663	811.36	831.185	863.98	859.812
Power (kVA)	1739.54	1764.83	1833.93	1848.2	1768.84
Power (kVA)	1792.87	1782.64	1792.81	1786.41	1788.83
Power (kVA)	76.949	82.495	83.431%	79.666%	77.5%

## 7 Conclusion and Future Scope

### 7.1 Conclusion

The feasibility to convert ac transmission line to a composite ac–dc line has been demonstrated. For the particular system studied, there is substantial increase (about 83.45%) in the loadability of the line. The line is loaded to its thermal limit with the superimposed dc current. The dc power flow does not impose any stability problem. The advantage of parallel ac–dc transmission is obtained. Dc current regulator may modulate ac power flow. There is no need for any modification in the size of conductors, insulator strings, and towers structure of the

original line. The optimum values of ac and dc voltage components of the converted composite line are  $1/2$  and  $1/\sqrt{2}$  times the ac voltage before conversion, respectively.

## 7.2 Future Scope

In this paper, it is shown that by injecting DC power in AC power transmission lines, we can improve the transmission capacity of the line by 2 to 4 times without altering the physical equipment. This work can be extended for analyzing the effect of faults on this type of transmission. This work is done on double circuit AC transmission lines but it can be extended to other types of transmission methods.

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