

SPECIAL FEATURE

Performance Analysis of
Indoor Visual Light

Silicon

...beyond teaching

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Data Science

Data Science is the art of extracting knowledge from heaps of data and utilizes different processes and algorithms to get insights from the data. Data Science along with big data is capable of delivering valuable and strategic information to business enterprises. Data Science requires the understanding of several interdisciplinary fields- computer science, statistics, mathematics, and business practice. The new profession of data scientist is one of the most sought-after professions in the field of information technology these days.

Data Science consists of processing the data in different phases before the knowledge can be extracted. It requires cleaning of data stored in the databases. Once the data is cleaned it is analyzed and explored, further application of machine learning techniques is done to find patterns in the data. These patterns and trends found in data are utilized to provide valuable business information. Interpretation of these patterns is done using data visualization tools. All these scientific processes requires a host of skill sets including database management, scripting languages like python, R, in-depth understanding of machine learning, visualization tools, Hadoop, and a thorough knowledge of the business domain. Data scientists also need to have a deep understanding of the information needs of the user.

Data Science is omnipresent and used in numerous applications. Speech recognition as used by Google and Siri employ methods of Data Science. Face recognition techniques used by facebook to tag friends automatically

is also the result of Data Science. Biologists conduct thousands of experiments to predict different degenerative diseases like cancer and Parkinson's disease. These researchers often use Data-Science based methods for their studies. Another prominent application of Data Science is the recommendation system. "Suggested videos" on youtube, "people you might know" on facebook and linkedin, "people who have bought this product also purchased.." on online shopping sites, are recommendation systems built on Data Science techniques. Sentiment analysis of tweets, facebook comments and user reviews on different portals is fuelled by Data Science. Search engines on internet are capable of retrieving accurate results in a fraction of a second using some of the Data Science techniques. Gaming giants like Zynga, Sony, EA Sports use Data Science to upgrade the gaming experience amongst their users. Finance companies use risk and fraud detection techniques powered by Data Science.

Over the past decade Data Science has emerged as a much sought-after discipline. With the explosion of digital data and availability of high speed computational devices, Data Science is being used in increasingly different domains. Business houses have benefited by imbibing Data Science into their business process. The demand for data scientists is bound to proliferate. Learning these skills will enable one's job prospects to be enhanced significantly. Data Science is surely the way to go!!

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Consumer Load Management to Minimize the Surge in Electricity Price

Abstract : Electricity is a critical component which drives economy, a fact which is uncontested. But the irony lies behind the fact that India is a power surplus country; the problem lies between power generation and power consumption-transmission and distribution. Peak power management is one of the major issues for power grids as it incurs excessive reactive power in the system which can prove to be harmful to both the grids and the consumers. Thus, Indian power scenario needs a shift from the present power tariff model to a dynamic pricing system which will result beneficial to both the distributors and the consumers. This model also investigated how air-conditioning applies a pre-cooling method when there is a substantial risk of a price spike. The results indicate the potential of the scheme to achieve financial benefits for consumers and target the best economic performance for electrical generation distribution and transmission. This project aims to optimize the domestic energy cost of air-conditioning systems under dynamic pricing system in India. It is to develop an independent and minimal user interference response-model for the consumers. It incorporates a pre-cooling system for ACs based on a prediction model for the price spike. The proposed model can assist the consumer to optimize the energy cost for air conditioning to meet a spike and spike probability cases. It also involves the economic benefits for both the consumer and distributor under this model for optimizing their system.

I. INTRODUCTION

Power systems engineering is a subfield of electrical engineering that deals with the generation, transmission, distribution and utilization of electric power, and the electrical apparatus connected to such systems. An electrical load is an electrical component or portion of a circuit that consumes (active) electric power. Electric lamps, air conditioners, motors, resistors etc. are some of the examples of electrical loads. Domestic load consists of lights, fans, home electric appliances (including TV, AC, refrigerators, heaters etc.), small motors for pumping water etc. Most of the domestic loads are connected for only some hours during a day. For example, lighting load is connected for few hours during night time. The usage of domestic load depends upon various factors like time of the day, season, environmental conditions, etc. the operation of some of the loads can be changed or scheduled while that of other remains fixed. Depending upon this, the domestic loads are classified as Deferrable loads and Non- Deferrable load.

A non-deferrable load is an electrical load that requires a certain amount of energy whose time of operation is fixed. Lights, fans, television are some examples of non-deferrable loads. Lights, fans are base loads whose time of operation depend upon environmental conditions and cannot be changed according to the pricing. Similarly operation of television depends upon the users choice not on the spike in demand. There is no flexibility in the time of operation of non-deferrable loads. A deferrable load is an electrical load that requires a certain amount of energy within a given time period, but the exact timing is not important; it can wait until power is available. Loads are normally classified as deferrable

when they are associated with storage. Water pumping is a common example—there is some flexibility as to when the pump actually operates, provided the water tank does not run dry. The deferrable load is second in priority after the primary load. The amount of money frame by the supplier for the supply of electrical energy to various types of consumers is known as an electricity tariff. In other words, the tariff is the method of charging a consumer for consuming electric power. The actual tariffs that the customer pay depends on the consumption of the electricity. The consumer bill varies according to their requirements. The industrial consumers pay more tariffs because they use more power for long times than the domestic consumers.

The total bill of the consumer has three parts, namely, fixed charge D , semi-fixed charge Ax and running charge given by: $C = Ax + By + D$

where,

- C – total charge for a period (say one month)
- x – maximum demand during the period (kW or kVA)
- y – Total energy consumed during the period (kW or kVA)
- A – cost per kW or kVA of maximum demand.
- B – cost per kWh of energy consumed.
- D – fixed charge during each billing period.

Every tariff consists of fixed cost ('D') that is charged for the network installation. Depending upon the values of A and B , tariffs are classified as fixed price electricity tariff (A and B are constants) and differential price electricity tariff (at least one or both A and B are

variable). Differential tariff is an example of demand side management where the price per unit of energy varies with the consumption. If a power utility uses differential tariff, it may change the rate per kWh of energy used during different times, such as raising the price during times of high energy consumption and lowering the price during times of low energy consumption.

Two different network tariffs were considered:

1) EBT 2) PBT.

Both tariffs consist of a fixed annual network fee and a charge based on the energy consumed by the customer. However, the PBT also includes a fee based on the peak demand of the customer, to encourage the customer to reduce their peak demand. The peak-demand is defined as the average power consumption under one hour. The PBT is either based on the monthly or on the daily peak-demand of each customer, i.e. MPT or DPT.

II. LITERATURE REVIEW

Demand response means that an electricity consumer changes its electricity consumption in accordance with some input coming from an actor so that the actor and the consumer benefit from the action. In other words, demand for electricity responds to some input in a way that benefits both of the parties involved. There can be many types of market actors and related inputs. Actors can be e.g. electricity retailer, transmission system operator (TSO) or a distribution network operator (DNO). The holistic societal benefit is to minimize the infrastructure costs of electricity grids within certain boundary conditions such as the level of service of DNOs. This implies a need for a high utilization rate of electricity networks. The utilization rate is often quite low because network components are rated for high peak loads. To achieve a high utilization rate, load duration curves in the network should be quite flat and the levels of the network components should be near to their techno-economic maximum loading levels. From the utilization rate perspective, encouraging DR for load profile flattening is reasonable. One indirect way a DNO may offer financial DR incentives for small electricity users is to offer distribution tariffs which would encourage changing one's consumption habits [1].

III. A GLANCE TO THE CONCEPTS

3.1. MATLAB

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and language developed by Math Works. MATLAB allows matrix

manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems [2]. Table 1 shows the parameter values considered in this project.

3.2. CONCEPTS OF THERMODYNAMICS

Thermodynamics is the branch of physics concerned with heat and temperature and their relation to energy and work. The behaviour of these quantities is governed by the four laws of thermodynamics, irrespective of the composition or specific properties of the material or system in question. A description of any thermodynamic system employs the four laws of thermodynamics that form an axiomatic basis. The first law specifies that energy can be exchanged between physical systems as heat and work, and is consequed.

The second law defines the existence of a quantity called entropy, that describes the direction, thermodynamically, that a system can evolve and quantifies the state of order of a system and that can be used to quantify the useful work that can be extracted from the system.

In thermodynamics, interactions between large ensembles of objects are studied and categorized. Central to this are the concepts of the thermodynamic system and its surroundings. A system is composed of particles, whose average motions define its properties, and those properties are in turn related to one another through equations of state. Properties can be combined to express internal energy and thermodynamic potentials, which are useful for determining conditions for equilibrium and spontaneous processes.

Table 1. Parameters

No.	Parameter	Value	Unit
1.	Heat Transfer Co-efficient from wall and ceiling(Q)	1	W/m ²
2.	Total Area (A)	54	m ²
3.	Heat Capacity of the Room (H)	44.4	J/
4.	Heat Transfer from the AC (B)	15	W
5.	Rating Power of AC (P)	2.6	KW

3.2.1. HEATING CYCLE

According to the Second Law of Thermodynamics, heat transfer is only possible in the direction from a higher temperature to a lower one. It becomes zero if temperatures are equal. The heat loss through an envelope should therefore be proportional to the difference: $T_{outside} - T_{inside}$ or to a positive power of it for small differences. Since outside temperature is more than inside temperature heat transfer occurs from outside to inside raising the room temperature. The heat transfer is given by:

Heat Transfer $\propto$ Temperature Difference (ΔT)

Heat Transfer $\propto$ Area of the room (A)

The heat transfer per unit time is given by:

$$\frac{dT}{dt} = \frac{Q \cdot A \cdot (T_o(t) - T(t))}{H}$$

3.2.2. COOLING CYCLE

Air conditioners transfer heat from the indoors to the outdoors. They actually remove heat energy from the air and then return it. The heat is sent outside. When heat is removed from the indoor air, the air is cooled down.

Heat removed $\propto \frac{1}{\text{Heat capacity of the room}(H)}$

$$\frac{dT}{dt} = -\frac{B}{H}$$

where, B is Heat transfer from the AC (in watts), H is Heat capacity of the room (in J/°C). Since we have taken heat transfer from outside to inside as positive, the heat removed by ac from the room is considered as negative. So the final equation consisting of both heating and cooling cycles is given by:

$$\frac{dT}{dt} = \frac{Q \cdot A \cdot (T_o(t) - T(t))}{H} - \frac{B \cdot U(t)}{H}$$

$U(t)$ is the AC status which takes binary values 0 (for switch OFF condition) and 1 (for switch ON condition).

The magnitude of $\frac{B}{H}$

is greater than that of $\frac{Q \cdot A \cdot (T_o(t) - T(t))}{H}$

to ensure that cooling occurs.

IV. LOAD MANAGEMENT

Load management, also known as demand side management (DSM), is the process of balancing the supply of electricity on the network with the electrical

load by adjusting or controlling the load rather than the power station output. This can be achieved by direct intervention of the utility in real time, by the use of frequency sensitive relays triggering the circuit breakers (ripple control), by time clocks, or by using special tariffs to influence consumer behaviour. Load management allows utilities to reduce demand for electricity during peak usage times (peak shaving), which can, in turn, reduce costs by eliminating the need for peaking power plants. In addition, some peaking power plants can take more than an hour to bring on-line which makes load management even more critical should a plant go off-line unexpectedly for example. Load management can also help reduce harmful emissions, since peaking plants or backup generators are often dirtier and less efficient than base load power plants. New load-management technologies are constantly under development both by private industry and public entities [3].

4.1 OPTIMIZATION OF LOADS

Major component of the domestic loads consists of AC due to its high power consumption. The objective function is to minimize energy costs with constraints on room temperatures. The energy cost is based on the AC status, that is, no cost when the AC status is off ($U = 0$) and market cost if the AC status is on ($U = 1$). The problem statement for scheduling AC is given as following:

Minimize Cost as a function of Normal Price

$$Z(t) = \min \int_{t=1}^{t=n} [(S_n(t) \cdot P(t) \cdot D(t) \cdot U(t))] dt$$

Minimize Cost as a function of Spike Price

$$Z_s(t) = \min \int_{t=1}^{t=n} (S_s(t) \cdot P(t) \cdot D(t) \cdot U(t)) dt$$

Subject to constraints:

$$\frac{dT}{dt} = \frac{Q \cdot A \cdot (T_o(t) - T(t))}{H} - \frac{B \cdot U(t)}{H}$$

$S_n(t)$: Normal Price

$P(t)$: Power Rating of the AC

$D(t)$: Duration of Operation

$U(t)$: AC Status

$S_s(t)$: Spike Price

$T_o(t)$: Outside Temperature

$T(t)$: Room Temperature

The assumptions taken to solve this problem are:

- A single day is divided into 24 segments of 1 hour each.
- Final temperature for a single segment will be the initial temperature for the next segment.
- Outside temperature doesn't change for a specific segment.
- AC Status can only take binary input (0 for OFF and 1 for ON).
- AC (AC Status=0) is considered turned off before the application of our system.
- The temperature of the room is constant at every point.
- Heat transfer from other materials in the room (except air) are neglected as they are considered to be bad conductor of heat e.g. wooden materials

CONDITION-I

For simplicity, we have considered inside temperature to be constant for an interval of 1 hour. The value of inside temperature outside temperature and the ac status gets updated after an interval of 1 hour

CONDITION-II

In this condition, we have considered a more practical case i.e., we have taken the inside temperature to be a continuous function of time. But the value of outside temperature and the ac status gets updated after an interval of 1 hour.

Pre-cooling is a method to reduce the room temperature in advance of a possible spike. This method is considered to be effective because it can minimize energy costs and can keep room temperatures comfortable for the consumer. However, pre-cooling is only undertaken when there is a substantial risk of a price spike because it costs a lot and the spike may not always occur on the system. However, while applying this method is expensive, it is more efficient than switching on the AC at all times during the critical time. This pre-cooling method provides a better option to optimize the price. When both the spike status is high and AC status is on, this algorithm switches off the AC during that period but switches it on before that i.e., pre-cools the room depending upon the price

V. CONCLUSIONS

In this project, the proposed consumer DSR model that aims to allow consumers to proactively manage air-conditioning peak electricity demand for every period based on the electricity market price. The model is applicable for both residential and commercial consumers in order to address fluctuating energy prices by optimizing energy costs for air-conditioning. This model indicates that the outside temperature, starting temperature of the spike and the probability of a price spike have a significant impact on defining the market cost of the spike and total market cost. The proposed model can assist the consumer to optimize the energy cost for air conditioning to meet a spike and spike probability cases. As a result, the energy costs are minimized. In addition, the pre-cooling method should be applied to avoid high electricity prices at critical times. However, pre-cooling is only undertaken when there is a substantial risk of a price spike. When there is a spike in price and the AC is switched on, instead of cooling the room in the spike price interval, the room is cooled before it depending upon the pricing. Depending upon this variation in AC status the price of electricity consumed is calculated. Without precooling, the price is found to be 221. With the application of pre-cooling concept, the AC status gets changed and the cost is found to be 49.4. Then the total savings for the day i.e. the difference in price before and after pre-cooling is found. In our case, it is found to be 171.6

REFERENCES

- [1] Marwan Marwan, Gerald Ledwich, Arindam Ghosh, "Demand-side response model to avoid spike of electricity price", Journal of Process Control Volume 24, Issue 6, June 2014.
- [2] Queensland Government, Queensland Energy Management Plan, Department of Employment Economic Development and Innovation, Queensland Government, Brisbane, 2011.
- [3] S. Widergren, C. Marinovici, T. Berliner, and A. Graves, "Real-time pricing demand response in operations," in Proc. IEEE PES Gen. Meeting, San Diego, CA, USA, Jul. 2012, pp. 1-5.

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Smart Rapple Android Application

Abstract: In this fast moving world, people are always in rush. Sometimes it happens that people misplace or lose the thing, and one cannot easily afford losing the things like mobile. In this work the design of an android application is presented that makes it easier for the user to find the lost device with the help of the contact list of user. The app also has an additional feature of providing a no disturbance mode to the user and helps in making wise decisions of answering the calls in this no disturb mode.

Keywords: Android Application

I. INTRODUCTION

The main goal of the presented app - "Smart Rapple" is to help the users, who usually are so busy in their work that they often loose their devices by keeping it somewhere. The app will contain contact number of some peer groups (that can be friends, family members etc) given by the user. Whenever the device is lost, and when anyone among the peer group will send a specially formatted SMS to the user's device, the phone will ring even if it's in silent mode. If the device call is not in reach of the user then another SMS from the same member will lead to automatically sending of GPS location of that phone to that peer group member. So this application will help user to find their phone by ringing the silent phone or by getting the GPS location, when the device is not in reachable mode. SIM change notification receiver is another feature that sends email to user when the registered SIM has been removed from the device and a new SIM is registered. Also, the user can set a no-disturbance mode under which the device will become silent during a particular time period/schedule or by accessing the GPS current location. The application has a decision making capability during no-disturbance-mode to understand weather the phone call is emergency or not, accordingly it will notify the device owner [1].

II. FEATURES

The Smart Rapple supports features such as security for lost or misplaced device, SIM change notification and no-disturbance-mode. The use case diagram for this app is presented in figure (1) with all supported features.

A. SECURITY FOR LOST OR MISPLACED DEVICE

When the device is misplaced or it's not in reachable range, either a Ringer codeword or a GPS codeword can be used. A Ringer codeword is a keyword that user has defined within application. When user's loses their mobile

within a reachable range but unable to locate it, a friend may help user by sending a simple text messages (called Ringer codeword) that will make user's mobile ringing. A GPS codeword is a keyword that user has defined within the application. When a trusted user sends this codeword from his/her trusted mobile to user's number as a text message, a p p l i c a t i o n recognizes it and generates a link that can help user to view his/her location on Google Map. This link is sent back to trusted user's mobile so that he/she can locate user's mobile on Map [2].

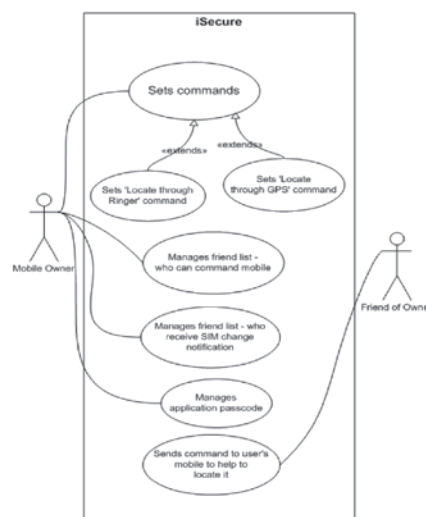


Figure. 1: Use case diagram- security for lost or misplaced device

B. SIM CHANGE NOTIFICATION RECEIVER

SIM change notification receiver sends an email to user when the registered SIM has been removed from the device and the new SIM is inserted. The email contains the new SIM number and the time and date of changing the SIM.

C. NO-DISTURBANCE MODE

First the user will set the location where he/she wants to use no-disturbance mode. When the device will be in that location then it will automatically enter into no-disturbance mode (in silent mode). Also, the user can set a schedule or time where they want to use this mode. When the scheduled time is about to end, this application will alert the user by vibrating the device in a particular pattern. This feature will help the user to make the phone

silent if they forgot. Even in the non disturbance mode priorities can be set from contact list that we don't want to put in this mode like parents or some important official contacts. So that when they will call or message the app informs the user either by vibrating or by ringing. At night time[12pm-6am] when the phone will be in no disturbance mode and if someone is calling repeatedly 3 to 4 times then the app will be alert and will send a message to the caller 'if it is necessary or not' and based on caller's reply our app will behave differently.

III. IMPLEMENTATION ENVIRONMENT

The platform used to design this application is Android studio using MYSQL, SQLite database. SQLite database is used to store temporary information on the user's device, whereas MYSQL is used to store the information permanently on the server.

A. Android Studio

Android Studio is the official Integrated Development Environment (IDE) for Android app development, based on IntelliJ IDEA . On top of IntelliJ's powerful code editor and developer tools, Android Studio offers even more features that enhance the productivity when building Android apps [3].

B. Xampp Server, Mysql, Apache Tomcat

XAMPP is a free and open-source cross-platform web server solution stack package developed by Apache Friends, consisting mainly of the Apache HTTP Server, MariaDB database, and interpreters for scripts written in the PHP and Perl programming languages. Since most actual web server deployments use the same components as XAMPP, it makes transitioning from a local test server to a live server possible. So Xampp server consist of many things such as MySql, Tomcat, Mercury etc. Data is

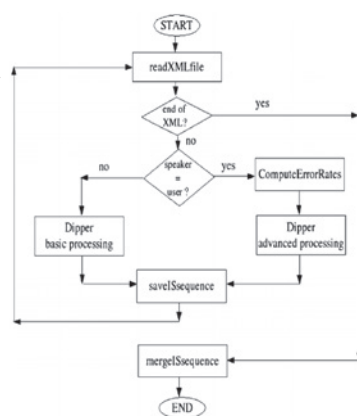


Figure 2: Flow of execution



Figure 3: Flow of execution

fetches from the XML file and is being processed in Java file. Using Asynchronous Task the data is sent to the Tomcat server which passes it to PHP. Then the data is processed and validated in the PHP file and stored in the MySQL database [4]. The flow of execution is presented in Figure (2) and (3).

C. Sqlite

Android Studio is the SQLite is an in-process library that implements a self contained, serverless, zero-configuration, transactional SQL database engine. The code for SQLite is in the public domain and is thus free for use for any purpose, commercial or private. SQLite is the most widely deployed database in the world which includes several high-profile projects. Sqlite is a light weight database that is used when the application is not connected to internet. SQLite is an embedded SQL database engine. Unlike most other SQL databases, SQLite does not have a separate server process. SQLite reads and writes directly to ordinary disk files. A complete SQL database with multiple tables, indices, triggers, and views, is contained in a single disk file.

D. Blue Stack

BlueStacks is an American technology company that produces the BlueStacks App Player and other cloud-based cross-platform products. The BlueStacks App Player is designed to enable Android applications to run on PCs running Microsoft Windows and Apple Macintosh. So this software is used as an emulator during the development of the presented application.

IV. IMPLEMENTATION DETAILS AND RESULTS

In order to use this application, Internet connection and Android Devices are required. The implementation phases are discussed below-

- **Registering the user for the first time:** When the user uses this application for the first time, he/she has to register by giving details such as phone number, name, email address. The user also has to set a password during the registration process. The screen short of the user login page is shown in Figure (4) and Figure (5) shows the sign up phase for new user registration.

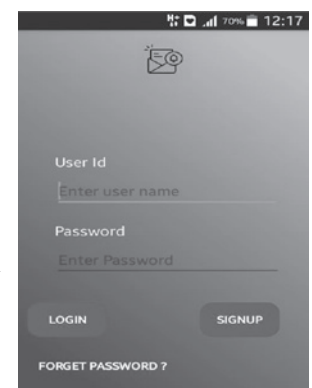


Fig.4: Login and Sign-up Page

- **Email and phone number verification:**

Once the registration is done by validating the email of the user, the phone got verified by sending an OTP to the user's phone.

- **Application main interface:**

After successful login and registration, the app will give a demo like a slide show, telling what all this app is for and its features. The screen short of the dashboard or landing page is shown in figure (6).

- **Whitelist- list of trusted user numbers:**

After a brief demo of the application, the user is asked to create a peer member group by adding the contact numbers from which message (containing the code words) can be sent to the misplaced phone. The screen short of the peer group generation phase is shown in figure (7).

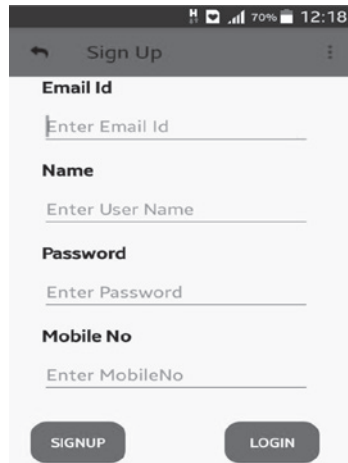


Fig..5: User Registration Page

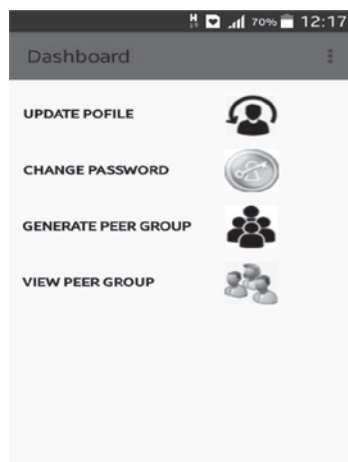


Fig.6: Dashboard or Landing Page

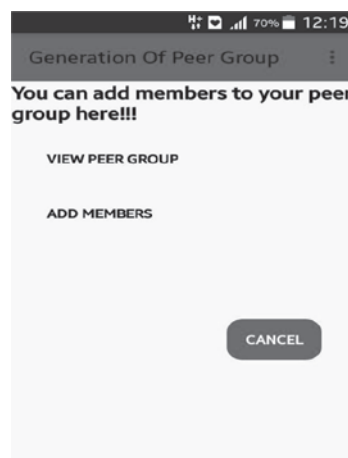


Fig.7: Generation of Peer group member

Code generation:

Code generation is very important so as to know that whether the message send by peer member is a genuine message or not. For authentication purpose only the code received will be checked by the application i.e it will check whether the same code was generated for that

peer member, in order to maintain privacy and security.

- **SIM change notification setup:** The users will be asked to set the default SIM during the startup of the application. If some other SIM card is inserted then an alert message will be send to the device owner's registered email address mentioning the information about the phone gps coordinates as well as the number of the new SIM card .

V. CONCLUSIONS AND FUTURE SCOPE

In this work, some basic features such as security for lost or misplaced device, SIM change notification and no-disturbance-mode are included. Some advancement in futures may be possible for better features and better user experience. The model may be enhanced by using some machine learning techniques to make a decision whether the phone call will be answered or not when it is in no-disturb-mode. Advance controls may be used to add or remove text fields as per user's need. Also, application may allow user to fetch contact from contact list and to select accordingly. This app may be extended to make use of internet to allow the device to be located through another device by trusted users (already registered with application) and to track movements of user's device.

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REFERENCES

- [1] Android app development, developers.google.com/training.
- [2] Security for lost or misplaced device by 100project.org.
- [3] Android login and registration using Php, mysql and SQLite Database tutorial, www.androidtutorialshub.com/android-login-and-register-with-sqlite-database-tutorial/
- [4] Material Design for android for designing purpose, <https://developer.android.com/guide/topics/ui/look-and-feel/>

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Performance Analysis of Indoor Visible Light Communication System

Abstract: Now-a-days, the data demand is increasing exponentially but due to the limited availability of the radio spectrum, alternatives will be necessary to accommodate the needs of wire-less communication systems. One of the alternatives is visible light communication. Here LEDs are used for wireless communication as well as illumination. White LEDs are mostly preferred over the existing incandescent light. A simulation program for indoor visible light communication environment is reported based on MATLAB. The program considers the positions of the transmitter, receiver and the channel between transmitter and receiver. Using the simulation program, the distribution of power is analyzed at bottom surface. In the analysis of the distribution of power, the performance of the system is enhanced by using holographic light shaping diffusers (LSD) for different angles which results in the increment of range and uniform distribution of power. The simulation results show that more uniform optical power distribution can be achieved using the hexagonal geometry with a 30° holographic LSD diffuser compared to no LSD.

I. INTRODUCTION

LEDs are being widely used as sources in indoor optical wireless communication (OWC) links for local area network (LAN). They offer numerous advantages compared with the conventional radio frequency (RF) systems such as offering a huge band width a secure links as rays cannot penetrate through walls or opaque objects etc. LED is more advantageous than the existing incandescent in terms of long life expectancy, high tolerance to humidity, low power consumption, and minimal heat generation lighting. LED is used in full colour displays, traffic signals, and many other means of illumination. By mixing three primary colours (red, green and blue), we can produce white. This white LED is considered as a strong candidate for the future lighting technology. Compared with conventional lighting methods, white LED has lower power consumption and lower voltage, longer lifetime, smaller size, and cooler operation. Our group has proposed an optical wireless communication system that employing white LEDs for indoors wireless networks. In this system, LED is not only used for illumination but also for communication device [1, 2]. The common link configurations for indoor OWC system is line-of-sight (LOS) as it offers a much higher channel capacity, a higher data rate and a longer range. To achieve higher data rates as well as a wider coverage area, a cellular system is preferred. In this paper, we have analyse models for rectangular shapes with and without LSD. In order to increase the cell coverage area with a uniform power distribution light shaping diffuser (LSDs) of different angles are employed.

The rest of the paper is organized as follow. In section 2, characteristics of the transmitter, diffuser, channel and receiver are described. In section 3, the experiment work is shown followed by results and discussion. Finally, the conclusion is given in the last section IV.

II. SYSTEM DESCRIPTION

A.SYSTEM OVERVIEW

The cellular indoor VLC (Visible Light Communication) system is shown in Fig.1. LEDs are used both for illumination as well as communications. LEDs are used as the transmitters and are connected to the ceiling. Communications for the entire room is covered by four LEDs, each of which has a wide divergence angle. At the receiving end, the optical receivers, mounted on a mobile terminal, has a dedicated FOV of 30° to ensure

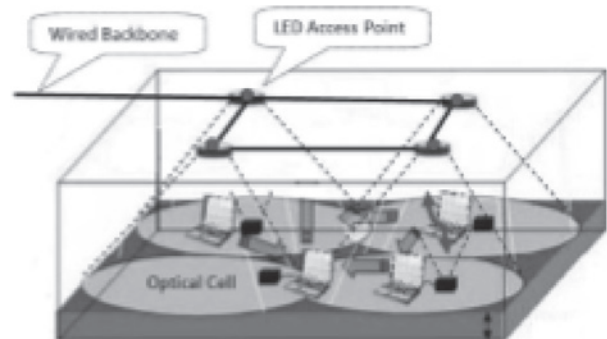


Fig. 1: Proposed indoor VLC system

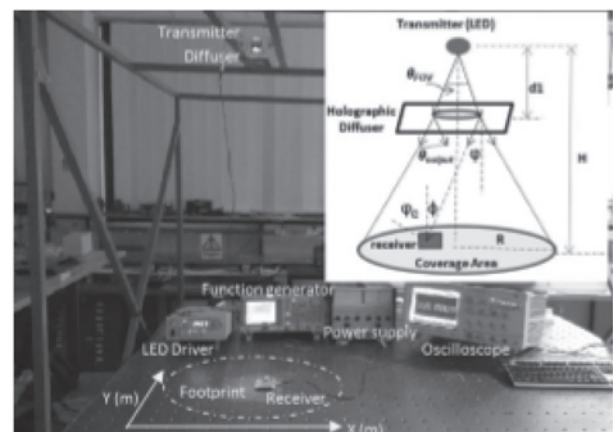


Fig. 2: Practical setup of indoor VLC system

connectivity. In addition the suitable modulation scheme can also be adopted to improve the overall system capacity [3].

Fig. 2 shows the proposed practical cellular indoor VLC link. The metallic frame has a dimension of $1.8 \times 1.5 \times 1$ m³, which is divided into four compartments (or cells). Each cell consists of an LED transmitter, a diffuser and an optical receiver. The separation between the source and receiver is 1 m.

B. TRANSMITTER

LEDs, with no light shaping lenses, can be essentially considered as the source. In many applications, there are requirements for specific radiation distributions to ensure a full coverage and an optimum performance. In such cases optical beam shaping lenses are used at the transmitter. Here the light source positioned at the centre of a cell is composed of an LED and an optical lens. With the transmitter's FWHM of 7° . To achieve a wider coverage area with a uniform radiation distribution pattern, a holographic LSD (10, 20° and 30°) is employed [4, 5].

C. HOLOGRAPHIC LSD

Using the holographic LSD, the effective divergence angle of the transmitter can be extended and is given by:

$$\theta_{\text{output}} = \sqrt{\theta_{\text{FOV}}^2 + \theta_{\text{LSD}}^2} \quad \dots\dots\dots(1)$$

Where θ_{output} is the effective output angle
Where θ_{FOV} is the FWHM angle of source
 θ_{LSD} is the divergence angle of LSD.

The hologram LSD is a two-level diffractive element [6, 7]. In order to simplify calculation of the beam intensity through the holographic LSD, we have divided the LSD into an array of 'pixels' and the intensity of light can be considered uniform after passing through the single

'pixel'. Finally, the overall coverage area is could be the sum of individual footprints per pixel as shown in Fig. 3.

D. OPTICAL WIRELESS CHANNEL

Considering the LOS configuration and assuming no optical filter and optical concentrator are used, the LOS channel DC gain is given by:

$$H(0) = \begin{cases} \frac{(m+1)A}{2\pi D_d^2} \cos^m(\varnothing) \cos(\varphi), & 0 < \varphi < \varphi_c \\ 0, & \varphi > \varphi_c \end{cases} \quad \dots\dots\dots(2)$$

where A is the photodetector surface area, $\varnothing$ is the incidence angle, φ is irradiance angle, φ_c is the FOV (field of view) at the receiver and, D_d is the distance between transmitter and receiver, $m = -\ln 2 / \ln(\cos \varnothing_{1/2})$ is the order of Lambertian radiant which is related to the transmitter semiangle $\varnothing_{1/2}$. The order m of the LED which we used is 110. The received power is given by:

$$P_r = P_t \times H(0) \quad \dots\dots\dots(3)$$

Where

P_t is the Optical transmitted power of LED

P_r is the Optical received power on the receiving plane

E. RECEIVER

This receiver consists of PIN junction photodetector and a trans-impedance amplifier. The specifications for the receiver are given in Table-1 below

Table-1: Specification for indoor VLC system

PARAMETERS	VALUES
LED working wavelength	455 nm
LED output power	40 mw
Diffuser	LSD 10°,20°and 30°
Channel distance	1m
Lambertian order of LED	110
Field of view	14°

III.RESULTS

We have used Matlab to simulate the optical power distribution of the indoor cellular OWC system. Using Eqs. (2) and (3), the normalized power distribution for a single transmitter is illustrated in Fig. 4. Fig. 5(a) represents the power distribution for four transmitters and Fig. 5(b) is the contour of the power density at the receiving plane. It is seen that most of the power is concentrated near the centre of each cell and goes on decreasing sharply towards the cell edges. Fig. 5(b) is defined as the contour plot of Fig. 5(a). The middle part of the contour is defined as the no coverage area or the 'dead zones' with no optical illumination. Similarly,

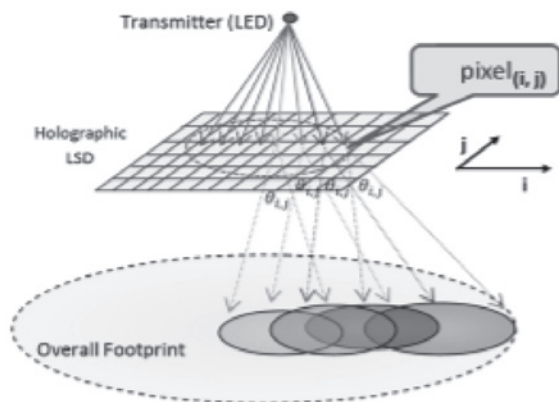


Fig.3: Multiple beam profiles after holographic LSD

power distribution for seven transmitters is shown in Fig. 6(a) and its contour plot in Fig. 6(b).

A. PRACTICAL MEASUREMENTS

Fig. 7 gives the optical power distributions with and without holographic LSD for a single cell configuration. The power density is more uniform when larger angle LSDs are used. Comparing the power density simulation without a holographic LSD with that of 30° holographic LSD(Figs. 7(a) and 7(d)),it can be seen that there is a wide increase in the coverage area. Fig. 8(a) represents the normalized power distribution at the receiving plane using 30° LSD for four transmitters and its corresponding contour is shown in Fig. 8(b).

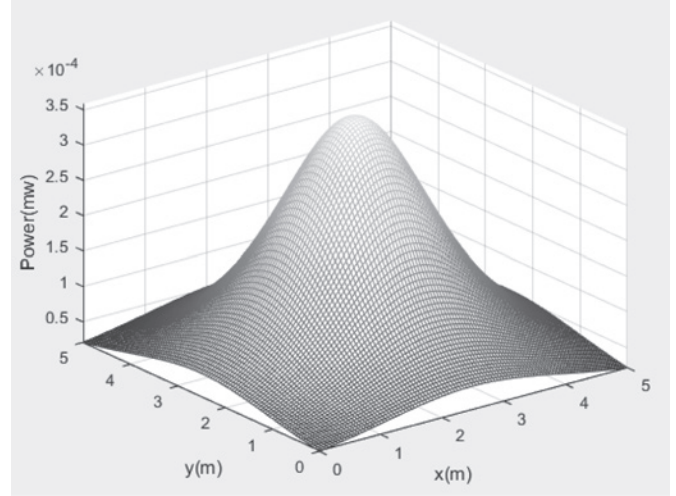


Fig.4: Power distribution for single transmitter

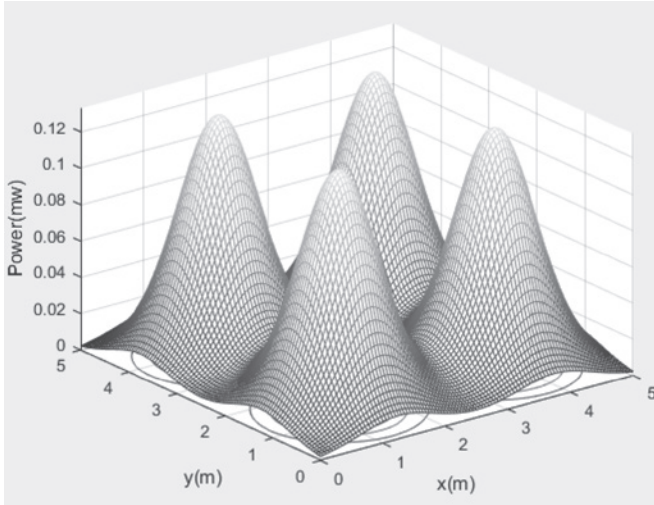


Fig.5(a): Power distribution for four transmitters.

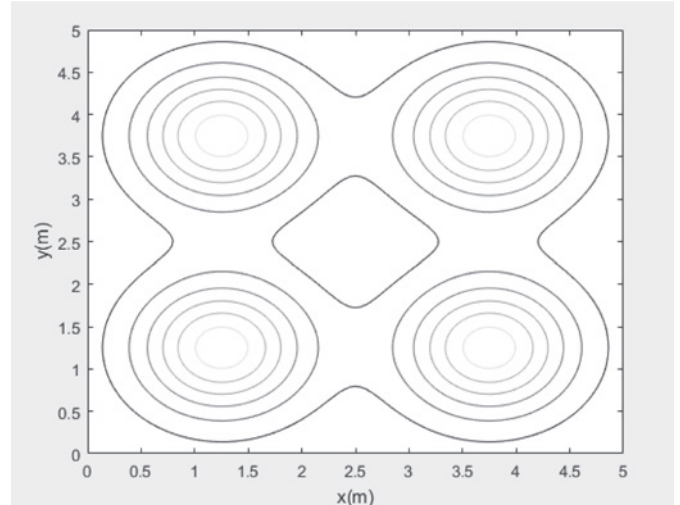


Fig.5(b): Contour plot for four transmitters.

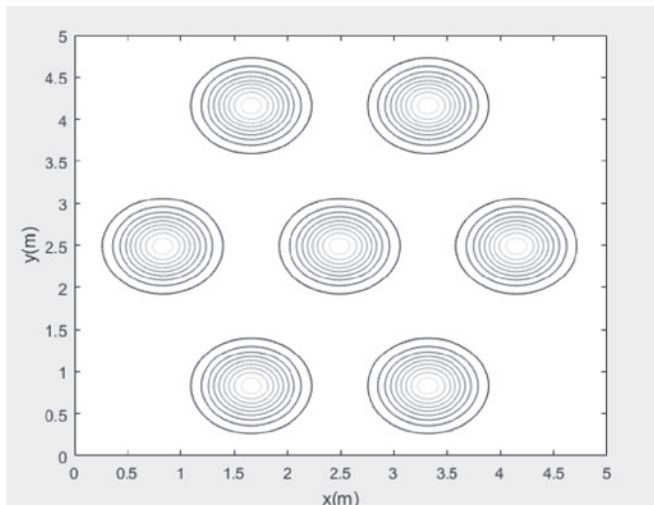


Fig.6(a): Power distribution for seven transmitters

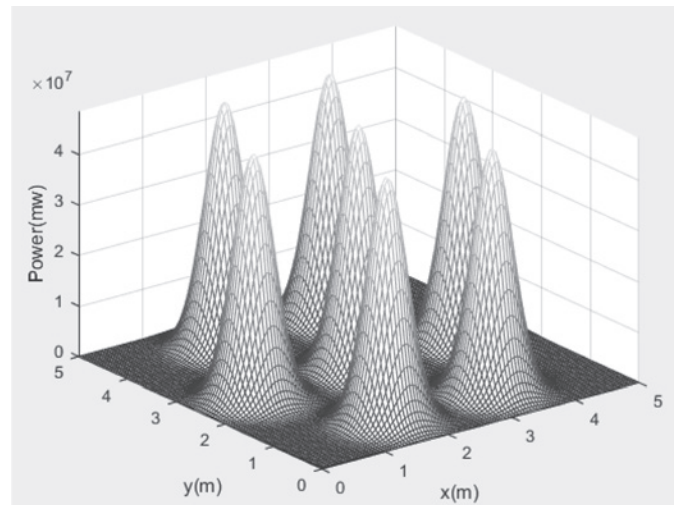


Fig.6(b): Contour plot for seven transmitters.

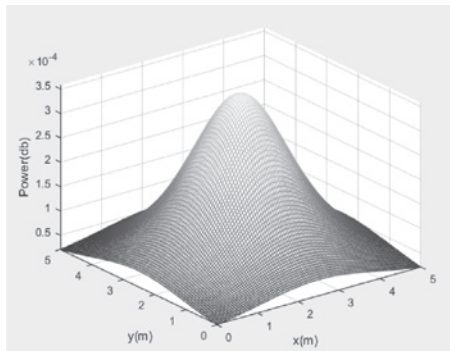


Fig 7(a):

Distribution of received power without LSD

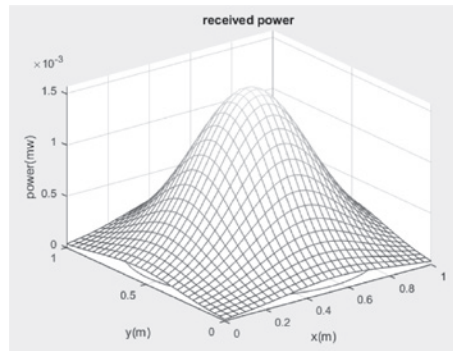


Fig.7(b):

Distribution of received power with 10° LSD

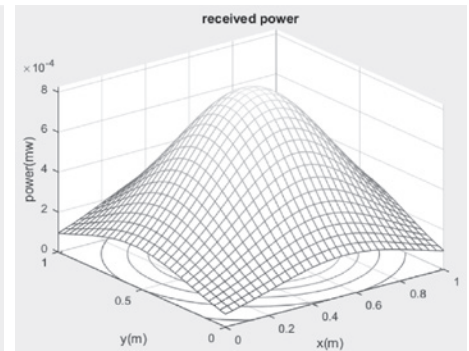


Fig.7(c):

Distribution of received power with 20° LSD

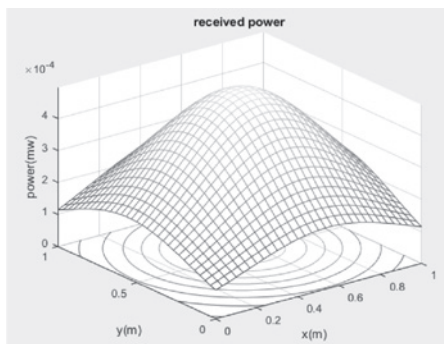


Fig.7(d): Distribution of received power with 30° LSD

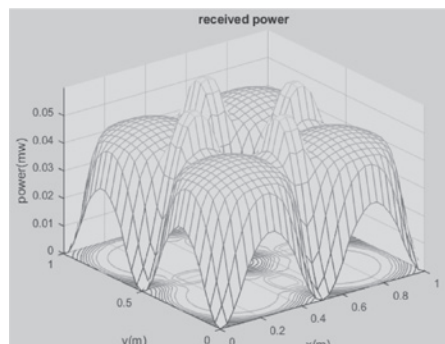


Fig.8(a): Normalized power distribution at the receiving plane using 30° LSD

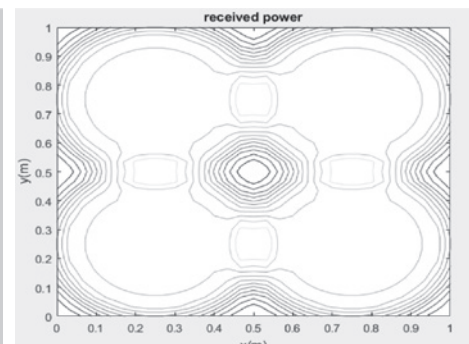


Fig.8(b): Contour plot for 30° LSD

IV.CONCLUSION

In this paper, we have modelled, simulated and measured the received power distributions for a practical indoor VLC using a holographic diffuser. The analysis showed that, using holographic LSDs with different angles, a uniform power distribution can be obtained thus increasing the coverage area in indoor VLC environment.

V.REFERENCES

- [1] H.L.Minh,et al, "100-Mb/s NRZ visible light communication using a post-equalized white LED," IEEE Photonics Technology Letters, vol. 21, no.15, August 1, 2009.
- [2] T. Komine, J.H. Lee, S. Haruyama and M. Nakagawa, "Adaptive equalization system for visible light wireless communication utilizing multiple white LED lighting equipment," IEEE Trans. on wireless communications, vol.8, no.6, pp.1536-1276, 2009.
- [3] Z. Feng, G. Papageorgiou, Q. Gao, S. V. Krishnamurthy, "Performance of Visible Light Communications with Dimming Controls," IEEE Commun. Syst. 2014.
- [4] A. Sivabalan and I. John, "Improved power distribution in diffuse Indoor Optical Wireless systems employing multiple transmitter configurations," Opt. Quantum Electron. 38, 711-725 2006.
- [5] T. Komine, M. Nakagawa "Fundamental Analysis for Visible Light communication system using LED light," IEEE Trans. Consum. Electron. 50,100-107,2004.
- [6] B. Carruthers, S. M. Carroll, "Statistical impulse response models for indoor optical wireless channels," Int. J. Commun. Syst. 18,267-284 2005.
- [7] Luminit, "Light Shaping Diffusers", http://www.luminitco.com/files/u1/Technical_Data_Sheet_rev_9-2810.pdf(Accessed: 15Jan 2011)

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Dept. of ECE

Voice Assisted Helpdesk System using Voice API

Abstract: It is often difficult, for a help desk team of an organization to manage large crowd that occurs occasionally, at the help desk. For example, during the new academic year, the college's help desk/ information desk has to face a large number of queries from parents, guardians and students. Hence, during the admission time, it becomes difficult for the help desk team to manage the crowd making a need of some smart technology that would resolve the problem of traditional help desk system. This work presents development of a Voice Assisted Help Desk System using Alexa Voice Service (AVS) by Amazon. The system also stores the frequently asked questions to provide quick answers.

Keywords: Amazon Alexa, Alexa Voice Service, Voice Assisted System, Helpdesk System

I. INTRODUCTION

In many areas, there are various forms of help desk services available to provide help to users. In conventional help desk services, groups of human experts who differ in their knowledge and expertise try to solve the customer's problems. Their roles are determined according to their problem solving ability and the degree of the problem difficulty. Thus, to provide help desk service of high quality, the availability of high level expert is crucial. However, the number of such high level experts is limited and the demand for automated help desk system is increasing. An expert system approach is a feasible solution. In addition to this, worldwide computer networks such as the internet are becoming the major communication media. The rapid communication enabled by such computer network has also increased the demand for effective maintenance of the knowledge for the helpdesk services [1].

A voice assistant is a digital assistant that uses voice recognition, natural language processing and speech synthesis to provide aid to users through phones and voice recognition applications. Voice assistants are used in help and service phone lines, smart phones and other places to assist users with tasks, including listening to an audio book, requesting information, entering search queries, making reservations, adding items to a shopping list, performing mathematical calculations, playing music, etc.

The presented Help Desk System uses Alexa Voice Service (AVS) by Amazon. The system is designed in such a way that, it stores the Frequently Asked Questions (FAQs) and provides the answers to the different queries most commonly asked at the help desks. This type of response system holds immense importance as it lessens the workload of the people at the help desk by responding to the queries in a more smart way. It can be further used in places like banks, airports, hospital, railway stations

etc. The technologies used here are: Amazon Voice API and Amazon Alexa Devices.

II. AMAZON ECHO

Amazon Echo, the voice-enabled speaker from Amazon allows to get things done by using voice commands. The brain behind Echo and other Amazon voice-enabled devices like Echo Show, Echo Dot, and Amazon Tap is Alexa — the cloud based service that handles the speech recognition, machine learning, and natural language understanding for all Alexa enabled devices. Alexa provides a set of built-in capabilities, referred to as skills, that define how you can interact with the device. For example, Alexa's built-in skills include playing music, reading the news, getting a weather forecast, and querying Wikipedia. In addition to these built-in skills, you can program custom skills by using the Alexa Skills Kit (ASK). An Alexa user can access these new abilities by asking Alexa questions or making requests. It connects to Alexa – a cloud based voice service to play music, make calls, check weather and news, set alarms, control smart home devices, and much more. It has seven microphones, beam-forming technology, and noise cancellation, Echo Dot hears you from any direction-even in noisy environments or while playing music [2].

III. BUILDING AN ALEXA SKILL

All skills, like web or mobile applications, contain two parts: Interaction Model (the frontend) and the Hosted Service (the backend). The Interaction Model is much like the graphical user interface of a mobile app, Alexa skills needs a Voice User Interface (VUI). The Hosted Service (backend) contains the programming logic, hosted on the internet that responds to a user's requests. The overview of the front end interaction model and back end hosted service is presented in Figure (1) [3].

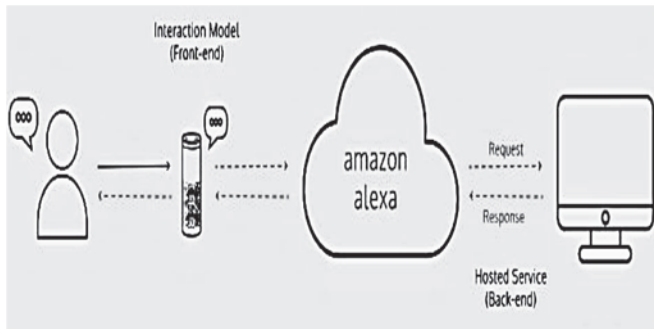


Fig.1: Overview of Alexa Skill-Interaction model and hosted service

IV. ALEXA SKILL AND ALEXA SKILL KIT (ASK)

Alexa is Amazon’s voice service and the brain behind tens of millions of devices like the Echo family of devices, Fire TV, Fire Tablet, and third-party products with built-in access to Alexa. Alexa provides capabilities, or skills, that enable customers to create a more personalized experience. There are now tens of thousands of cloud-based skills from brands like The Ellen DeGeneres Show, Universal Studios, and Uber as well as individual designers and developers. The Alexa Skills Kit (ASK) is a collection of self-service APIs, tools, documentation, and code samples that makes it fast and easy for you to add skills to Alexa. ASK enables designers, developers, and brands to build engaging skills and reach customers through tens of millions of Alexa-enabled devices. With ASK, one can leverage Amazon’s knowledge and pioneering work in the field of voice design [4].

V. ALEXA VOICE SERVICE

The Alexa Voice Service (AVS) enables to access cloud-based Alexa capabilities with the support of AVS APIs, hardware kits, software tools, and documentation. It simplifies building voice-forward products by handling complex speech recognition and natural language understanding in the cloud, reducing the development costs and accelerating the time. Best of all, regular Alexa updates bring new features to your product and add support for a growing assortment of compatible smart home devices.

VI. CONNECTION WITH ALEXA AND ITS IMPLEMENTATION

A. Test Simulator

When we say “Hello”, our speech audio was sent to Alexa in the cloud. Alexa used Automatic Speech Recognition (ASR), and Natural Language Understanding (NLU) technologies to parse our request and figured out that we want to talk to the Codecademy skill. It then sent a

request (in the form of a JSON object), as shown in the Lambda Request and Lambda Response. The requests include the intent to our Lambda function. Our Lambda function received the request and responded to Alexa with another JSON object, which included the output speech in text format. Alexa converted this output speech from text to speech and returned the audio to the device where it is played back. The overview of the test simulation process is presented in Figure (2).

B. Intents and Utterances

Each intent defines a specific behavior, like buttons on a web page. An intent takes user input and executes some code based on it. Some sample utterances are- Hello, how are you, howdy, whats up. These sample utterances help Alexa connect the intents to phrases spoken by the user. In this case, these sample utterances will help Alexa map the spoken user input to our “HelloIntent”. The mapping is shown in Figure (3).

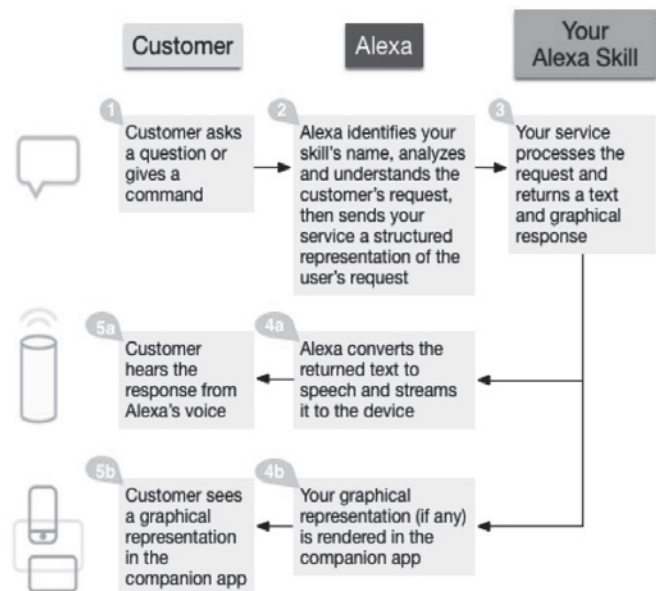


Figure.2: Overview of test simulator

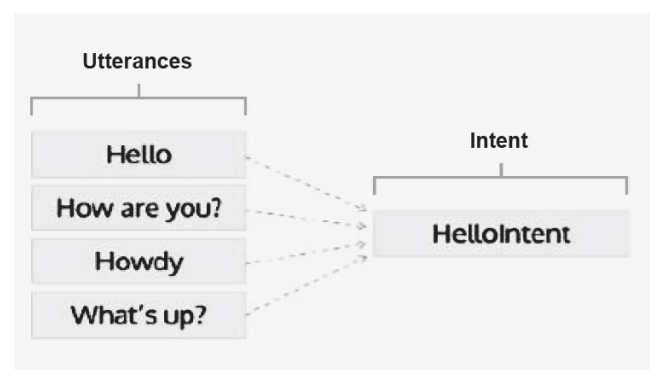


Figure. 3: Mapping of sample utterances to HelloIntent

C. Alexa Developer Console

At first the interaction model called the Voice User Interface (VUI), a voice/speech platform that enables human interaction with computers is created using the Alexa Developer Console. For this purpose, first an Amazon Developer Account has to be created. Then the VUI can be build by following the below steps-

- Create a Skill by selecting Skill builder
- Set the Skill Invocation name
- Create the Interaction model and add sample utterances.
- Save and Build Model.

This VUI can then be linked to the backend programming logic that produces a response to the user.

D. Connect Lambda Function

After the interaction model (the frontend) is created, the programming logic (the backend) can be connected to it. For this, AWS Lambda function is used. For Alexa to be able to talk to the backend, it needs access to the internet. Lambda is a server-less computer service from Amazon Web Services (AWS) that runs the code in response to events. For our Alexa skill, the Lambda function is triggered when the new skill is started. To connect the frontend to a Lambda function (the backend) its Amazon Resource Name (ARN) is needed to be provided, which is a unique identifier that represents the Lambda function. Then the frontend can be connected to a Lambda function (the backend) using its Amazon Resource Name (ARN). This is shown in Figure (4).

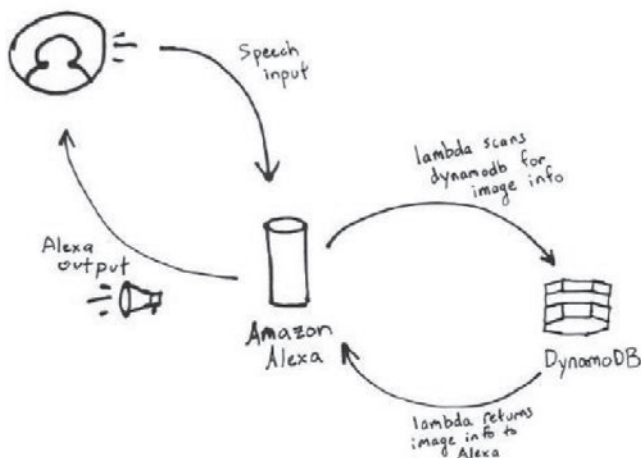


Figure. 4: Connectivity with lambda function

E. Testing with Echoism.io

There are a few ways to test the created skill. The first one is the Amazon Echo Simulator - Echosim.io, a browser-based interface to Alexa. Alexa used Automatic Speech Recognition (ASR), and Natural Language Understanding (NLU) technologies to parse the request.

VII. CONCLUSIONS AND FUTURE SCOPE

The presented Help Desk System uses Alexa Voice Service (AVS) by Amazon. The system is designed in such a way that, it has the Frequently Asked Questions (FAQs) stored in it and AVS provides the automatic speech recognition, natural language understanding and text-to-speech engines. This type of response system holds immense importance as it lessens the workload of the people at the help desk by responding to the queries in a more smart way. There are a number of possible directions where work in this project may further be continued.

It can further be enhanced to be used at places like banks, hospitals, post offices, Airports, Railway Stations etc. Alexa offers a glimpse into the future – a world where artificial intelligence has the capacity to entertain, inform, and control the devices and services we use every day.

ACKNOWLEDGEMENT

We express our sincere gratitude to our project guide Mr. Gopal Krushna Sahu of IT department for his guidance and encouragement in carrying out this research work.

REFERENCES

- [1] <https://www.codecademy.com/learn/learn-alexa>
- [2] <https://developer.amazon.com/alexa-voice-service/learn>
- [3] <https://www.hackster.io/patriot-iot/alexa-controlled-photon-project-without-alexa-coding-f47d84>
- [4] <https://www.makeuseof.com/tag/creative-uses-for-amazon-echo-and-alexa/>

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OPTICAL LOCATION OF TCSC DEVICE IN OPF OF TRANSMISSION SYSTEM

Abstract: In a competitive power market, the task of an independent system operator (ISO) is to ensure full dispatch of the contracted power. However, if it causes the line flows exceeding their limits, thus threatening the system security, the ISO makes decision on the curtailment of the contracted power. Role of flexible AC transmission system (FACTS) devices on reducing the transmission congestion and curtailment of the contracted power has also been studied. Study has been conducted on modified IEEE-14 bus system. In this paper, intelligent technique PARTICLE SWARM OPTIMISATION algorithm (PSO) is being used. Now, the PSO algorithm is utilized to identify the optimal location of FACTS device i.e TCSC. The proposed method is implemented in MATLAB platform and tested with the IEEE 14 bus and then further analysed.

Keywords: PSO, OPF, FACTS devices, optimal power, TCSC

I. INTRODUCTION

In a regulated power market, the scheduling of generation is done following a centralized unit commitment and economic dispatch algorithm, which also ensures that all transmission flow limits are satisfied. Under a competitive environment, generation is not centrally dispatched but, rather, it is based primarily on the transaction agreed to in the open market. In the market situation, the difficulty lies in ensuring the negotiated transactions, particularly under congestion. The Optimal power flow (OPF) main objective is to make the generator as well as the distribution company run on profit. There are both equality and inequality constraints [1]. The Generator MW outputs, transformer taps and the phase angles include the accessible controls of the OPF [3]. The non-linear approach applying the Newton's Raphson method is one of the solution techniques of the OPF which addresses the marginal losses, though comparatively sluggish and faced with the issue of deciding the binding parameters [4]. Whereas the linear programming approach is quick and effective in deciding the binding constraints, it faces the trivial losses and is effectively employed in the power world simulator. The Congestion management is one of the essential motives of the ISO which realizes it through market based techniques in feasible markets for cutting down Congestion problem [2]. Whenever the physical or operational constraints in a transmission network become active, the system is said to be in a state of congestion. The possible limits that may be hit in case of congestion are: line thermal limits, transformer emergency ratings, bus voltage limits, transient or oscillatory stability, etc. These limits constrain the amount of electric power that can be transmitted between two locations through a transmission network. The market based techniques are effectively categorized into various categories such

re-dispatching based systems, constraint of favoured schedules along with re-dispatch, safety constrained OPF, area based technique with sensitivity features, and the importance of FACTS to manage communication Congestion as it helps in reduction of the Congestion expenses.

II. CONGESTION

Whenever the physical or operational constraints in a transmission network become active, the system is said to be in a state of congestion. The possible limits that may be hit in case of congestion are: line thermal limits, transformer emergency ratings, bus voltage limits, transient or oscillatory stability, etc. These limits constrain the amount of electric power that can be transmitted between two locations through a transmission network. Flows should not be allowed to increase to levels where a contingency would cause the network to collapse because of voltage instability, etc. The peculiar characteristics associated with electrical power prevent its direct comparison with other marketable commodities. First, electrical energy cannot be stored in large chunks. In other words, the demand of electric power has to be satisfied on a real time basis.

III. DEREGULATION MARKET

Electric deregulation is the process of changing rules and regulations that control the electric industry to provide customers the choice of electricity suppliers who are either retailers or traders by allowing competition. Deregulation improves the economic efficiency of the production and use of electricity. Due to competition in the electric industry, the power prices are likely to come down which benefits the consumers.

The main objectives of the deregulated power market:

- To provide electricity for all reasonable demands.
- To encourage the competition in the generation and supply of electricity.
- To improve the continuity of supply and the quality of services.
- To promote efficiency and economy of the power system.

The important concepts of deregulation are: 1) Competition 2) Deregulation 3) Open-Access

IV. LOAD FLOW

The main purpose of the load-flow solution is to evaluate the individual phase voltages at all busbars/buses connected to the network corresponding to specified system conditions. As the active and reactive powers, voltage magnitudes, and angles are involved for each bus four independent constraints are required to solve for the above mentioned four unknowns parameters. There are two main types of buses, i.e., load and generator buses. A special type of generator bus is used as reference bus and is named as slack bus. For different types of buses the constraints are different.

The Newton-Raphson approach is the most preferred load flow method because of its various advantages. It has powerful convergence characteristics compared to alternative processes and considerably low computing times are achieved when the sparse network equations are solved by the technique of sparsity-programmed ordered elimination

The admittance matrix is used to write equations for currents entering a power system. Equation (2) is expressed in a polar form, in which J includes bus I

$$I_i = \sum_{j=1}^n |Y_{ij}| |V_j| \angle \theta_{ij} + \delta_j$$

The real and reactive power at bus I is

$$P_i - jQ_i = V_i^* I_i$$

Substituting for I_i in Equation (12) from Equation (13)

$$P_i - jQ_i = |V_i| \angle -\delta_i \sum_{j=1}^n |Y_{ij}| |V_j| \angle \theta_{ij} + \delta_j$$

The real and imaginary parts are separated:

$$P_i = \sum_{j=1}^n |V_i| |V_j| |Y_{ij}| \cos(\theta_{ij} - \delta_i + \delta_j)$$

$$Q_i = \sum_{j=1}^n |V_i| |V_j| |Y_{ij}| \sin(\theta_{ij} - \delta_i + \delta_j)$$

The above Equations constitute a set of non-linear algebraic equations in terms of $|V|$ in per unit and δ in radians. Equations are expanded in Taylor's series about

the initial estimate and neglecting all higher order terms, the following set of linear equations are obtained.

In the above equation, the element of the slack bus variable voltage magnitude and angle are omitted because they are already known. The element of the Jacobian matrix are obtained after partial derivatives of Equations are expressed which gives linearized relationship between small changes in voltage magnitude and voltage angle. The equation can be written in matrix form as

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} J_1 & J_3 \\ J_2 & J_4 \end{bmatrix} \begin{bmatrix} \Delta \delta \\ \Delta |V| \end{bmatrix}$$

The new estimates for bus voltage are

$$\delta_i^{(k+1)} = \delta_i^{(k)} + \Delta \delta_i^{(k)}$$

$$|V_i^{(k+1)}| = |V_i^{(k)}| + \Delta |V_i^{(k)}|$$

V. THYRIETOR CONTROLLED & SERIES CAPACITOR (TCSC)

The basic thyristor- controlled series capacitor scheme, proposed in 1986 by Vithayathil with others as a method of "rapid adjustment of network impedance," is shown in fig.-1. The basic conceptual TCSC module comprises a series capacitor, C , in parallel with thyristor-controlled reactor, L_s , as shown in fig.1. However, a practical TCSC module also includes protective equipment normally installed with series capacitors, as shown in fig.2.

The equivalent impedance, Z_{eq} , of this LC combination is expressed as

$$Z_{eq} = \left(j \frac{1}{\omega C} \right) || (j\omega L) = -j \frac{1}{\omega C - \omega L}$$

The impedance of the FC alone, however, is given by $j/\omega C$.

VI. RELATED WORKS

In the arena of market-based power systems, a particle swarm optimization (PSO)-based algorithm has been brought to limelight by Hajforoosh [3] to perform congestion management by appropriate appointment and placement of one unified power flow controller (UPFC) tool. The ambitious algorithm advocates quadratic smooth bends for generator costs. To augment the accuracy of the version by blending the effects of load difference on the optimization dilemma, a unique load duration curve (LDC) is envisaged. To disseminate the near-optimal GenCos, the revolutionary method configures the employment of the PSO algorithm together with the optimal location and size of UPFC while the Newton Raphson solution drastically cutbacks

the variation of the power flow equations. To analyze the bang of UPFC on the blocking phases of the dependability test system (RTS) 24-bus test system, simulation outcomes were employed. Replication impacts of the brainchild PSO algorithm were additionally assessed with solutions achieved by the traditional sequential quadratic programming (SQP) approach.

Nima Amjady et al. [8] naively advocated an amazing solution technique for the optimal power flow with security constraints (OPF-SC) hassle, which represented an improved edition of the bacterial foraging (BF) approach. The OPF-SC represented a nonlinear programming optimization issue with intricate uneven solution space. The BF was a sophisticated stochastic search approach endowed with superior deployment and local search skills to be on the hunt for the promising regions of the solution space with superior resolution. To enfold the diverse regions the solution space keeping aloof from being caught unawares in the local minima, the search skills and variety of the search functions of the BF were fine-tuned in the innovative improved version of the BF (IBF) exploiting the advantages of the BF. The excellence in execution of the ground-breaking solution strategy to handle the OPF-SC challenge was extensively illustrated with investigation mechanisms.

With an eye on successfully addressing the minor signal oscillations in a multi machine power system, D. Mondal et al. [7] proficiently proposed the PSO for selecting the optimal location and setting the parameters of SVC (Static Var Compensator) and TCSC (Thyristor Controlled Series Compensator) controllers. An earnest endeavour was also made to analyse and contrast the performance of the TCSC controller with that of the SVC with the intent to resolve the trivial signal stability menace. The replications were carried out in a multi machine system for two universal contingencies such as the load increase and transmission line outage to illustrate the relevance of their dream scheme. By deftly employing the Eigen value and time domain response, the adverse impact of the insignificant signal stability investigation was symbolized. It was observed that the TCSC controller emerged incredibly effective when compared with the performance of the SVC even during the elevated loading in finding an appropriate solution to the minimal signal stability predicament.

T. Nireekshana et al. [9] were instrumental in accounting the determination and improvement of Available Transfer Capability (ATC) in the deregulated functioning of the power mechanisms. In their document they investigated the deployment of FACTS devices, such as the SVC and TCSC, to utilize the power transfer transactions in the

course of the usual and contingency scenarios. The ATC was evaluated with the help of the Continuation Power Flow (CPF) approach in respect of the thermal bounds and the voltage profile. The real-code Genetic Algorithm (RGA) was utilized as an optimization mechanism to ascertain the location and regulating constraints of the SVC and TCSC. The technique was experimented on the IEEE 14-bus system and the IEEE 24-bus dependability test mechanism for the usual and diverse contingency cases. Ch Venkaiah et al. [10] have victoriously evolved a novel technique of fuzzy adaptive bacterial foraging (FABF) based congestion management (CM) as a debut by optimal rearrangement of dynamic powers of generators selected in accordance with the generator sensitivity to the jam-packed line. In the novel technique, generators were shortlisted according to their sensitivity to the packed line with a view to employ the generators proficiently and optimal rearrangement of the dynamic powers of the contributing generators was endeavoured by FABF, which was tested on IEEE 30-bus system and Practical Indian 75-bus system and the answers were contrasted with the Simple Bacterial Foraging (SBF) and Particle Swarm Optimization (PSO) algorithms for ascertaining the robustness and effectiveness of congestion management. It was gratifying to note that the FABF was par-excellence in effectively cutting down the overheads of production vis-a-vis SBF and PSO in the case of optimal reschedule of generators to mitigate the zooming congestion in the transmission channel.

PROBLEM FORMULATION

The power balance state of the system depends on the rule of equilibrium among total generation and total load of the system. The system constraints such as, real power of generators, reactive power of the generators and voltage limits are the main factors on which the power balance condition and optimal power flow are depended upon. The power balance equations is as follow,

$$P_{Gi} = P_{Di} + \sum_{y=1}^n |V_x| |V_y| |Y_{xy}| \cos(\theta_{xy} - \delta_x + \delta_y)$$

$$Q_{Gi} = Q_{Di} + \sum_{y=1}^n |V_x| |V_y| |Y_{xy}| \sin(\theta_{xy} - \delta_x + \delta_y)$$

Where, P_{G_x} , Q_{G_x} , P_{D_x} and Q_{D_x} are the real and reactive power inserted at x^{th} bus and the related load demands correspondingly. Y_{xy} and θ_{xy} are the admittance matrix and voltage angle among x^{th} and y^{th} buses. V_x , V_y , δ_x and δ_y are the magnitude and angle of bus x^{th} and y^{th} correspondingly. The

production limits of the generating units are i.e . upper and lower bound which stretches out in between the real limits.

$$P_{G_s}^{\min} \leq P_{G_s} \leq P_{G_s}^{\max}$$

$$Q_{G_s}^{\min} \leq Q_{G_s} \leq Q_{G_s}^{\max}$$

In the paper, the voltage limits, power balance condition, power loss and power flow limits of generators are evaluated. The power loss of the system is evaluated using the following equation,

$$P_L = \sum_{i=1}^N \sum_{j=1}^N \alpha_{ij} (P_i P_j + Q_i Q_j) + \beta_{ij} (Q_i P_j - P_i Q_j)$$

Where,

$$\alpha_{ij} = \frac{r_{ij}}{V_i V_j} (\cos(\delta_i - \delta_j))$$

$$\beta_{ij} = \frac{r_{ij}}{V_i V_j} (\sin(\delta_i - \delta_j))$$

From the above equation, the power loss of the system is assessed.

The TCSC is used in this model, the controllable reactance is integrated in series to the transmission line and the line impedance is altered. With the result, the apparent power going through the line is either perked up to the maximum or scaled down to the minimum depending on the loading condition. Usually, the OPF issue is framed to cut down the fuel cost to the least in respect of the generation. The objective function of fuel cost is incorporated with the inequality constraints of active power bounds of the generator. The quadratic equation of fuel cost is furnished by Equation 1 give below.

$$\text{Fuel cost, } F_c = \sum (a_i + b_i P_{gi} + c_i P_{gi}^2) \$ / hr$$

Where, F_c represents the aggregate fuel cost, a_i , b_i and c_i signify the fuel cost coefficients, P_{gi} symbolizes the active power produced by generator. The equality and inequality constraints are employed for the investigation of the safety optimal power flow with the TCSC. And the generator real power, the voltage magnitude and the reactance of the TCSC are taken as the inequality constraints. A concise account of these constraints is furnished below.

The real power balancing condition is expressed by means of Equation 2 shown below.

$$P_{inj,i} = P_{g,i} - P_{L,i}$$

The reactive power balancing condition is estimated by the following Equation 3.

$$Q_{inj,i} = Q_{g,i} - Q_{L,i}$$

The security constraints representing the active power bounds of the generators are represented by Equation 4 shown below.

$$P_{g,i}^{\min} \leq P_{g,i} \leq P_{g,i}^{\max}$$

By means of the following Equation 5, the voltage magnitude of the i^{th} buses is estimated.

$$V_i^{\min} \leq V_i \leq V_i^{\max}$$

The reactance bounds of the TCSC are expressed by the following Equation 6.

$$-0.7 X_{line} \leq X_{TCSC} \leq 0.2 X_{line}$$

Where, $P_{inj,i}$ represents the real power infused into bus i , $P_{g,i}$ depicts the real power produced by the i^{th} generator, $P_{L,i}$ characterizes the real power of

the i^{th} load bus. Hence, it is highly essential that these two parameters are kept to the least. In this regard, the objective function is expressed by means of the following Relation 14

$$Q_i = \min(P_i)$$

The dependent parameters of the captioned equation are furnished as the input of the proposed technique so as to optimize the best parameters, based on which the optimal location and the capability of the TCSC are calculated.

VIII. PROPOSED METHODOLOGY FOR OPF

Here, an intelligent algorithm is used to solve the optimal power dispatch problem. The intelligent optimising technique is the Particle Swarm Optimisation (PSO) algorithm proposed for reducing the power loss of the system. Initially, the transmission line real and reactive powers, voltage and power losses are calculated in the normal condition using Newton Raphson Method. After that, the transmission congestion is created by randomly loading the transmission line to cross its limits. According to the overloading of transmission line, the power loss, voltages, real and reactive power are measured and place the FACTS devices for controlling the system. We will be using series type of FACTS devices i.e, TCSC is utilized for the reduction of the system loss and minimizing the voltage deviation. The optimal location of FACTS devices is determined by using the above proposed technique. By using this algorithm, the power loss and voltage deviation is reduced and increases the real power of the system. Then the evaluation of the real power variation of the system and calculation of the corresponding output after fixing the FACTS device. Then we evaluate the power loss of the system. Modified IEEE 14 Bus system is shown in Fig-1.

MoM

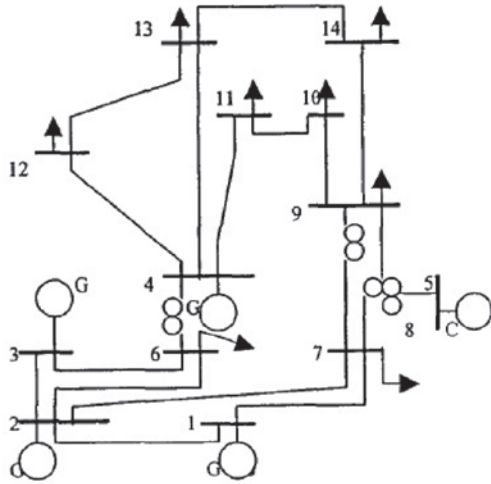


Fig.-1: Modified IEEE 14 bus System.

IX. PSO ALGORITHM FOR OPTIMAL LOCATION OF TCSC

In this topic, the optimal location of TCSC is performed so as to improve the dynamic stability of the power system based on an intelligent technique proposed. This intelligent technique is none other than Particle Swarm Optimisation (PSO) algorithm. The optimal location of the TCSC depend on the security index which are named as the apparent power flow, voltage stability and cost function. When the transmission line is overloaded, the optimal location of the TCSC is determined by the PSO algorithm. Initially, by the IEEE standard benchmark, systems normal power flow and the stability condition are analyzed by using load flow method. Afterwards the loading faults are introduced in the bus system. Then the maximum overload bus is determined by the sorting algorithm where the top five most overloaded bus are sorted in decreasing order. Further PSO algorithm technique is used in order to determine the most favourable location for fixing the TCSC. It is used to recover the normal operating condition and enhance the dynamic stability, as shown in Fig-2.

w^t ... inertia weight; a damping factor, usually decreasing from around 0.9 to around 0.4 during the computation

c_1, c_2 acceleration coefficients; usually between 0 and 4.

Many versions of the particle speed update exist, for example:

$$v_i^{(t+1)} = w^t \cdot v_i^t + c_1 \cdot r_1 (p_i^t - x_i^t) + c_2 \cdot r_2 (l_i^t - x_i^t).$$

The symbols c_1 and c_2 represent random variables with the $C(0,1)$ distribution. The first part of the velocity

formula is called “inertia”, the second one “the cognitive (personal) component”, the third one is “the social (neighborhood) component”.

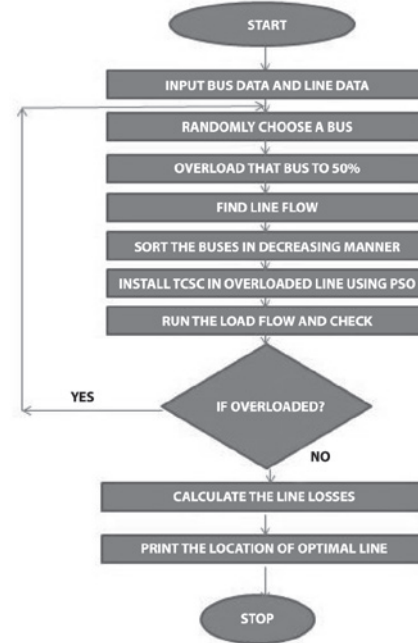


Fig.-2: PSO Algorithm for Optimal Location of TCSC.

FLOWCHART FOR PSO ALGORITHM

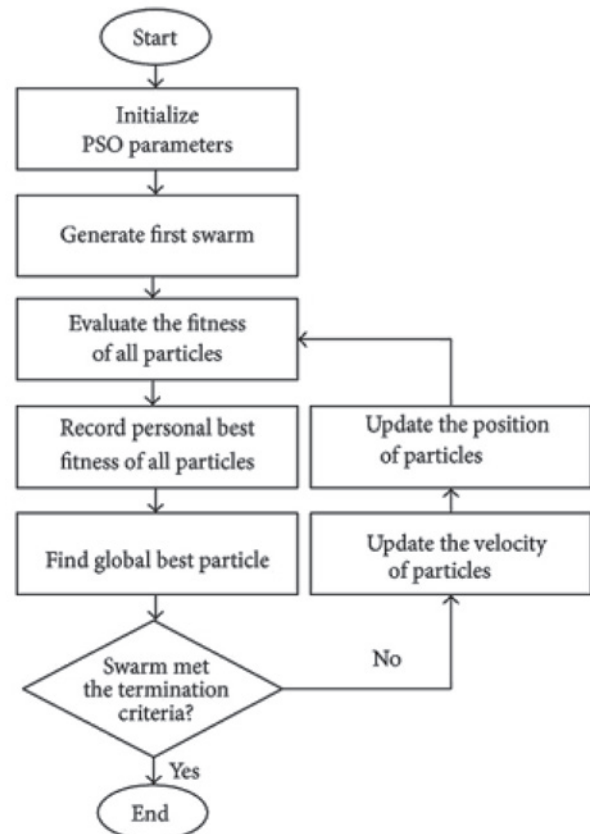


Fig.-3: Flowchart of PSO Algorithm.

RESULTS & DISCUSSIONS

Sl. No.	Voltage before 50% loading	Voltage after 50% loading	Voltage after TCSC
1	1.0600	1.0600	1.0494
2	1.0450	1.0350	1.0345
3	1.0100	1.0100	0.9999
4	1.0000	1.0042	1.0031
5	1.0000	1.0078	1.0064
6	1.0700	1.0600	1.0593
7	1.0000	1.0349	1.0352
8	1.0900	1.0700	1.0692
9	1.0000	1.0188	1.0202
10	1.0000	1.0152	1.0196
11	1.0000	1.0335	1.0357
12	1.0000	1.0430	1.0427
13	1.0000	1.0361	1.0362
14	1.0000	1.0078	1.0091

CONCLUSION

In the paper, an intelligent technique is proposed for reducing the power loss and improving the power flow of the system. This intelligent technique is named as Particle Swarm Optimization (PSO). In order to obtain the optimal power flow, here the TCSC is installed. After that, the optimal location of the TCSC is obtained by using the proposed method. Then, the generation cost, voltage profiles, power and losses are evaluated. These factors depend on the load factor and the power flow index and changing the loading state of the system.

The total power generated by the system, power evaluated and compared with the proposed method. Also, the power flow security of the proposed losses, generation cost, and line flow power are method is studied by line outage and it reduces the load power limits. From the analysis, it is observed that the results of line outage can ensure the power flow security and voltage enhancement by setting of the installed TCSC. Therefore, by locating TCSC optimally in the normal and loading conditions ensures secured power flow of the transmission system.

REFERENCES:

1. S.C. Srivastava and Perveen Kumar, "Optimal Power Dispatch in Deregulated Market Considering Congestion Management", International Conference on Electric Utility Deregulation and Restructuring and Power Technologies 2000, City University, London, 4-7 April 2000.
2. R. S. Fang and A. K. David, "Transmission congestion management in an electricity market", IEEE Transactions on Power System, Vol. 14, NO. 3, August 1999, pp. 877-883.
3. Felix F. Wu and Pravin Varaiya, Coordinated multilateral trades for electric power networks: Theory and implementation", Electrical Power and Energy Systems Vol. 21,1999, pp.75-102.
4. Mariano Ventosa, Andres Ramos & Michel Rivier, "Modelling profit maximization in deregulated power markets by equilibrium constraints", Proc. of 13* PSCC, Trondheim Norway, June 28-July 2 1999,pp.231- 237.
5. IEEE Tutorials, 'FACTS Applications', IEEE Power Engineering Society Winter Meeting 1996, Publications No. 96 TP 116-0.
6. J. Nanda, D. P. Kothari and S. C. Srivastava, "New optimal power dispatch algorithm using Fletcher's quadratic programming method",IEEE Proceedings, Vol. 136,Pt. C, No. 3, May 1989,pp.153-161.
7. D. Mondal, A. Chakrabarti and A. Sengupta, "Optimal placement and parameter setting of SVC and TCSC using PSO to mitigate small signal stability problem", International Journal of Electrical Power & Energy Systems, Vol. 42, No. 1, pp. 334–340, November 2012
8. Nima Amjady, Hamzeh Fatemi, and Hamidreza Zareipour, "Solution of Optimal Power Flow Subject to Security Constraints by a New Improved Bacterial Foraging Method", IEEE Transactions on Power Systems, Vol.27, No.3, pp.1311-1323, 2012
9. T. Nireekshana, G. Kesava Rao, and S. Siva Naga Raju, "Enhancement of ATC with FACTS devices using Real-code Genetic Algorithm", International Journal of Electrical Power & Energy Systems, Vol.43, No.1, pp.1276–1284, 2012
10. Sujatha Balaraman, and N. Kamaraj, "Cascade BPN based transmission line overload prediction and preventive action by generation rescheduling", Neurocomputing, Vol.94, pp.1–12, 2012

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Design of Pilot Based Channel Estimation in MIMO OFDM Communication System

Abstract: Orthogonal Frequency Division Multiplexing (OFDM) technology with Multiple Input Multiple Output (MIMO) is an assertive air interface for broadband wireless communications. This combination is more useful in higher data rates. In addition, MIMO-OFDM technology acquires appropriate spectral efficiency in order to deliver the highest capacity and data throughput. However, precise channel state information is needed at the receiver to achieve better performance in wireless communications. This is attained by using efficient channel estimation techniques. Therefore, two techniques such as Least Square Error (LSE) and Minimum Mean Square Error (MMSE) of channel estimation techniques are discussed in this paper and compared with their simulation results.

Keywords: OFDM, MIMO, channel estimation, MMSE, LSE.

I. INTRODUCTION

In wireless and mobile communications, rapidly increasing demands in mobile data and multimedia services leads to improve the channel capacity. However, high spectral efficiency under varying channel conditions is a major challenge to furnish higher data rates with limited spectrum to develop a wireless system. Moreover, MIMO-OFDM system provides high data rate, increased spectral efficiency, improved link reliability along with high gain and also robust to multipath delay [1] in wireless communications. In MIMO system, multiple number of antennas are placed at the transmitter and receiver to increase channel capacity without the need of extra band width. And also transmission rate is increased in case of spatial multiplexing as well as Bit Error Rate (BER) is improvised in case of spatial diversity.

- **Spatial multiplexing:**

It is the technique used in MIMO to transmit more than one signals of data through a single channel simultaneously.

- **Spatial diversity:**

Also known as space diversity or antenna diversity is a technique that uses two or more antennas to convey information to improve quality and reliability of the link.

In OFDM, the entire channel is divided into many narrowband sub-channels which causes reduction in Inter Symbol Interference (ISI) by the use of cyclic prefix (CP) which is just the copy of the last part of the symbol used again at the front part of the symbol and also by increasing symbol duration in multipath environments. Thus, using MIMO-OFDM increases the spectral efficiency as well as data rate and decreases the ISI. In order to implement efficient MIMO-OFDM system, IFFT/FFT algorithm and MIMO encoding have major role under varying channel conditions and to achieve the

performance improvements, accurate channel estimation methods are employed [2, 3].

In a wireless system, channel state information (CSI) gives the channel properties of the link. This provides the details about the effects of scattering and fading. In this paper, two types of channel estimation methods, one is Least Square Error (LSE) and the other is Minimum Mean Square Error (MMSE) are implemented and the simulation results are compared. The organization of this paper has been designed as follows, In Section II, we describe the basic system model in short; in Section III, we put forward the concept of LS channel estimation; the detailed study of the LS channel estimator is mentioned in Section IV, as a result of which we successfully deduce an optimal training strategy; Section V portrays the outcomes of simulations, and at last, conclusions are jotted down in Section VI.

Notation: Upper-case (lower-case) letters will normally be denoted for frequency-domain (time-domain) symbols; bold letters will be used to denote matrices and column vectors; $(\cdot)^H$ will indicate Hermitian (conjugate transpose), $(\cdot)^+$ matrix pseudo. We would use $[A]_{n,m}$ to denote (n,m) th element of the matrix A ; I_N will indicate the $N \times N$ identity matrix and $0_{N \times M}$ will denote the all-zero matrix. Further, $\text{diag} \{ X \}$ stands for the diagonal matrix with the column vector X on its diagonal; finally,

$$J = \sqrt{-1}.$$

II. MIMO-OFDM SYSTEM MODEL

When it comes to wireless communications, MIMO-OFDM is believed to be a strong and well established technology. And in this model, a multicarrier system can be effectively implemented in discrete time domain with the help of an inverse FFT (IFFT) that would behave as a modulator and an FFT to act as a demodulator

Fig. 1 shows the transmitter-receiver model of N×M MIMO-OFDM SYSTEM with K number of sub carriers signalling via a fading channel that is frequency selective in nature [4, 5]. Suppose all the N×M channel paths have memory upper bounded by L.

Let $X = X_0, X_1, \dots, X_{N-1}$ represent the length N data symbol block. The IDFT of the data block X gives the sequence $x = x_0, x_1, \dots, x_{N-1}$ i.e

$$x_n = \text{IFFT}_N \{ X_k \}(n) \quad (1)$$

So as to curb the effects of channel delay spread, a guard interval comprising of either a CP or a suffix is appended to the sequence X [6]. For CP, the sequence that is transmitted along with guard interval is

$$x_n^g = x(n)_N(2) \\ n = G, \dots, -1, 0, 1, \dots, N-1$$

Where G is the guard interval length in samples. When we pass the sequence x^g through a pair of ADCs (to generate the corresponding real and imaginary components) with sampling rate $1/T$ s. To avoid ISI, the CP length G must be equal to or exceed the length of the discrete-time channel impulse response M.

The remaining signal at the j-th receive antenna for the n-th block can be expressed as:

$$r_j(n) = \sum_{i=1}^N \hat{H}_{i,j} x_n + \tilde{v}_j(n) \quad (3)$$

$$j = 1 \dots M$$

Where $\tilde{v}_j(n)$ is the vector describing the unknown white Gaussian noise of dimension $K \times 1$ at the j-th receive antenna and $\hat{H}_{i,j}$ is the $K \times K$ circulant channel matrix. The k-point DFT of channel matrix can be expressed as

$$H_{i,j} = \text{DFT}(\hat{h}_{i,j}) \quad (4) \\ H_{i,j} = [H_{i,j}(0), \dots, H_{i,j}(L-1)]_{1 \times L}$$

The normalized DFT of the received signal vector from the jth receive antenna is then represented as:

$$y_j(n) = \text{DFT} r_j(n) \\ = \sum_{i=1}^N \text{diag}(H_{i,j}) x_i(n) + v_j(n) \\ j = 1 \dots M$$

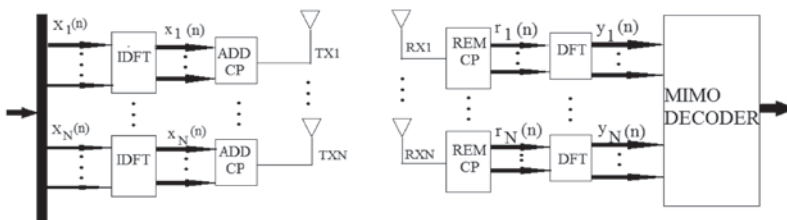


Figure 1: Transmitter and receiver structure of MIMO-OFDM model

$\text{diag}(H_{i,j})$ is a diagonal matrix with diagonal element obtained from $H_{i,j}$. it can be easily shown that the random noise vector $v_j(n)$ has the same statistical distribution as $\tilde{v}_j(n)$. then the beyond MIMO-OFDM system model can be rewritten by a matrix notation as

$$Y_n = H_y X(n) + V(n) \quad (5)$$

Where H_y represents the overall frequency domain channel matrix. Or it can be expressed in other form i. e

$$\begin{bmatrix} Y_1(n) \\ \vdots \\ Y_M(n) \end{bmatrix}_{MK \times 1} = \begin{bmatrix} H_{1,1} & \dots & H_{1,M} \\ \vdots & \ddots & \vdots \\ H_{M,1} & \dots & H_{M,M} \end{bmatrix}_{MK \times NK} \begin{bmatrix} X_1(n) \\ \vdots \\ X_M(n) \end{bmatrix}_{MK \times 1} + \begin{bmatrix} V_1(n) \\ \vdots \\ V_M(n) \end{bmatrix}_{MK \times 1}$$

III. LEAST SQUARES CHANNEL ESTIMATION

We can obtain the LS estimate of h^q where

$$h^q = [h^{q,1^T}, \dots, h^{q,Nt^T}]^T$$

$$\text{Now, } \hat{h}^q = h^q + A + E^q$$

And here $\hat{h}^q$ is equal to the sum of the channel vector h^q and a term that represents noise in the system.

The above two equations can be simplified and written as $\hat{h}^q = \tilde{A} + \tilde{Y}^q = h^q + \tilde{A} + E^q \quad (6)$

IV. CHANNEL ESTIMATION ANALYSIS

The L.S channel estimate and the MSE channel estimate is computed and the corresponding optimal pilot sequences and optimal placement of its tones are derived in this section.

The MSE equation of the LS channel estimate is as follows

$$\begin{aligned} \text{MSE} &= \frac{1}{LN_t} E\{||\hat{h}^q - h^q||^2\} \\ &= \frac{1}{LN_t} E\{||\tilde{A} + \tilde{E}^q||^2\} \\ &= \frac{1}{LN_t} \text{tr}\{\tilde{A} + E\{\tilde{E}^q \tilde{E}^{qH}\} \tilde{A} + H\} \end{aligned} \quad (7)$$

Therefore, the optimal pilot sequences can be designed arbitrarily split each sequence of length P into g succeeding of length P/g, and randomly allocate each subsequence to a non identical OFDM symbol [7].

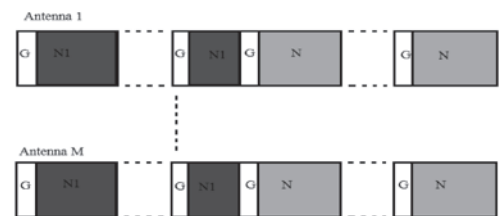


Figure 2: Frame structure of OFDM SYSTEM

V. RESULTS AND ANALYSIS

In figure 3, we clearly obtained the curves for capacity of MIMO and MIMO-OFDM using SVD by changing the number of transmitters and number of receivers. Hence, it is observed that the capacity of MIMO-OFDM is better, when compared with capacity of MIMO.

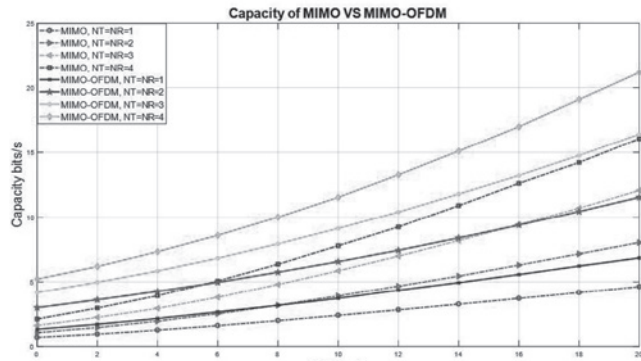


Figure 3: Capacity of MIMO vs MIMO-OFDM

In figure 4, the BER vs SNR of MIMO is compared with MIMO-OFDM system and it is seen that MIMO-OFDM combining perform better than each individually

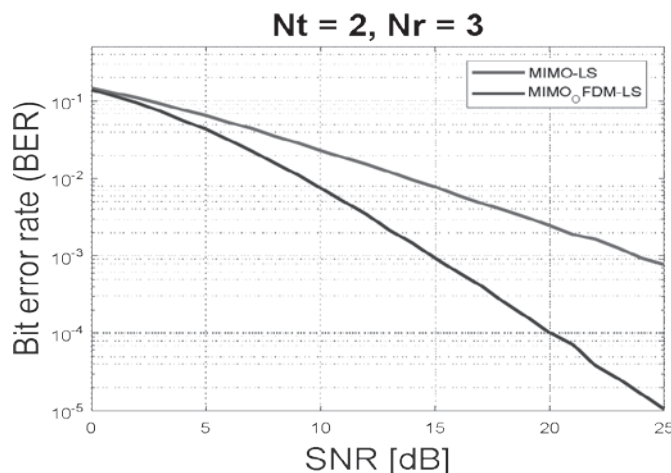


Fig. 4: Comparison between BER vs SNR of MIMO and MIMO-OFDM

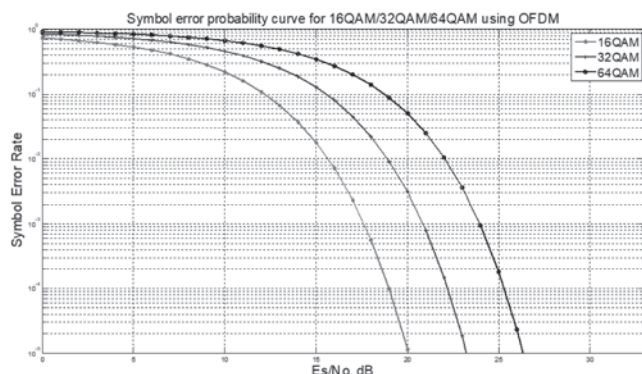


Fig. 5: Symbol error probability curve of OFDM

In figure 5, the analysis of QAMs in OFDM is done which indicates the BER of 16 QAM outperforms the 32 QAM and 64 QAM.

VI. CONCLUSIONS

In this work, MIMO OFDM based LS channel estimation scheme based on pilot tones has been proposed. The pilot sequences must be equipowered, equispaced, and phase shift orthogonal, to obtain the minimum MSE of the LS channel estimate. Efficiency decreases with the increase in the number of transmit antennas as more pilot tones for training are required. when the channel is slowly time-varying. When the channel is slowly time-varying, this effect can be mitigated by estimating the channel parameters over multiple OFDM symbols.

REFERENCES

- [1] L.Deneire, P. Vandenameele, L.Van der Perre, B.Gyselinckx, and M.Engels, "Channel Estimator for OFDM," in Proc. IEEE Int. Conf. Commun., Helsinki, Finland, June 11-14, 2011
- [2] L.J. Cimini, Jr., "Analysis and simulation of a digital signal using orthogonal frequency division multiplexing," IEEE Trans. On Communications., vol. 33, pp. 665-675, July 2009
- [3] Gordon L. Stüber, John R. Barry, Steve W. McLaughlin, Ye li, M. ingram, and Thomas G. Pratt , "Broadband MIMO-OFDM Wireless Communications," Proceedings of the IEEE, vol. 92, no. 2, feb. 2014
- [4] A.Zaier and R. Bouallègue, "Blind channel estimation enhancement For mimo- ofdm systems under high Mobility conditions IEEE International Conference on Communications ,Vol. 4, No. 1, February 2012
- [5] I.Barhumi, G.Leus, and M.Moonen, "Optimal Training Design for MIMO OFDM Systems in Mobile Wireless Channels," IEEE Trans. Signal Processing, vol. 51, no. 6, june. 2013
- [6] W Hardjawana, R Li, B Vucetic and Y Li, "A New Iterative Channel Estimation for High Mobility MIMO-OFDM Systems," IEEE Trans. Vehicular Technology Conference, pp. 1-5, 2010.
- [7] Maryam Imani, Hamidreza Bakhshi, "Training Based Channel Estimation in MIMO-OFDM System", 2012,p.54-60

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Test Effort Estimation using Use Case Model and Class Model

The two main characteristics used to measure the success and acceptability of a software product is quality and reliability. Quality of a software product is a major area of concern for both customers as well as developing organizations. Moreover, the reputation and business of the developing organization depend on the feedback given by the customers based on their experience of using the product. It is well known that complete, comprehensive and meticulous software testing is essential for delivering quality expected from a software product. Because of this, many software development and test-centric organizations are giving higher emphasis to software testing phase of Software Development Life Cycle (SDLC). In order to deliver a software product of required quality within a stipulated timeline, thorough planning is essential. Managers involved in planning activities need accurate estimations to be able to plan diligently. Over the years, experts have proposed a number of methods for estimating development as well as test efforts of a software product. These methods have their own benefits and pitfalls. Early estimation of test effort is an unexplored area with a very limited amount of research work undertaken. Early estimation of efforts has many advantages but has its challenges as well. The early availability of test effort will enable the managers to prepare for the initial resource plans, test activity schedules and acquire suitable resources for the testing phase. This will help the project immensely with meeting its quality and timeline goals. But, the challenge is unavailability of the required details about the software at an early stage of SDLC. So, a multistage estimation approach is necessary in which the initial estimation can be refined later when more information becomes available.

In this work, we propose an innovative two-stage approach to estimate system test effort early with reasonable accuracy for systems developed using Object Oriented Methodology (OOM). Our estimation process includes initial test effort estimation in the requirements stage, followed by a refined estimation carried out during the design stage using selected Unified Modeling Language (UML) Models that are available early. Unified Modeling Language (UML) is the most widely used standard for representing Object Oriented Systems (OOS) through a number of models built during different phases of software development. Experts over the years have observed that UML Models of the system created

with required amount of information can be utilized for early test effort estimation, benefitting both development and test-centric organizations. The Use Case Models are the first models of the system built during the requirements stage of SDLC. Use Case Models represent functional requirements and user interfaces of the system from a customer's viewpoint. The Use Case contains the sequence of steps to achieve a functional objective and is vital during System and Conformance testing. Since, Use Case Models are available early; they serve as the most appropriate inputs for initial test effort estimation along with Use Case specifications. The Class Models are built in the design stage to represent the structural elements (Classes) of the system from a developer's viewpoint. Hence, we have deployed the Class Models for refined test effort estimation during the design stage.

Majority of contemporary software products are built using OOM and are implemented as web applications. In this work, we focus mainly on the system test effort estimation for such products. We propose a simple two-stage approach to estimate System Test effort from the Use Case and Class Models of the system during the requirement and design stages by using their inherent attributes as parameters. As part of the experimental study, 19 recently completed projects were selected from varied domains and platforms. A majority of these projects were executed in the IT departments of public and private sector enterprises. These projects are mainly web-applications developed using OOM. Based on our estimation approach, we have predicted system test efforts in early stages of software development. The results obtained from the experiments confirmed that the estimations derived using Class Models demonstrated better accuracy than those derived using Use Case Models in majority of the cases. This inference is supported by the Average Magnitude of Relative Error (MRE) values obtained corresponding to the Use Case and Class Models. The above outcome can be attributed to the fact that, the Class Models developed in a later stage of SDLC contain more detailed information compared to the Use Case Models. Furthermore, the estimation accuracy achieved by our method compares favorably to that of a number of similar studies conducted in recent past.

Dr. Pulak Sahoo

Dept of IT

Space Elevator?



Today, if one wants to travel to space or deploy payloads to orbit, the only way is by using rockets. And the rockets are very costly, many of them are used once and they have a tendency to explode! That is why for over a century scientists and science fiction writers have dreamed of an easier and reliable mode of transportation to space by Elevators! The idea of a space tower was first proposed by a Russian scientist, Konstantin Tsiolkovsky in 1895. And then in 1979, a sci-fi writer Arthur C. Clarke wrote about space elevator in his work, 'The Fountains of Paradise'.

Conceptually a space elevator can be constructed by anchoring a cable to the Earth and the other end connected to a stationary mass beyond the earth's Geostationary Orbit. The cable would be kept taut by the centrifugal

force produced due to the rotation of earth. The cable needs to be anchored near the equator, where Coriolis force is less effective (thus few hurricanes or tornados). The cable can then be used as a support to climb up and down. The main hurdle in this concept is constructing a very strong, light weight and 36,000 Km long cable.

With the current technology we have many scientists considered this idea practically impossible. But

only recently, scientists of Shizuoka University, Japan are set to test transportation between two mini satellites using the world's first space elevator. The test was scheduled on 11th September, 2018, but due to typhoon launch was postponed. The mini space elevator consists of a 10-metre long steel cable connecting the satellites. A small motorised box of dimension 6 cm x 3 cm x 3 cm would run between the satellites. The movement of the box will be monitored using cameras. This test will be done to analyse any unexpected movements or oscillations during motion of the elevator.

If the expected results are obtained and no major issues halt the project, the same concept can be implemented on a larger scale. Japanese firm Obayashi Corporation, which is collaborating with Shizuoka University is set to construct a fully functional space elevator with a carbon nanotube tether anchored to a platform in the Pacific Ocean for space tourism by 2050. The company plans of building six elevators each capable of carrying 30 people. The speed of ascent will be 200kmph. The elevator would take a week to reach the geostationary orbit.

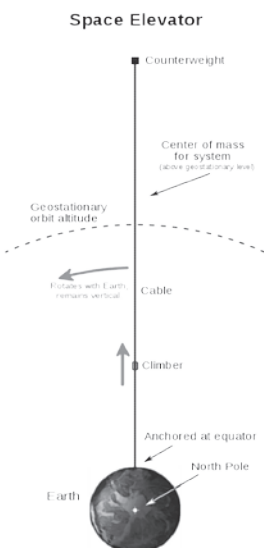
Although the plan seems hypothetical, a space elevator is theoretically possible and will be practically implemented in the next hundred years in not in the next fifty years. A space elevator will reduce the risk of travelling to space as well as reducing the travel cost.

Jagannath Gouda

Image Credits:

Pic1: Obayashi Corporation

Pic2: Wikipedia.org



Design and Analysis of Swastika-Slot Circular Microstrip Patch Antenna for WLAN and Wi-MAX Applications

Abstract: This paper proposes the microstrip circular patch antenna with multiband frequency for effective gain and radiating properties. The Swastika shaped circular patch antenna specially aided with Wireless Local Area Network (WLAN) and worldwide interoperability for Microwave Access (Wi-MAX) applications are the notable features of this circular antenna designed for better gain and electronics gadget remodeling. The analyses were carried out using ANSOFT High Frequency Structure Simulator (HFSS). This antenna operates at 5.2 GHz corresponding to WLAN and 5.4/5.8 GHz corresponding to Wi-MAX band. This antenna exhibits high gains of -19dB. Feeding techniques used for this antenna is coaxial line feeding. Designed antenna is characterized with better radiation pattern and gain with 19.77 dBi. For each frequency band farfield pattern with return loss graph has plotted with corresponding gain.

Keywords: Circular patch, Swastika slot, Coaxial Feed, Return loss, WiMAX, WLAN.

I. INTRODUCTION

In today's advancement of wireless communication, devices are getting compact and equipment are redefining the performances. This better experiences and technological enhancement has to give certain credits for designing of multifunctioning, cost effective yet better radiating antennas.

Keeping the compactness of the devices in mind, the Microstrip antennas has achieved immense popularity as they are lighter in weight, easy to fabricate and comes at normal costs. The fact that Microstrip antennas can be readily printed onto circuit board, these are required for high mobility. Moreover the space needed is much less and being light weight it reduces the overall volume of wireless gadgets. Nowadays these antennas find their application in wide ranges as they are more relevant over the microwave antennas [1].

The Literature survey of some of the Published paper has been done which is briefly enlightened by us is follows:

The C-shaped slot on the Circular Patch Antennas using different feeds for WLAN and Wi-MAX applications has been designed and optimized in [2] having operating frequency as 2.4GHz/5.2GHz for WLAN and 2.5/3.5/5.8GHz for Wi-MAX applications.

In [3] we searched that the Human Shaped Microstrip Patch Antenna using CST Software is done for the WLAN application.

The Slotted Microstrip Antenna is analysed in [4] for Wi-MAX and Other Wireless application having 3.6GHz using probe feed technique with the help of HFSS software.

In [5] the Swastik Slot loaded Microstrip antenna using coaxial probe feeding technique has been analysed which

is having 21.7% bandwidth with -21.783 dB return loss using CST software.

The Swastika shaped Microstrip Patch Antenna for ISM band applications which resonates at 2.416 GHz frequency using Inset feed technique with the help of CST 2011 Simulation tool [6].

In [7] the Rectangular Microstrip Antenna with Swastika Electromagnetic Band Gap (EBG) Structure on the Ground has been analysed whose operating frequency range is 5-15 GHz where WLAN and Wi-MAX applications takes place.

The Kite symbol Microstrip Patch Antenna for WLAN and Wi-MAX applications has been proposed in [8] having 3.189GHz – 4.601GHz operating frequency range using IE3D simulation tool.

The Coaxial feed single layer rectangular Microstrip patch antenna has been analysed for MSS network, Wi-MAX and WLAN application which operates at 2.25GHz, 3.76GHz and 5.23GHz in [9] using HFSS v.11 EM simulator, from Ansoft.

In [10] the Swastika Shaped Wideband Microstrip Patch Antenna for GSM and WLAN application whose operating frequency range covers 1.696GHz to 2.646GHz using IE3D software package of Zealand has been simulated.

The Swastika shape Microstrip Patch Antenna having coaxial probe feed technique has been designed on 1.8 GHz (L-band) and 2.5GHz(S-band) in [11] by the help of IE3D software.

Patch antennas can radiate in any geometry be it planar or even non planar. Majorly it consists conducting patch

on one side of the dielectric substrate whereas the ground plane fixed to other end.

Even though circular and rectangular patches are fabricated generally for being the basic structures, the advantage of using a circular patch antenna is that it always results in symmetric radiation patterns. The circular patch can have suitable modes for patch, ground plane and the material between them by designing the two as a circular cavity. The radius of the patch is dependent on the range for the controlling of modes by the antennas.

Several feeding techniques are used in the surveyed papers. Here in this proposed design the coaxial probe feed technique has been used. In this method the attachment of inner conductor with radiating patch is done and outer conductor is connected to the ground.

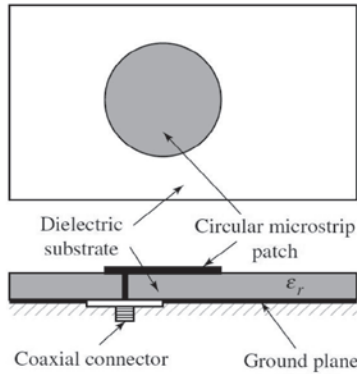


Figure 1: Coaxial Probe Feed Technique

The resonant frequency is largely related to the shape and position of the slots of antenna. Conscious care is taken to improve the gain and radiating properties along with the multi applications of the antenna for multiband and for wide range of frequencies.

This multi applicable antennas such as aided with Wi-MAX and WLAN applications helps to handle multiple functions without going for different antennas for different functions in same device. Thus to overcome such drawbacks, the shape of antennas to be carefully designed. And it is observed for swastika shaped antenna on circular patch is best suited for better gain and suitable radiation properties.

The article is planned as follows: How the antenna has structured and designed is briefly described in section II. In section III the Results and what we discussed is briefly described. The section IV and V is about Conclusion and References respectively.

II. ANTENNA STRUCTURE AND DESIGN

Among all the antenna configuration of patches, the circular patch is the most popular antenna configuration. A very thin metallic circular strip over a substrate of height (h) is placed over a ground plane is the constituents

of a circular patch antenna.

Here the design is outlined through the specified information which includes the dielectric constant of the substrate (ϵ_r), the resonant frequency (f_r) and the height of the substrate (h).

The actual radius (ra) of patch is calculated as follows:

$$a = \frac{F}{\left\{ 1 + \frac{2 \times h}{\pi \times \epsilon_r \times F} \left[\ln \left(\frac{\pi \times F}{2 \times h} \right) + 1.7726 \right] \right\}^{1/2}} \quad (1)$$

Where:

$$F = \frac{8.791 \times 10^9}{f_r \times \sqrt{\epsilon_r}} \quad (2)$$

The Radius of the Circular Patch Antenna is determined initially for which the antenna resonates at 5.2GHz correspondingly for WLAN applications and 5.4/5.8GHz correspondingly for Wi-MAX applications.

In each of the iteration, physical dimensions such as length, width, heights of substrate and ground plane of the coaxial probe feed patch antenna are set and corresponding design with resonating bands are analyzed.

Table 1: Dimension of Circular Patch Antenna with Swastika Slot

Dimensions	Value (mm)
Radius of Patch (ra)	22
Height of substrate	1.6
Length of Substrate	63.2
Width of Substrate	63.2
Length of Ground	63.2
Width of Ground	63.2
Wavelength	120

The above proposed antenna is having Swastika slot which is having 6 rectangular slots of a fixed dimensions

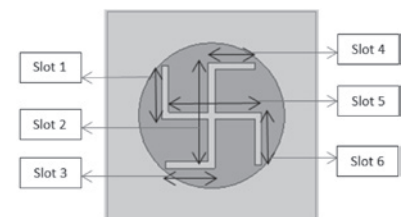


Figure 3: Labeling of Swastika slot



Figure 2: Swastika Shape Microstrip Patch Antenna

The dimensions for each rectangular slot which is used to design the Swastika shaped over circular patch antenna are given in the table as follows:

Table II: Dimension of the Rectangular Slot of Swastika Shaped Microstrip Patch Antenna

Slot Name	Length (mm)	Width (mm)
Slot 1	15	2
Slot 2	30	2
Slot 3	14	2
Slot 4	14	2
Slot 5	30	2
Slot 6	15	2

III. RESULTS AND DISCUSSIONS

The proposed antenna designs are simulated by the help of ANSOFT HFSS software. The designed antenna gives the best result over previous encountered and design of Swastika antenna. This Swastika slot design is totally simulated very well and giving the best result over the previous one.

The design is giving the best antenna for WLAN and Wi-MAX applications. The antenna resonates at 5.2GHz for corresponding WLAN applications and 5.4/5.8GHz corresponding Wi-MAX applications. The highest gain from the entire multiband is -19dB.

For determining the particular bandwidth for a particular application to works in that frequency range a return loss parameter analysis is the best approach from where we further got corresponding gains with respective frequency as marked in the below as follows:

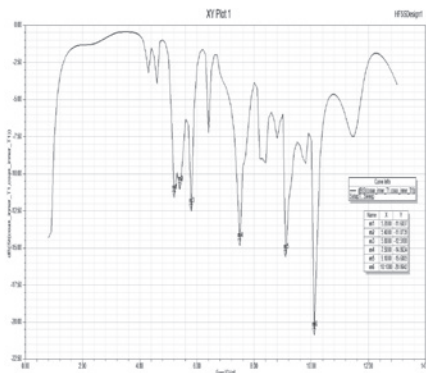


Figure 4: S-Parameter of the Swastika Shape Microstrip Patch Antenna

This proposed patch antenna with its suitable application bands with respective frequency bands and its return loss are determined from the simulated tool as follows:

Table III: Performance of Circular Patch Antenna with Swastika Slot

Sl. NO.	Center Freq. (GHz)	Application Band	Gain(dB)	
			$\phi=0$ deg	$\phi=90$ deg
1	5.2	WLAN	5.3263	2.7249
2	5.4	Wi-MAX	4.4542	4.3071
3	5.8	Wi-MAX	0.9292	2.0901
4	7.5	Fixed-Satellite (Space-to-Earth)	0.4375	3.1791
5	9.1	Aeronautical Radio Navigation	13.4202	13.4148
6	10.1	Fixed Mobile Radiolocation	18.6827	19.7789\

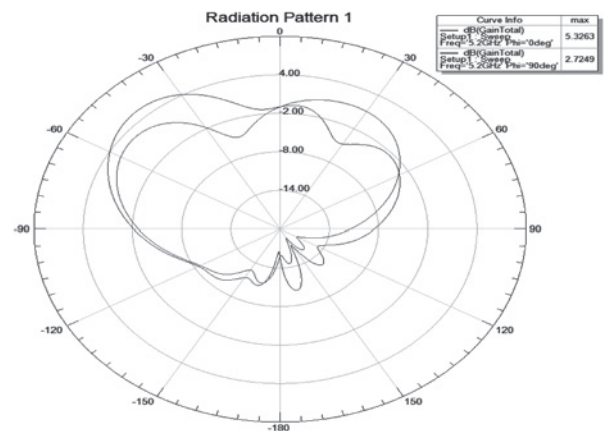


Figure 5: Radiation Pattern of 5.2 GHz frequency with gain

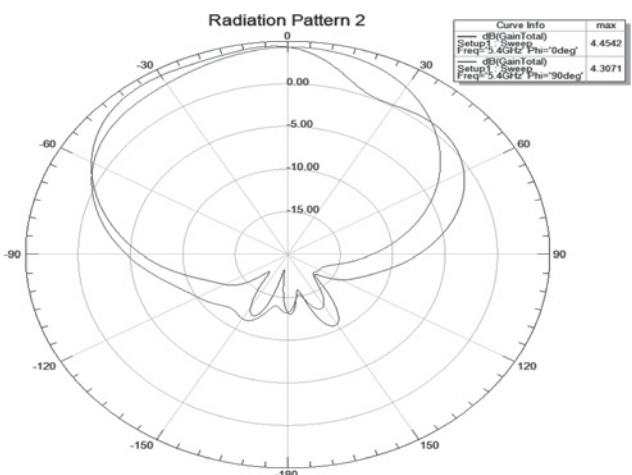


Figure 6: Radiation Pattern of 5.4 GHz frequency with gain

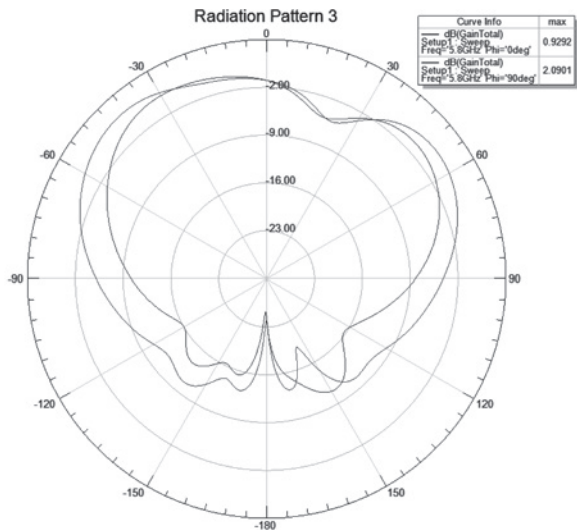


Figure 7: Radiation Pattern of 5.8 GHz frequency with gain

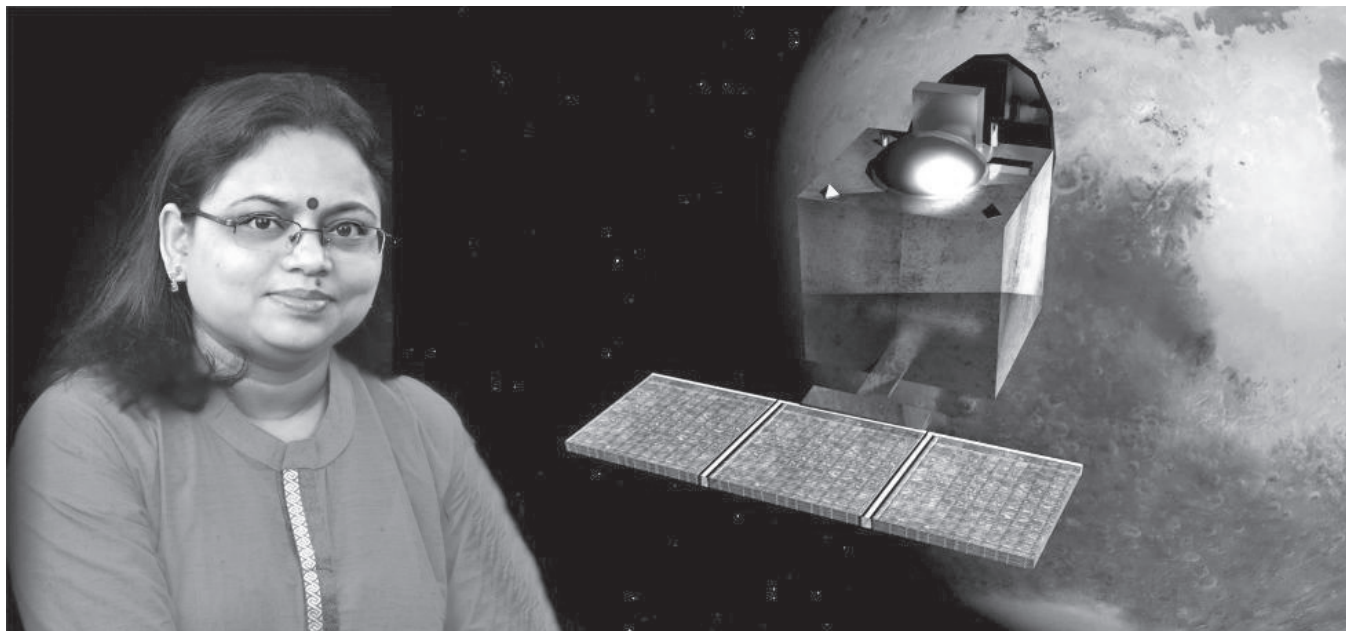
IV. CONCLUSION

In this paper, a compact size Swastika-slot circular patch antenna has been designed having good radiating properties and gains. The proposed antenna which resonates in WLAN and Wi-MAX band at 5.2 GHz and 5.4 GHz/5.8 GHz frequency band respectively. As per the knowledge, modifications on the patch geometry helped too much to maintain and improve the specified design parameters such as return loss, gain, resonating frequency. Their ease of mass production using printed circuit technology leads to a low fabrication cost.

REFERENCES

- [1] Balanis C. A, "Microstrip Antennas", Antenna Theory, Analysis and Design, Third Edition, John Wiley & Sons, pp-811-876, 2010
- [2] A. B. Sahoo, G. P. Mishra, M. R. Jena, and B. B. Mangaraj, "Optimal design and comparative study of circular patch antennas using different feeds for WLAN and WiMAX applications," International Journal on Communications Antenna and Propagation, vol. 6, no. 3, pp. 188-196, June 2016.
- [3] M. Malathi, S. Priya, K. Suganya, "Human Shaped Microstrip Patch Antenna for WLAN Application," International Journal of Advanced Research in Electronics and Engineering (IJARECE), vol. 6, no. 6, June 2017.
- [4] P. Paneliya, S. Khakariya, S. Sreenath Kashyap, "Design of Slotted Microstrip Antenna For Wi-MAX Application," International Journal of Advance Engineering and Research Development, vol. 2, no. 4, April 2015.
- [5] A. K. Maurya, A. Singh, B. Pandey, S. Srivastava, R. Singh, "Design and Analysis of Swastik slot loaded Microstrip Antenna at FR4 Lossy Substrate on L-Band," International Journal Of Engineering Sciences & Research Technology(IJESRT), Maurya, 4(5): May , 2015.
- [6] U. Raithatha, S. Sreenath Kashyap, D. Shivakrishna, "Swastika Shaped Microstrip Patch Antenna for ISM Band Applications," International Research Journal Of Engineering and Technology (IRJET), vol. 02, no. 02, May 2015.
- [7] S. M. Shakha, Vani R. M, Prashant R.T and Hunagund P.V, "Rectangular Microstrip Antenna With Swastik Electromagnetic Band Gap Structure," International Journal of Research In Engineering and Technology(IJRET)
- [8] V. S. Rathor, J.P. Saini, "Compact CP Feed Broadband Microstrip Patch Antenna for Wireless Application," IOSR Journal of Electronics nad Communication Engineering(IOSR-JECE), vol. 9, no. 1, PP 54-58, Jan 2014.
- [9] B. Bag, "Microstrip Slot Antenna For Triple Band Application in Wireless Communication," World Academy of Science, Engineering and Technology, International Journal Of Computer, Energetic, Electronics and Communication Engineering, vol. 8, no. 6, 2014.
- [10] V. S. Rathor, J. P. Saini, "A Design of Swastik Shaped Wideband Microstrip Patch Antenna for GSM/ WLAN Application," Journal Of Electromagnetic Analysis and Application, no. 6, 31-37 February 2014.
- [11] A. K. Tripathi, S. Srivastava, Dr. H.P. Sinha, "Design and Analysis of Swastik Shape Microstrip Patch Antenna at Glass Epoxy Substrate on L-Band and S-Band" in International Journal of Engineering and Innovative Technology(IJEIT), vol. 2, no. 7, January 2013.

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Ritu Karidhal: from Sky-Watcher to Rocket Woman

Ritu was born in a middle class family in Lucknow, Uttar Pradesh, India. Her parents were blessed with five children, including two sons and three daughters. Ritu's father was in the defense services. Her father's discipline always guided the five of them to emphasize on education a lot. Since her kindergarten days, Karidhal was interested in space sciences. She was often found gazing at the sky for hours. She kept wondering about the moon, the outer space. As a part of her research, she used to collect articles and activities related to space from newspaper. This helped her keeping track of activities of ISRO and NASA.

She graduated in physics from Lucknow University. Later on she cracked the Graduate Aptitude Test in Engineering (GATE) and got into the Indian Institute of Science in order to complete her Masters degree in Aerospace Engineering. After it's completion, in the year 1997, applied for a job at ISRO and became a space scientist," she says. She has worked on several projects since then, but what put her into limelight is the ISRO's Mars Orbiter Mission, Mangalyan.

She looked after the detailing and the execution of the craft's onward autonomy system. She made sure that the craft's autonomous brain was designed in such a manner that it could function on it's own and also can overcome any type of malfunctions. As a working mother, she has to maintain a pretty tight schedule. During the last 10 months of the launch, she used to look after her kids' studies in the evening and later on after finishing the household works, she would resume her work between midnight and 4 am. She was also the Deputy Operations Director of this mission. She is also an important member of the Chandrayaan 2 mission.

In the year 2007, she received the ISRO Young Scientist award from A.P.J Abdul Kalam. After the success of Mangalyaan, Ritu was named as one of the Rocket Women of India along with Nandini Harinath, Anuradha T.K, Seetha S., Minal Rohit, B. Codanayaguy, Lalithambika V.R.

Abhilash Mishra

Vehicle Break Down Assistance

Abstract: Without roadside assistance roadside emergencies are unpredictable and can be fatal, risky and stressful. One who does not possess any workshop's number can only rely on the help of a car passing by with a risk of being scammed. It is difficult to find mechanics nearby areas while travelling. This work presents a system that helps to overcome this issue by providing mechanic details in just one click. The locator allows the users to search mechanics from different locations. The online mechanic locator reduces the work and can easily find the mechanics from various locations. The main objective of the system is to provide a better service and to make the process easier to appoint a mechanic quickly reducing the time and cost.

I. INTRODUCTION

A lot of people are facing difficulties getting help when their car breaks down on the road. Many of them do not have any Car Repair Service Providers' contact number and could not get help as the Car Repair Service Providers might be far away from their locations. These problems are the motivations for the development of the Vehicle Break Down Assistance (VBA) system to help those who are in need when their car breaks down along the roads. Roadside assistance is a vehicular support service to individuals who experience a vehicular breakdown. The service typically provides benefits such as getting the vehicle fixed on the spot, refueling it, towing the vehicle to the nearest garage or a specific location, and much more. Assistance offers the best road assistance for cars / four wheelers and two wheelers in India. For this work, the focus is on the user's side to solve the problem faced by the public on the road. The development of this Vehicle Breakdown Service System will try to bring minimal interaction in terms of managing the application and interaction between user interfaces of the mobile application during the times of frustration [1].

II. VEHICLE BREAK DOWN ASSISTANCE SYSTEM

The problems faced by the drivers are not solely car breaking down. Car breakdown will cause frustration to the driver, the frustration will then cause the driver to make bad decisions and being scammed by the tow truck scammers. Another problem is getting help from workshops or mechanics. One who does not possess any workshop's number can only rely on the help of a car passing by and risk being scammed. Based on all these related problems, it is vital to come out with a solution that can solve these problems. Revising back the background studies, the current way of how people obtain service from workshops might be satisfying; however the development of this system aims to improve

the way on how the public contact the VBA and to provide convenience for both sides. The development of this Vehicle Breakdown System also aims to overcome the flaws of some of the existing applications in the market. With open source resources, the development cost of this VBA System is very low and thus it can provide assistance to the user with free of charges [2] [3].

The presented system is accessed by three entities namely, Admin, Mechanic and User. A mechanic can perform task such as viewing request received from users and can also send feedback to the admin. User can send a request and can appoint a mechanic on respective date-time. Admin is allowed to access and manage mechanic details. The ways the entities interact with the system are presented in figure (1).

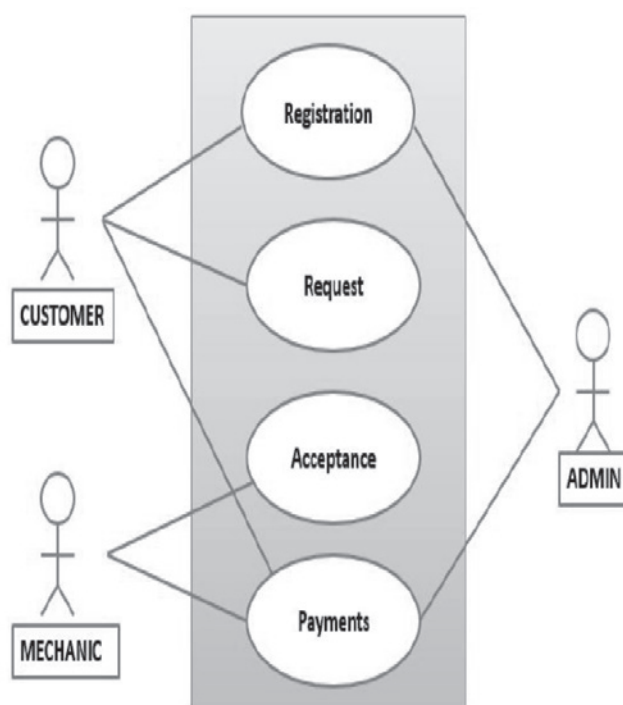


Figure.1: Functionalities of the VBA system used by the entities.



Figure.2: Login page of VBA system



Figure-3: Request service page of VBA system

To make the VBA system work, first the verified details of the mechanics such as name, dob, phone_no, DL_no, etc are maintained in a database by the administrator [4]. For using the VBA system, the users have to first register by providing their details and creating a login id and password. In order to request for some service, the users have to login to the system and provide the description about vehicle breakdown. The admin of the system can view all requests and can assign a mechanic who will be nearest to the reported incident spot. The customers can select the payment mode- cash on delivery or card payment to pay the charges of the mechanic. The screen shots of the login page and request service page are shown in Figure (1) and Figure (2) respectively.

III. CONCLUSIONS

The presented Vehicle Breakdown System aims to overcome the vehicle breakdown situation by providing mechanic details in just one click. The online mechanic locator reduces the work and can easily find the mechanics from various locations. With open source resources, the

development cost of this VBA System is reduce which can be used free of cost to provide assistance to the users. This work may further be enhanced by adding more features on the VBA system to provide more services to the users just in one click.

REFERENCES

- [1] https://www.researchgate.net/publication/311795116_A_car_breakdown_service_station_locator_system
- [2] <http://nevonprojects.com/on-road-assistance-finder/>
- [3] <https://www.arrivealive.mobi/roadside-assistance-and-road-safety>
- [4] https://en.wikipedia.org/wiki/Roadside_assistance

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5th Sem. MCA

Software Reliability Prediction Using Ensemble Learning Approach

Abstract: Software reliability is an indispensable part of software quality and is one among the most inevitable aspect for evaluating quality of software product. Software Industry endures various challenges in developing highly reliable software. Ensemble learning is a machine learning paradigm, where multiple base learners are trained to solve the problem. Here a set of hypotheses are constructed and combined to give improved results. Software reliability modeling based on test data is done to estimate whether the current reliability level meets the requirements for the product. Software reliability modeling also provides possibility to predict the reliability of the modules in software. In this work, the ensemble methods are used on various machine learning approaches. Using ensembling, a module in a software is classified whether to have defects or not based on certain features and predictions of the next failure in the software given the meantime between the failures.

Keywords: Software Reliability, Ensemble Learning, Machine Learning

I. INTRODUCTION

Software reliability is the probability of failure-free software operation for a specific period in a specified environment [1]. Software industries face various challenges in developing highly reliable software. In this project ensemble learning approach is used to predict and evaluate the software models based on their performance [2]. Ensemble learning is a machine learning approach where multiple base learners are trained on the performance data of the software [3]. Here set of hypotheses are constructed and combined to improved results. In this work, various machine learning approaches are used as ensemble learning approach and then bagging, boosting and stacking is used. Using ensembling learning approach, modules in a software is classified whether to have defects or not based on certain features and predictions of the next failure in the software given the meantime between the failures. The flow chart of the adopted methodology for software reliability prediction is presented in figure (1).

II. PREDICTION PROBLEM

In prediction problem, the software reliability time dataset is used. The dataset is preprocessed and the original data is retrieved from the raw dataset. The preprocessed data is then used in ensemble learning approach where different types of regression models are used to predict the output from the dataset. The preprocessed data is then sent to the regression model and the regression model fits with the data and then with respect to the original data output value is predicted. In ensemble learning method different types of regression models are used which are Ridge regression, Lasso Regression, Elastic Net regression, Polynomial regression, Decision Tree regression, Random Forest regression. Each regression model is fitted with the preprocessed dataset and then with respect to the original dataset the output is predicted and stored [4]. A certain loop variable is also

set for the regression model. After getting the output from the regression model, the average of the value is taken which gives nearly equal value to the output value. Then the value is predicted based on the mean time between failure (MTBF) using a single feature dataset representing the meantime between failures in chronological order. Here in the prediction the ensemble learning approach is used as the regression problem, where different types of regression approaches are used to predict the output value. Here in the prediction problem the set of hypotheses are construed and combined to give the improve results.

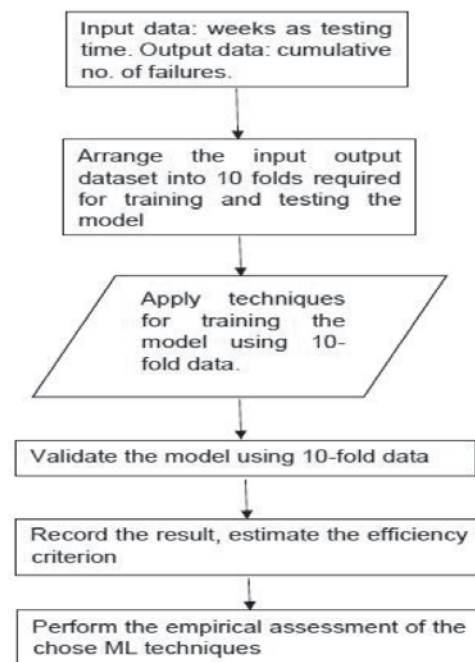


Figure.1: Flowchart of software reliability prediction methodology adopted

III. CLASSIFICATION PROBLEM

In classification problem, based on certain parameters of a module in a software like cyclomatic complexity,

essential complexity, design complexity and number of lines etc. , the module of a software needs to be classified whether it would have one or more reported defects or not. Using Ensemble learning for the classification problem is based on different types of classifiers, where different classifiers like SVM, Naïve Bayes, Decision Tree, Radom Forest, Logistic regression, ANN, KNN classifiers are used. The data of the software reliability is first preprocessed, and the input and output parameters are separated, then if categorical data is present in the dataset; then that is handled and then the raw data is scaled. A special approach is used where based on the set of the range, the random dataset is generated and then that dataset is fitted into all the classifiers mentioned above [5]. The classifiers are trained again and again based on the range inputted and all the output value from the classifiers are stored and bagging method is applied on that output accuracy value and the final accuracy is predicted for each classifier. Here in the bagging approach voting is used where on a vote basis output is predicted.

IV. ENSEMBLING METHODS

In statistics and machine learning, ensemble methods use multiple learning algorithms to obtain better predictive performance than could be obtained from any of the constituent algorithms alone [6]. Machine learning ensemble consists of only a concrete finite set of alternative models, but typically allows for much more flexible structure to exist among those alternatives. Supervised learning algorithms are most commonly described as performing the task of searching through a hypothesis space to find a suitable hypothesis that will make good predictions with a problem [7]. Even if the hypotheses space contains hypotheses that are very well-suited for a problem, it may be very difficult to find a good one. Ensembles combine multiple hypotheses to form a better hypothesis. The term ensemble is usually reserved for methods that generate multiple hypotheses using the same base learner. The broader term of multiple classifier systems also covers hybridization of hypotheses that are not induced by the same base learner. Evaluating the prediction of an ensemble typically requires more computation than evaluating the prediction of a single model. Therefore, ensembles may be thought of to compensate for poor learning algorithms by performing a lot of extra computation. Fast algorithms such as decision trees are commonly used in ensemble methods (for example, random forests), although slower algorithms can benefit from ensemble techniques as well [8].

An ensemble is itself a supervised learning algorithm, because it can be trained and then used to make

predictions. The trained ensemble, therefore, represents a single hypothesis. This hypothesis, however, is not necessarily contained within the hypothesis space of the models from which it is built. Thus, ensembles can be shown to have more flexibility in the functions they can represent. This flexibility can, in theory, enable them to over-fit the training data more than a single model would, but in practice, some ensemble techniques (especially bagging) tend to reduce problems related to over-fitting of the training data. Empirically, ensembles tend to yield better results when there is a significant diversity among the models. Many ensemble methods, therefore, seek to promote diversity among the models they combine. Although perhaps non-intuitive, more random algorithms (like random decision trees) can be used to produce a stronger ensemble than very deliberate algorithms (like entropy-reducing decision trees). Using a variety of strong learning algorithms, however, has been shown to be more effective than using techniques that attempt to dumb-down the models to promote diversity. While the number of component classifiers of an ensemble has a great impact on the accuracy of prediction, there is a limited number of studies addressing this problem.

A prior determining of ensemble size and the volume and velocity of big data streams make this even more crucial for online ensemble classifiers. Mostly statistical tests were used for determining the proper number of components. More recently, a theoretical framework suggested that there is an ideal number of component classifiers for an ensemble such that having than this number of classifiers would deteriorate the accuracy. It is called “the law of diminishing returns in ensemble construction.”[9]. Their theoretical framework shows that using the same number of independent component classifiers as class labels gives the highest accuracy.

V. COMMON TYPE OF ENSEMBLES AND THEIR IMPLEMENTATIONS

A. Bootstrap aggregating (Bagging)

Bootstrap aggregating, often abbreviated as bagging involves having each model in the ensemble vote with equal weight. To promote model variance, bagging trains each model in the ensemble using a randomly drawn subset of the training set. As an example, the random forest algorithm combines random decision trees with bagging to achieve very high classification accuracy.

In Sampling with replacement given a dataset length of d and then k number of datasets are created where a set of data tuples are randomly picked from the dataset in which 66% non-redundant data and 33% are redundant data are available. The whole dataset is applied for testing the model and then the model predicts

or classifies the data and then it gives us the output. For single instance of the prediction of problem Lag method is used to generate a set of lagged and combined value for the machine learning prediction problem. The lag Algorithm is presented in Algorithm-1.

Algorithm 1 Lagging

- Input: Dataset, lag sequence(k, e.g.: k=3 or 4 or 5 etc)
- Algorithm:
 1. Length = length of the input dataset
 2. for i in 0 to Length-k+1:
 3. Store data from i to i+k index of the dataset in the list z
 4. return z
- Output: array with lagged value from the original dataset in this case z list

Considering a dataset D having d number of instances as a classification problem, the pseudo code for Bagging is presented in Algorithm 2. The Training of different ML model on sample with replacement dataset is presented in figure (2) and the classification on different instance and voting is presented in figure (3).

Algorithm 2 Bagging

- Input: Dataset (K train dataset D_1 to D_k by sampling with replacement), d number of instances
- Training:
 1. for i in 1 to k
 2. D_i = lagged the dataset using Lag algorithm [Algorithm 1]
 3. For j in 1 to d
 4. r = random number between 1 to d
 5. Store $D[r]$ in D_i
 6. Return D_i
- Output: $D[]$
- Train K Classifiers on respective dataset bases on a model:
Here different classifiers models are used such as SVM, Naïve Bayes, Decision Tree, Random Forest, KNN, ANN, Logistics regression.

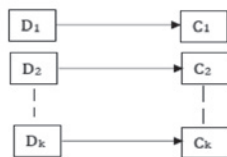


Figure.2: Training of different ML model on sample with replacement dataset

- To classify an instance, that instance is classified with K classifiers and maximum voting is done to classify the instance:

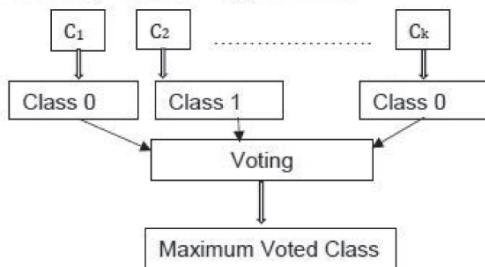


Figure.3: Classification on different instance and voting

B. Boosting

Boosting involves incrementally building an ensemble by training each new model instance to emphasize the training instances that previous models' mis-classified. In some cases, boosting has been shown to yield better accuracy than bagging, but it also tends to be more likely to over-fit the training data. By far, the most common implementation of boosting is Adaboost, although some newer algorithms are reported to achieve better results. In this work Adaboost algorithm is used to improve the accuracy of the weak classifiers. A boosting algorithm create an ensemble of classifiers, each one gives a weighted vote. The Algorithm for Boosting is presented below (Algorithm-3):

Algorithm 3 Boosting

- Input:
 - D (set of d training tuples), K (number of round-one classifier is generated per round), a classification learning scheme
- Method:
 1. The weight of each tuple in D is initialized to $1/d$
 2. For $i = 1$ to k do // for each round:
 3. Sample D with replacement acc. to the tuple weights
 4. Training set D_i is used to derive a model M_i
 5. $Error(M_i) = \sum_{j=1}^d w_j * err(X_j) / \sum(w)$
 6. if $Error(M_i) > 0.5$ then
 7. Go back to step 3 & try again
 8. End if
 9. For each tuple in D_i that was correctly classified
 10. Multiply weight of tuple with $Error(M_i) / (1 - Error(M_i))$
 11. Normalize the weight of each tuple
 12. End For
- To use the ensemble to classify tuple, X :
 1. Initialize weight of each class to 0
 2. For $i = 1$ to k to // for each classifier:
 3. $W_i = \log \frac{1 - error(M_i)}{error(M_i)}$
 4. $C = M_i(X)$; // get class prediction for X from M_i
 5. Add W_i to weight for class c
 6. End for
 7. Return the class with the largest weight;
- Output: A composite Model

C. Stacking

Stacking (sometimes called stacked generalization) involves training a learning algorithm to combine the predictions of several other learning algorithms. First, all the other algorithms are trained using the available data, then a combiner algorithm is trained to make a final prediction using all the predictions of the other algorithms as additional inputs. If an arbitrary combiner algorithm is used, then stacking can theoretically represent any of the ensemble techniques described in this article, although, in practice, a logistic regression model is often used as the combiner. The stacking model is represented as shown in Figure (4).

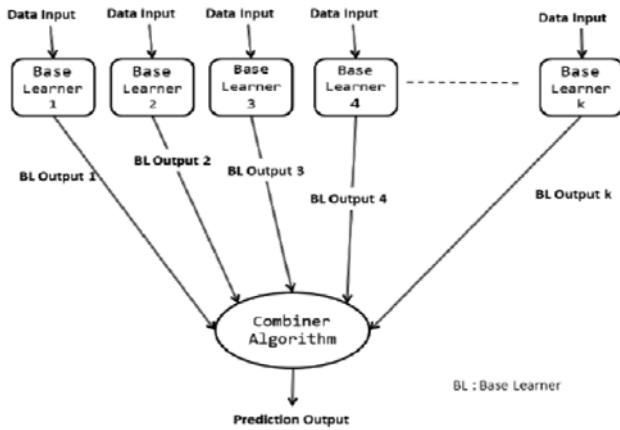


Figure.4: Stacking Model

Stacking typically yields performance better than any single one of the trained models. It has been successfully used on both supervised learning tasks (regression, classification and distance learning) and unsupervised learning (density estimation). It has also been used to estimate bagging's error rate. It has been reported to out-perform Bayesian model-averaging. The two top-performers in the Netflix competition utilized blending, which may be a form of stacking. The algorithm of stacking is presented in Algorithm-4 below:

Algorithm 4 Stacking

```

➤ Input: Dataset
➤ Classification:
1. BaseLearners = [Knn, Svm, Ann, Logistic....]
2. Combiner = [Random Forest]
3. X_train, X_test, Y_train, Y_test = test_train_split(Dataset)
4. Model = []
5. For function in BaseLearners:
6.   Model.append(function.train(X_train, Y_train))
7. Train_set = []
8. For i in range(length(X_train)):
9.   Train = []
10.  For m in Model:
11.    Train.append(m.predict(X_train[i]))
12. Combiner.train(Train_set, Y_train)
➤ Prediction:
1. Train_set_x = []
2. For m in model:
3.   Train_set_x.append(m.predict(x))
4. Output = Combiner.predict(Train_set_x)
➤ Output: Individual Accuracy array of each method, Stacking accuracy

```

D. Bayesian Parameter Averaging

Bayesian parameter averaging (BPA) is an ensemble technique that seeks to approximate the Bayes Optimal Classifier by sampling hypotheses from the hypothesis space and combining them using Bayes' law. Unlike the Bayes optimal classifier, Bayesian model averaging (BMA) can be practically implemented. Hypotheses

are typically sampled using a Monte Carlo sampling technique such as MCMC. For example, Gibbs sampling may be used to draw hypotheses that are representative of the distribution. It has been shown that under certain circumstances, when hypotheses are drawn in this manner and averaged according to Bayes' law, this technique has an expected error that is bounded to be at most twice the expected error of the Bayes optimal classifier. Despite the theoretical correctness of this technique, early work showed experimental results suggesting that the method promoted over-fitting and performed worse compared to simpler ensemble techniques such as bagging; however, these conclusions appear to be based on a misunderstanding of the purpose of Bayesian model averaging vs. model combination. Additionally, there have been considerable advances in theory and practice of BMA. Recent rigorous proofs demonstrate the accuracy of BMA in variable selection and estimation in high-dimensional settings, and provide empirical evidence highlighting the role of sparsity-enforcing priors within the BMA in alleviating overfitting.

E. Bayesian Model Combination

Bayesian model combination (BMC) is an algorithmic correction to Bayesian Model Averaging (BMA). Instead of sampling each model in the ensemble individually, it samples from the space of possible ensembles (with model weightings drawn randomly from a Dirichlet distribution having uniform parameters). This modification overcomes the tendency of BMA to converge toward giving all the weight to a single model. Although BMC is somewhat more computationally expensive than BMA, it tends to yield dramatically better results. The results from BMC have been shown to be better on average (with statistical significance) than BMA, and bagging.

The use of Bayes' law to compute model weights necessitates computing the probability of the data given each model. Typically, none of the models in the ensemble are exactly the distribution from which the training data were generated, so all of them correctly receive a value close to zero for this term. This would work well if the ensembles were big enough to sample the entire model-space, but such is rarely possible. Consequently, each pattern in the training data will cause the ensemble weight to shift toward the model in the ensemble that is closest to the distribution of the training data. It essentially reduces to an unnecessarily complex method for doing model selection.

The possible weightings for an ensemble can be visualized as lying on a simplex. At each vertex of the simplex, all the weight is given to a single model in

the ensemble. BMA converges toward the vertex that is closest to the distribution of the training data. By contrast, BMC converges toward the point where this distribution projects onto the simplex. In other words, instead of selecting the one model that is closest to the generating distribution, it seeks the combination of models that is closest to the generating distribution.

The results from BMA can often be approximated by using cross-validation to select the best model from a bucket of models. Likewise, the results from BMC may be approximated by using cross-validation to select the best ensemble combination from a random sampling of possible weightings.

F. Bayes Optimal Classifier

The Bayes Optimal Classifier is a classification technique. It is an ensemble of all the hypotheses in the hypothesis space. On average, no other ensemble can outperform it. Naive Bayes Optimal Classifier is a version of this that assumes that the data is conditionally independent on the class and makes the computation more feasible. Each hypothesis is given a vote proportional to the likelihood that the training dataset would be sampled from a system if that hypothesis were true. To facilitate training data of finite size, the vote of each hypothesis is also multiplied by the prior probability of that hypothesis. The hypothesis represented by the Bayes Optimal Classifier, however, is the optimal hypothesis represented by the Bayes Optimal classifier, however, is the optimal hypothesis in ensemble space.

VI. MACHINE LEARNING TECHNIQUES

There are different regression techniques for prediction like Linear regression, Logistic regression, Support Vector regression, Ridge Regression, Lasso regression, ElasticNet regression etc and for classification different ML classification algorithms are used such as Decision Tree, Random Forest, SVM, ANN, KNN, Naïve Bayes etc.

A. Linear Regression

Linear regression is a linear approach to modeling the relationship between a scalar response (or dependent variable) and one or more explanatory variables (or independent variables). The case of one explanatory variable, the process is called simple linear regression. For more than one explanatory variable is called multiple linear regression. In Linear regression, the relationships are modelled using linear predictor functions whose unknown model parameters are estimated from the data.

B. Logistic regression

It is estimating the parameters of a logistic model (Statistical model that, in its basic form, uses a logistic function to model a binary dependent variable; many more complex extensions exist); it is a form of binomial regression.

C. Support Vector Machine

In machine learning, Support Vector Machines (SVM) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier.

D. Ridge Regression

Ridge regression is a technique for analysing multiple regression data that suffer from multicollinearity. When multicollinearity occurs, least squares estimates are unbiased, but their variances are large, so they may be far from the true value. By adding a degree of bias to the regression estimates, ridge regression reduces the standard errors. It is hoped that the net effect will be to give estimates that are more reliable.

E. Lasso Regression

Lasso is a regression analysis method that performs both variable selection and regularization to enhance the prediction accuracy and interpretability of the statistical model it produces.

F. ElasticNet Regression

In the fitting of linear or logistic regression models, the elastic net is a regularized regression method that linearly combines the L1 and L2 penalties of the lasso and ridge methods.

G. Artificial Neural Network

Artificial Neural Network (ANN) are computing systems inspired by the biological neural networks. The Neural network itself isn't an algorithm, but rather a framework for many different machine learning algorithms to work together and process complex data inputs. Such systems learn to perform tasks by considering examples, generally without being programmed with any task-specific rules. ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit a signal from one artificial neuron to another. An artificial neuron that

receives a signal can process it and the signal additional artificial neurons connected to it.

H. K-Nearest Neighbours

The K-Nearest Neighbours (KNN) algorithm is a non-parametric method used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space.

I. Naïve Bayes Classifier

Naïve Bayes classifiers are a family of simple probabilistic classifiers based on applying Bayes' theorem with strong independence assumption between the features. Naïve Bayes classifiers are highly scalable, requiring several parameters linear in the number of variables in a learning problem. Maximum-likelihood training can be done by evaluating a closed-form expression, which takes linear time, rather than by expensive iterative approximation as used for many other types of classifiers.

J. Random Forest

Random forests are an ensemble learning method for classification, regression and other tasks. It operates by constructing multitude of decision trees at training time and outputting the class that is the mode of the classes or mean prediction of the individual trees. Random decision forests correct for decision trees' habit of overfitting to their training set.

K. Decision Tree

Decision Tree is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences, including chance event outcomes, resource costs, and utility. It is one way to display an algorithm that only contains conditional control statements.

VII. RESULT ANALYSIS

In this work, for software reliability prediction, three different ensembling machine learning approaches are used to predict and classify the dataset. In which bagging, boosting & stacking is implemented using python programming language given software reliability prediction & classification dataset. In software reliability prediction dataset given a single row of failure time of the software indexed in a file, where sample with replacement technique is used to build another dataset and train the model on that dataset and after that the prediction is done using the original dataset and similarly different rounds is used for the iteration purpose to improve the accuracy of the ensembling model. While predicting the output, different machine learning regression models are

used to predict the output and then find the error rate in the model.

A. Bagging

The prediction models or the regression methods those are used in this project are Linear Regression, Decision Tree regression, Ridge regression, Lasso regression, Elastic Net regression, Random Forest regression, Support vector regression and others. After predicting the dataset and finding the error; the error value is very less in each model. We can also say that the error is tends to zero. For each of the regression method the error rate is very less and for some regression like the logistic regression and support vector regression the error rate is bit high. The comparison between actual failure interval values versus various regression model and the bagging model is shown in figure (5), figure (6), and figure (7).

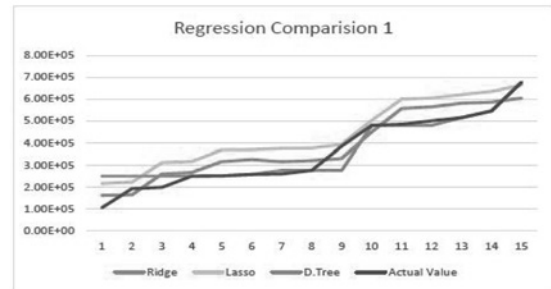


Figure.5: Regression model comparison between Ridge regression, lasso regression, Decision Tree regression model and the Actual time interval.



Figure.6: Regression model comparison between Random Forest regression, linear regression, Bayesian Ridge regression model, LassoLars Regression model and the Actual time interval

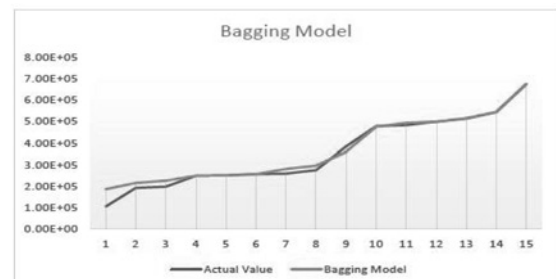


Figure.7: Actual failure time interval and Bagging model failure time interval comparison.

Similarly, in the bagging approach for the classification seven different models or machine learning classifiers are used to classify the sample with replaced dataset and then the original dataset is used to get the output class and then finding the final output voting approach is used to find the final output value. While displaying the output in the bagging approach accuracy of the model is printed also the confusion matrix and maximum value, minimum value, mean value and final bagging accuracy is printed which gives a clear idea about the classification of each model. The visualization of the accuracy of each model while where the iterator range is 7 is visualized below in Fig.8. Similarly, while we print the confusion matrix of each model there are four possible values where 2 out of 4 options are correct and others are incorrect. The accuracy value of each model depends upon the confusion matrix of each model and the accuracy can be calculated by using the confusion matrix. If there is a plot between each value of the confusion matrix in each model, then the line graph is shown as in Fig.9.

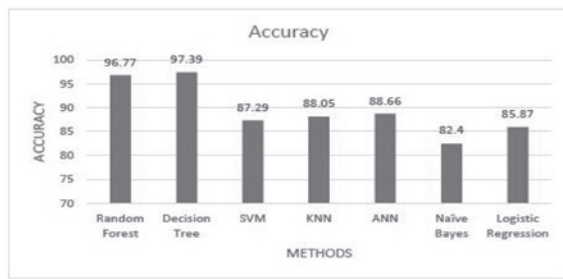


Figure.8: Accuracy of the different machine learning classification model

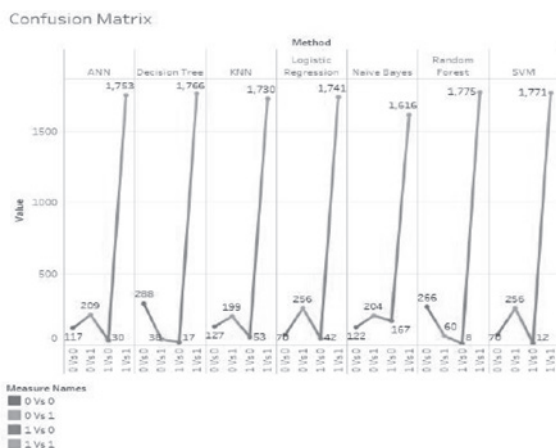


Figure. 9: Confusion matrix visualization of different machine learning models

B. Boosting

Adaboost algorithm is used to implement boosting over software reliability prediction to improve the accuracy of the dataset where for each model we are creating multiple instance of the boosting where each instance will act as a neuron; the weight will be initialized in very

small amount and then output will be predicted and again the weight will be adjusted and similar thing continues. At last the model gives the individual accuracy of each model and the boosted accuracy of each model for each iteration. The individual accuracy of each model for each iteration and boosting accuracy of each model for each iteration is presented in the figure (10), figure (11), figure (12) and figure (13).

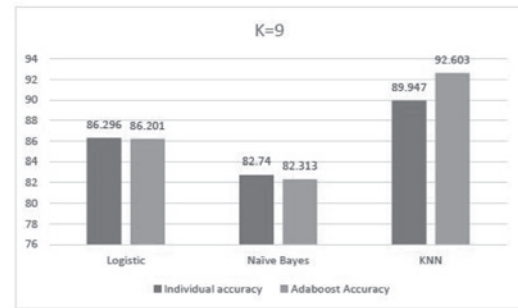


Figure.10: Comparison between boosting accuracy and individual accuracy of 3 models for iterative range k=9

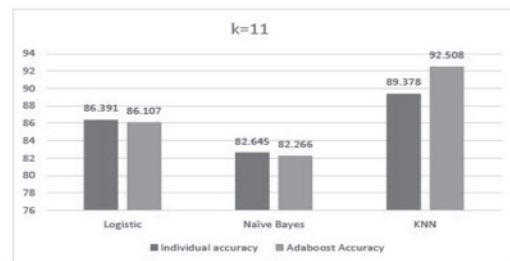


Figure.11: Comparison between boosting accuracy and individual accuracy of 3 models for iterative range k=11

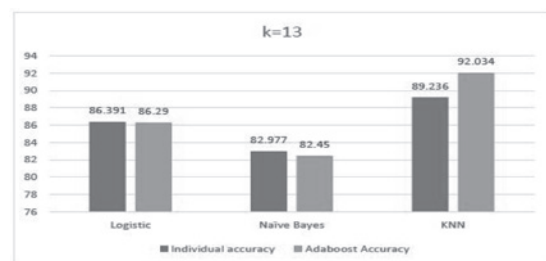


Figure.12: Comparison between boosting accuracy and individual accuracy of 3 models for iterative range k=13

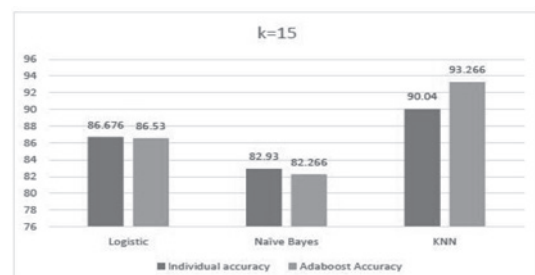


Figure.13: Comparison between boosting accuracy and individual accuracy of 3 models for iterative range k=15

C. Stacking

In stacking, to train machine learning algorithms with training dataset and then the new dataset is generated with these models. This new dataset is used as the input for the combiner machine learning algorithm. In stacking the sub-models produce different predictions. All these sub model's prediction is combined to generate a new dataset and then that is used for the combiner model. For different iteration of stacking different models are used in stacking and the accuracy value of the stacking is represented in the figure (14). Thus, from the above graph we conclude that for different value of k in different model different model give different accuracy. And from the above graph we can clearly see the variance of the accuracy for different models for different k.

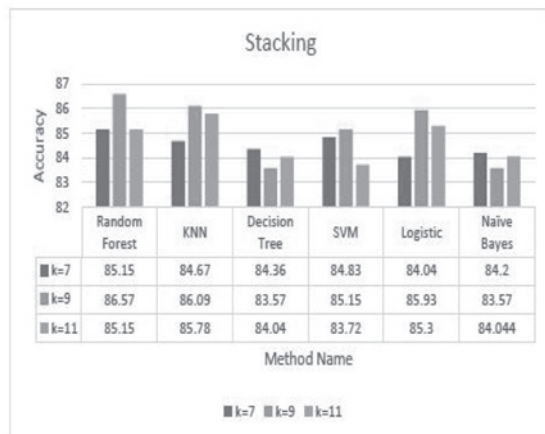


Figure. 14: Comparison between stacking accuracy of different machine learning model for different iterative range

VIII. CONCLUSIONS

Different machine learning prediction and classification algorithms are used in ensemble learning for software reliability prediction. As we have seen that in the bagging approach of the classification the output is classified in different class and then voting method is used to get the final output. In prediction problem we are getting very less error rate for prediction. In boosting model, we have taken weak machine learning model and then by using Ada Boost algorithm the accuracy of the model is improved. In stacking we are combining different base learner algorithm and then predicting the data set and finally we are using combiner algorithm to predict the output. All the output value is stored in xlsx file and tableau software is used to visualize the data or the output that is obtained from the Ensemble method for software reliability prediction.

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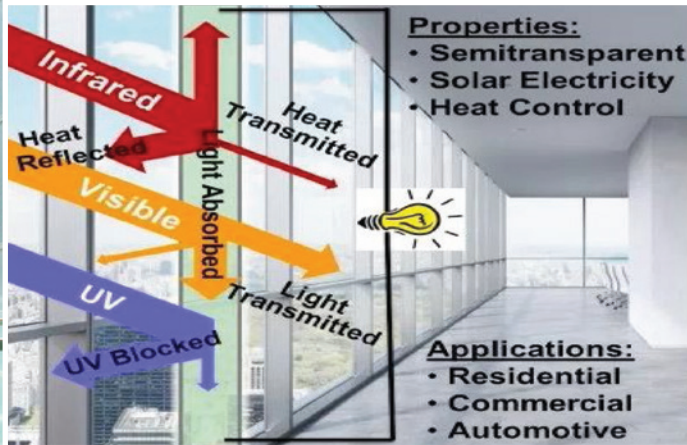
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REFERENCES

- [1] Aggarwal K K, Singh Y, Kaur A, Malhotra R (2006) Investigating the effect of coupling metrics on fault proneness in object-oriented systems. *Softw Qual Prof* 8(4):4–16
- [2] Aljahdali SH, Buragga KA (2008) Employing four ANNs paradigms for software reliability prediction: an analytical study. *ICGST AIML J* 8(2):1687–4846
- [3] Cai YK, Wen YC, Zhang LM (1991) A critical review on software reliability modeling. *Reliab Eng Syst Saf* 32(3):357–371
- [4] Eduardo OC, Aurora TR, Silvia RV (2010) A genetic programming approach for software reliability modeling. *IEEE Trans Reliab* 59(1):222–230
- [5] Ho SL, Xie M, Goh TN (2003) A study of connectionist models for software reliability prediction. *Comput Math Appl* 46(7):1037–1045
- [6] Hu QP, Dai YS, Xie M, Ng SH (2006) Early software reliability prediction with extended ANN model. In: *Proceedings of the 30th annual international computer software and applications conference (COMPSAC '06)*, vol 2, pp 234–239
- [7] Hua Jung L (2010) Predicting software reliability with support vector machines. In: *Proceedings of 2nd international conference on computer research and development (ICCRD'10)*, Kuala Lumpur, pp 765–769
- [8] Jun-gang L, Jian-hui J, Chun-yan S, Rui Z, Ang J (2009) Software reliability prediction model based on relevance vector machine. *IEEE international conference on intelligent computing and intelligent systems*, pp 229–233
- [9] Karunanithi N, Whitley D, Malaiya Y (1992) Prediction of software reliability using connectionist models. *IEEE Trans Softw Eng* 18(7):563–574

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SOLAR WINDOWS WITH 'SEMI-TRANSPARENT SOLAR CELLS'

In recent years, searching for environmental-friendly energy sources has been recognized as one of the most challenging issues in the scientific and engineering research fields. Among them, solar energy has received strong attention as one of the most promising candidates because it is clean, infinite, and relatively accessible. One way to increase the energy harvesting or energy density from sunlight is to incorporate semitransparent photovoltaic modules into transparent surfaces of high-rise buildings and automobiles or window panels in individual homes. Current semi-transparent photovoltaic are mostly based on Si, but it is difficult to adjust the colour transmitted through Si cells intrinsically for enhancing the visual comfort for human. Recent intensive studies on translucent polymer- and perovskite-based photovoltaic cells offer considerable opportunities to escape from Si-oriented photovoltaic because their electrical and optical properties can be easily controlled by adjusting the material composition. Visible light is only part of the total solar irradiation, whose power is spectrally distributed in the 380–780 nm range. The solar power distribution of the light transferred to buildings and houses through the transparent window has a big influence on visual comfort of humans. Other parameters such as AVT (average visible transmittance), transparency colour perception, corresponding colour temperature, and colour rendering index (CRI) should be evaluated for optimizing semi-transparent solar

cells. Semitransparency of photovoltaic cells provide wide varieties in the colour selection from light source, which allows residents to enjoy outside scenes with natural colours.

Researchers at The University of Tokyo have developed a semi-transparent solar cell. Instead of conventional silicon, the cell uses the organic-inorganic hybrid material perovskite to generate electricity. This material efficiently absorbs blue light, while nano-cubes of metallic silver improve the capture of red light, letting visually important green light through. Because of the efficient light capture, the perovskite layer can be made very thin, improving its transparency. The cell could therefore be used to coat windows. Since these new solar cells only absorb light that's invisible to us, the window appears transparent. While this is a huge step toward having solar windows on every new construction project, the technology isn't viable yet. Unfortunately, transparent solar windows only have an efficiency rate of about 1 to 3 percent. Until solar windows are as efficient as standard solar panels, they have little chance of proliferating in the market, but progress is being made every year, and it's only a matter of time before solar windows explode onto the design and construction scene.

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