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ELEKTRON

Transforming Humanity through Technology

A Publication of Department of Electrical Engineering.
University of Engineering and Technology, Lahore.
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MESSAGE FROM THE VICE CHANCELLOR

“

University of Engineering and Technology is an institution which has always nurtured its students to set and achieve lofty goals by providing them the freedom to polish their skill set through curricular and co-curricular activities. A commendable product of such efforts and skills is Elektron, a magazine by the Department of Electrical Engineering, produced by the Student Chapter of IEEE, UET Lahore. Elektron reflects the creative minds of the students of Electrical Engineering and their abilities to breathe life into their innovative ideas.

To make this magazine a constant source of guidance and inspiration for the masses, the work done by the team Elektron is indeed worthy of appreciation. The efforts put forth by the team Elektron should serve as a motivation for other students of UET Lahore to embark upon similar initiatives. I wish them best in their future endeavors.

”

Prof. Dr. Syed Mansoor Sarwar,
Vice Chancellor,
University of Engineering and Technology, Lahore.

MESSAGE FROM THE CHAIRMAN

“

The aphorism “publish or perish” asserts the importance of publishing the scholarly work by the faculty and students. The Department of Electrical Engineering, historically, has been highly reputed for its outstanding undergraduate program. It has never been more important to involve undergraduate students in research. To publish the work carried out by undergraduates has always been a challenge, due to the lack of availability of proper forum for this purpose. This is no more a limitation due to the introduction of Elektron magazine. The IEEE UET Lahore team has put an extensive effort to make the idea a realization. Elektron provides an excellent opportunity to both undergraduate as well as graduate students to publish their work. I believe this initiative will go a long way and will be pivotal in defining the careers of many.

Prof. Dr. Muhammad Tahir
Chairman, Department of Electrical Engineering
University of Engineering and Technology, Lahore.

”

MESSAGE FROM THE EDITOR IN CHIEF

“

In Pakistan, the students at the pre university level are often curious about opting their areas of professional education. However, it is observed that the students at those levels do not have access to the relevant knowledge to help make their minds taking suitable decision.

Electron magazine is an effort of the department of electrical engineering of UET Lahore, to remove this knowledge deficit of the pre university students. Specially, this magazine is an attempt to provide some knowledge to both the foundations and advances of the domain of science and engineering, in general and electrical engineering and its applications, in particular. Link among religion, philosophy and science is another relevant area of study, published under the scope of this magazine.

Other than helping pre university students, Elektron is also publishing articles to enhance the knowledge of early semester students of electrical engineering, professional scientists, engineers, specially, electrical engineers, and of the other readers interested in learning and knowing about foundations and advances of science and engineering.

This issue of electron invited the articles with very broad scope, but the preferred areas of interest for this issue were, but not limited to

- Religion and Science
- Contribution of Muslims in the Field of Science
- Science and Philosophy (a union)
- Technical Innovations in Electrical and Electronics Engineering
- Engineering Mathematics
- Engineering Protocols and Ethics
- Engineering Book Reviews
- Works of a Renowned Researcher
- Engineering Case Studies

Owing to the 100 years of excellence of the prestigious, UET Lahore, this issue is presenting the posters of the achievements of six highly notable and respected alumni of UET Lahore. Looking into these posters will motivate the student readers specially to work hard and then achieve as our alumni did. I hope that, the readers find the articles of this issue worth reading.

”

Muhammad Salman Fakhar
Editor in Chief (Faculty), Branch Counselor, IEEE UET, Lahore.
Lecturer,Department of Electrical Engineering
University of Engineering and Technology, Lahore.

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SURAH *"Al Baqara"*
VERSE *"22"*

الَّذِي جَعَلَ لَكُمُ الْأَرْضَ فِرَاشًا وَّالسَّمَآءَ بِنَآءً ۖ وَّأَنْزَلَ مِنَ السَّمَآءِ مَآءً فَأَخْرَجَ بِهٖ مِنَ
الثَّمَرٰتِ رِزْقًا لَّكُمْ ۚ فَلَا تَجْعَلُوْا لِلّٰهِ أَنْدَادًا وَّأَنْتُمْ تَعْلَمُوْنَ ﴿٢٢﴾

It is He Who has made the earth a rest-ing-place for you, and the sky a canopy, and sent down water from above wherewith He brought forth fruits for your sustenance. Do not, then, set up rivals to Allah when you know (the Truth).

This Picture is taken from "https://commons.wikimedia.org/w/index.php?curid=16128630" By Evan-Amos - Own work, Public Domain

Article 1

The Multi-functional and Reconfigurable Radio Frequency Devices for Modern Wireless Transceivers

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***Abstract*- This article highlights the importance of multi-functional & reconfigurable radio frequency (RF) devices for the realization of transceivers intended for future generations of wireless communications. The applications of such multi-functional and reconfigurable passive RF devices have been described briefly with the special focus on reconfigurable power dividers, power combiners, power couplers, filters, and antennas.**

Moreover, the role of reconfigurable antennas having the capabilities of beam-switching, polarization switching, and center operating frequency agility has been described for intended applications including cognitive radar. As the pattern reconfigurable antenna can switch its main beam towards the intended mobile user for improved wireless link performance.

So, two examples of such pattern-switching antennas have been given where simple beam-forming networks (BFNs) have been employed to realize the required beam-switching function for the integrated antenna arrays.

Keywords— Reconfigurable devices, tunable filters, antenna, beam switching, polarization switching

INTRODUCTION

The future generations of wireless communications including 5G, 6G, and the intended technologies for such communication links like software-defined radios (SDR) and in-band full-duplex techniques

require novel and versatile transceivers architectures having the capabilities to operate in multiple frequency bands and multi-function operability.
In addition, such transceivers must have the capabilities to suppress or mitigate the interference resulting from a very dense electromagnetic environment to avoid the resulting performance degradations.
Moreover, the novel RF passive components are very necessary for the realization of transceivers which require the co-integration of multiple wireless communication services and standards in a single radio with limited size.
This requires the realization of versatile and novel RF passive components which can perform multiple processing actions in a single circuit with reconfiguration capabilities.

APPLICATIONS OF RECONFIGURABLE RF DEVICES

The multi-functional and reconfigurable passive RF devices can be used for the effective realization of novel wireless communication systems operating in different frequency bands and polarizations etc.
For the realization of such transceivers, novel RF passive circuits and sub-systems with capabilities of the adaptive transfer function and improved performance are required. The intended passive devices for such transceivers should possess frequency-agile characteristics and reconfigurable polarization capabilities etc.
Moreover, the planar multi-functional and reconfigurable passive RF devices are of great interest to be integrated with other active RF subsystems to realize the wireless communication transceivers with reduced insertion losses and compact structures. For instance, the frequency adaptive power dividers, power combiners, RF couplers based on planar structures can offer reduced insertion losses, simple integration capabilities, and reduced size and cost of the transceivers compared to those with frequency static behaviour. Moreover, such components with multi-band operation capabilities can provide additional reductions in the system complexity and cost. Furthermore, the multi-functional and reconfigurable passive planar filters with controlled transmission zeroes in the pass band and stop band are of great interest to suppress the interference signal, especially for 5G and 6G communications.
The additional tunable pass-band capabilities for such filters can offer the realization of frequency-agile transceivers.
Such filters are very critical for RF preselect to define the operational frequency band for radio transceivers.

RECONFIGURABLE FILTERS

Although, a lot of research has been reported on multi-functional and reconfigurable passive RF devices especially focusing on power dividers, power combiners, and filters, etc. [1-2].
In fact, the filters are required for realizations of power dividers and power combiners too. However, most of the reported designs do not meet the required characteristics for multi-functional and reconfigurable passive RF devices.
For instance, such filters are not able to offer multiple passbands and multiple transmission zeros on both lower and upper sides of the pass-band to achieve sharp suppression capabilities. The same is the case with most of the other RF and microwave passive circuits and devices.

RECONFIGURABLE ANTENNAS

Recently, the reconfigurable antennas have gained tremendous research attention for the various wireless applications especially for the cellular radio system, satellite links, radar systems, airplanes, and unmanned airborne vehicle radar and smart weapon protection, etc. [3].
For instance, the reconfigurable antennas play a very critical role for mobile and satellite links to support the multiple wireless standards through suppression of strong interference signals, especially in a very complex wireless environment. In radar systems, reconfigurable antennas are required for multi-functional radar modes including the radiation pattern or beam-switching, polarization switching, and frequency agility.
One of the most important devices for such applications is the multi-functional reconfigurable antenna. For instance, such antennas are an integral part of cognitive radar [3]. Cognitive radar is a type of next-generation radar system which can provide improved measurement performance for the dynamic environment. For cognitive radar, the multifunctional reconfigurable antenna should provide the intended antenna beam pattern, polarization, centre operating frequency and impedance bandwidth, etc.
For instance, the intended mode of the employed antenna can be established through RF switches, etc. Moreover, the electromagnetic bandgap (EBG) based antennas can provide a very convenient way to create the beam in the desired direction and intended polarization for that beam [4-5].
The reconfigurable antennas with pattern switching (beam-switched antennas) will also play a very important role for 5G and 6G communications through multiple narrow switched beams for the

intended direction to serve the user(s). Such antenna has the ability to select one of several predefined beams (radiation patterns) to improve the power of the received signal from the required direction [6]. For instance, the BS (base station) can estimate the signal of interest directly from any active subscriber or user to switch the beam in that direction to communicate with that mobile transceiver with an improved signal to noise ratio as depicted in Figure 1. These spatially distributed beams or radiation patterns from antennas can suppress the interference to offer improved wireless coverage and frequency re-use performance. The reconfigurable antennas with polarization switching capabilities are an integral part of 5G cellular networks, wireless power IoT systems, and wireless sensor network applications [7-8]. The reconfigurable antennas with pattern switching or beam switching capabilities require a beam forming network (BFN) to generate or switch the radiations from the antenna in a certain direction as indicated in Figure 2.

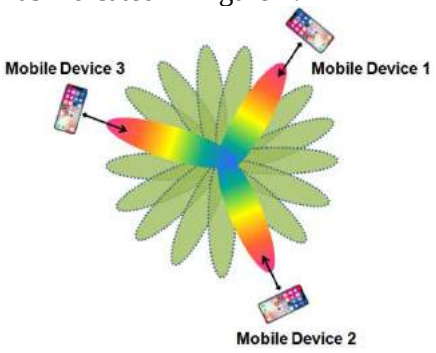

Figure 1. The pattern switching antenna for coverage in the mobile wireless environment.

The BFN provides the required amplitude and or phase excitation to direct the radiations from the antenna array (multiple antenna elements arranged in specific configuration) in the intended azimuth and elevation plane.

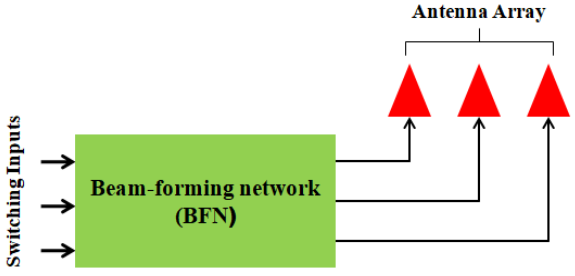

Figure 2. The basic configuration of transmits antenna array integrated with BFN for beam-switching.

The required BFN or beam-switching network should be simple and low loss along with the capabilities to generate a large number of switched beams for the specific application. For instance, two excellent designs of such antennas are reported in [6] and [9-10]. The reported antenna in [9] is based on a 2 × 10 antenna array with a series-feeding configuration for a 60 GHz frequency band. A very simple quadrature coupler has been used as BFN to generate three beams with the help of a single RF switch for excitation of the employed antenna array through the respective port of the coupler as depicted in Figure 3. The 2×2 series-fed antenna array reported in [6] employs two simple quadrature couplers as simple BFNs to generate ten (10) dual linearly polarized beams which can be switched in both azimuth and elevation planes as indicated in Figure 4. The passive quadrature couplers have also been used as BFNs in [10] to produce six dual circularly polarized beams in two-dimensional (2D) space with low beam scanning loss and reduced sidelobe levels.

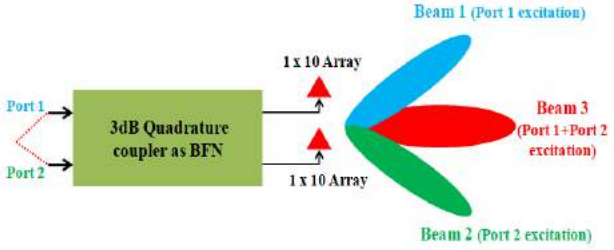

Figure 3. The generation of three switched beams through a quadrature coupler as BFN [9].

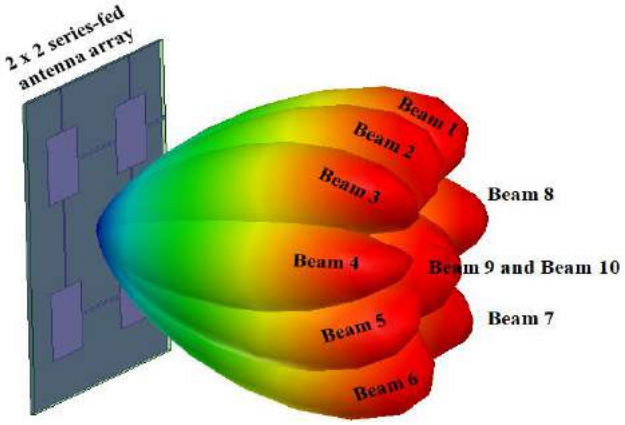

Figure 4. Generating ten (10) dual-polarized, switched-beams from 2 × 2 series-fed antenna array with the help of very simple and low power loss beam switching networks [6].

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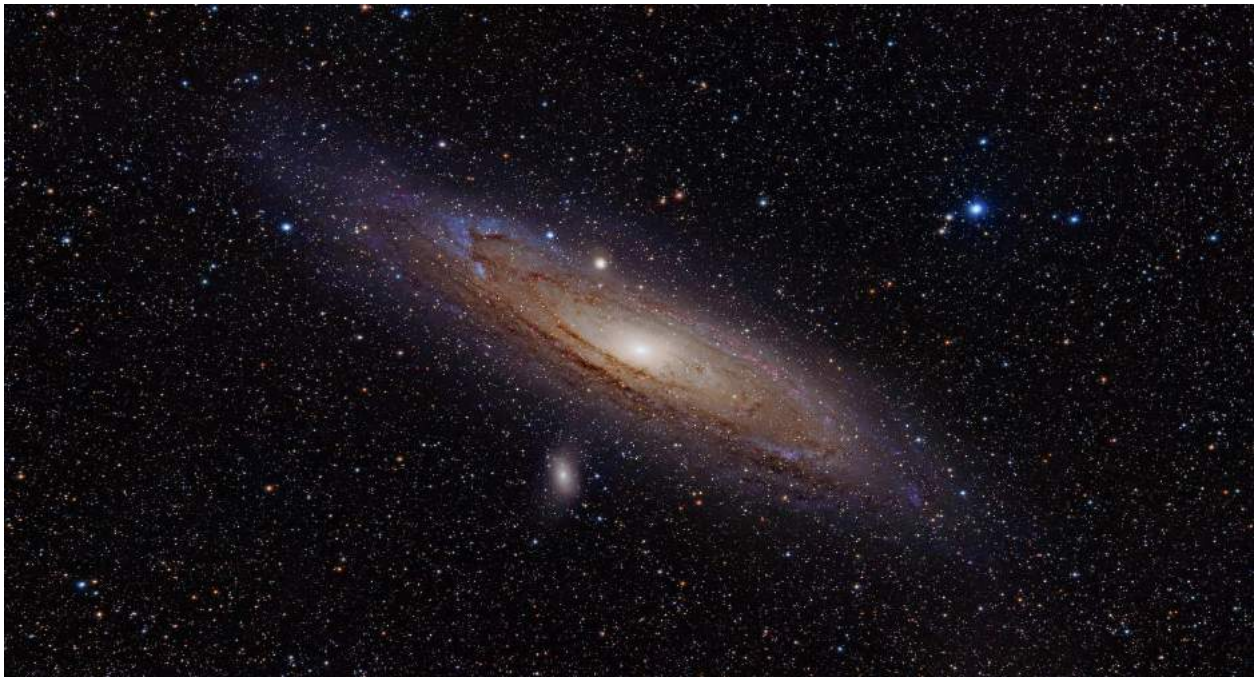

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Article 2

Cosmology: Science and Philosophy in Concert

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"Philosophy is empty if it isn't based on science. Science discovers, philosophy interprets."

~ Albert Einstein

Ever since the beginning of civilization, humans have been intrigued by the starry sky of the night trying to find answers to the most fundamental questions about the origin of this universe and its existence. Those who came up with the answers became the philosophers who tried to make sense of their limited observations. Philosophy thus became the prevailing approach towards cosmology and kept on influencing many of the earlier minds of this century. It laid the foundation of a methodology that paved the pathway to ponder upon the scientific ideas through every possible input of observational and rational thought processes.

Tremendous progress in cosmology has been seen in the last couple of decades. The extraordinary growth in this field of science has become possible with the recent advancements in technology through rapidly evolving innovations and techniques that have enabled scientists to gather data that can be interpreted mathematically and utilized quite accurately in various research models. It is during this period that the philosophers could not keep up with the pace and lost the run and cosmologists and astrophysicists themselves became the philosophers of science. However, modern cosmology still has a deeply embedded philosophical tone in its scientific approach towards research.

"Philosophers have not kept up with modern developments in science. Particularly physics."

~ Stephen Hawking

Nowadays, the philosophers of physics who turn their ideas into hypotheses employing mathematical equations and observations of the physical world to understand, describe and predict the laws governing natural phenomena are called theoretical physicists.

Of all the branches of science, many of the fundamental concepts of cosmology are based on deep-rooted philosophical ideas that were laid centuries ago by the great historical figures like Pythagoras, Plato and Aristotle and even Copernicus and Kepler who were very renowned philosophers as well as scientists and mathematicians of their times.

Modern cosmology started as theoretical physics through the works of Einstein and Lemaître[1]. It was until 1960 that cosmology was considered primarily as a branch of philosophy.

It is our limited capacity, as compared to the vastness and grandeur of the universe, of making observations that have been a source of continuous void in our knowledge and understanding of the universe that ultimately compels us to correlate and integrate our ideas about the creation of the universe and all the physical existence through philosophical discussions and arguments. Professor George Francis Rayner Ellis, the emeritus distinguished professor of complex systems in the Department of Mathematics and Applied Mathematics at the University of Cape Town in South Africa, once argued in one of his famous papers that most of today's major questions in the philosophy of physics like the nature of space-time, the unification in science and quantum theory of gravity, all share deeply embedded concepts within the philosophy of cosmology[2]. Philosophical ideas have been observed to direct the progress of cosmology throughout its evolution along with the observational tools that make indirect measurements as well as sometimes direct measurements. Moreover, cosmologists throughout history have always been quite open to discussing philosophical issues, for example concerning the very nature of science itself. Pythagoras' philosophy set out cosmology as the science of the harmonious and the beautiful that is finite and well orderly arranged. Later on, the Italian philosopher Giordano Bruno proposed the idea of an infinite universe[3] that was purely philosophical and made deep impressions on modern cosmology. The beauty in cosmology is its philosophical aspect where our lack of comprehension and observation provides us with reasonable grounds to make sense of the universe by devising new theories that can explain the nature of all the existence including our own. If one sincerely wants to reach the truth, he must thus consider all the data- the data about all the physical, spiritual, moral, emotional, and artistic realms as well as from the human history and incorporate the meaning and purpose of life based on human experiences because this is all part of the universe reflected in human existence that in turn itself is a part of the universe as the existence of life on earth.

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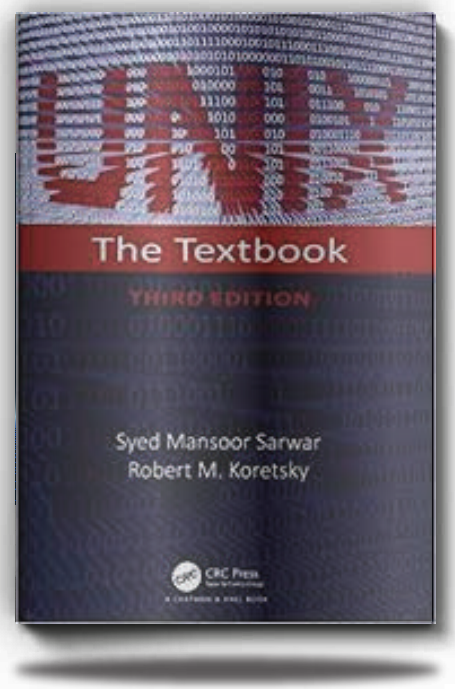
ALUMNI ACHIEVEMENT

VICE CHANCELLOR

Professor Dr. Syed Mansoor Sarwar

Prof. Dr. Syed Mansoor Sarwar With a Ph.D. in Computer Engineering from Iowa State University, Ames, Iowa USA, joined UET after serving Punjab University College of Information Technology (PUCIT) for over 12 years and took retirement after serving for more than 12 years in 2018. Previously, he had served the University of Portland as an assistant professor and associate professor for over a decade. He served at the Lahore University of Management Sciences (LUMS) as a professor and head of Computer Science Department. From January 1991 to August 1991, he was the Area Chair, Computer Science at the Pak-American Institute of Management Sciences, Lahore. From August 1988 to August 1990, he served as an Assistant Professor at the Department of Electrical and Computer Engineering, Kuwait University. He started his academic career in April 1982 as a Lecturer at the Department of Electrical Engineering, University of Engineering and Technology (UET), Lahore.

The latest book by Prof. Dr. Syed Mansoor Sarwar, Vice-Chancellor, University of Engineering & Technology, Lahore. Unix The Textbook, (third edition) — has been ranked 1st in Book authority's ranking of 73 Best Unix eBooks of all time and 2nd in the list of 100 Best UNIX Books of all time. Dr. Sarwar is the only Pakistani who has achieved such a coveted honor.



His Book ranked 1st in Book Authority's Ranking in the World.

ALUMNI ACHIEVEMENT

Professor Muhammad Nawaz

Professor Muhammad Nawaz, 68-UET alumni of Mechanical Engineering, started his academic career in 1975 with the University College of Engineering, Taxila (now UET Taxila). He was the first Mechanical Engineering lecturer (and the only one for a couple of years) in the College. From 1975 to 1986, besides teaching, he established many labs/workshops, held many portfolios like Social Welfare Officer, Senior Warden, Chairman Transport Committee. He was a Member of the Academic Council, UET Lahore too. In 1986, he moved to Australia.

In Australia, Muhammad Nawaz worked at the RMIT University, Melbourne, for more than 25 years. He taught many courses to engineering and business students; supervised scores of UG and PG researcher projects. In addition, as a Program Director in the School of Aerospace, Mechanical and Manufacturing Engineering (SAMME), he devised and managed many courses and UG & PG programs.

Highly cited research paper:

Other than his accomplishments as a teacher and administrator at UET Taxila and RMIT University, Muhammad Nawaz's golden achievement is a highly cited paper*, published in the Omega-The International Journal of Management Sci, 1983. To date, the article:

- has achieved more than 2800 Google Scholar and 1830 Scopus citations.
- is one of the most cited papers by Pakistani researchers.
- is the most cited paper by Pakistani engineers.

A recent study reported the paper is the most frequently cited article in 40 years of history of OMEGA.

NEH (Nawaz, Enscore, Ham) Algorithm:

The heuristic algorithm developed by Muhammad Nawaz, and described in the paper*, is now called the NEH algorithm - named after the authors of the paper – Nawaz, Enscore, Ham. The algorithm is:

- the best constructive heuristic for flow-shop makespan minimisation problem.
- in many UG/PG level textbooks.
- part of university courses in several countries.

The NEH algorithm has become a research topic itself. Scores of variants of the NEH algorithm have been developed to tackle many scheduling problems. Other than the traditional flow-shop environment, applications of the NEH algorithm include Computing, Computer Systems, Communications, Health Services, Defence operations, etc.

***A heuristic algorithm for the m-machine, n-job flow-shop sequencing problem**
M Nawaz, EE Enscore Jr, I Ham - Omega, 1983 - Elsevier

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Article 3

Real-Time Monitoring and Control of Transformer Using IoT

Mohsin Ali
Masters' student, session 2020
Department of Electrical Engineering, UET Lahore.
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Abstract- **The temperature of the transformer mostly depends upon the load, and it gradually rises with the load increment. Due to the overloading of the transformer, a high current in winding will increase I^2R losses which enhances the heating effect in the tank of the transformer which ultimately damages the winding on the core. Conventionally, to decrease the temperature and to cool down the transformer, all the cooling fans of the transformer run automatically just after the temperature crosses a threshold limit. But this practice is highly inefficient because it consumes a lot of power as all the transformer fans run automatically at once. To eliminate this hazard, we are implementing an online monitoring and control system of the transformer. It will allow the operator to control the transformer automatically or manually. The group fans will turn on automatically for set values of temperature. It will also fulfill the purpose of a conventional cooling system. The project is based on the internet of things.**

We have developed a mobile application for the remote monitoring and control of transformer cooling systems. Google cloud database is used for the communication between mobile applications and transformers. The real-time temperature of the transformer is accessed through a mobile application and the status of the current running cooling fans is also available in the application. For demonstration purposes, we have built a transformer prototype. Thermal and electrostatic analysis of the transformer has been done on COMSOL Multiphysics. This will allow us to see the thermal stresses on the windings of the transformer. The

conjugate heat transfer methodology has been used to predict the thermal properties of the transformer using the finite element method (FEM).

Keywords- Transformer, Control, Internet of things (IoT), COMSOL, Finite Element Method (FEM), Hotspots in Transformer, Temperature Sensor

INTRODUCTION

As we know a transformer is the most vital entity of a power system. Also, the transformer is the most expensive element at the grid station. Thus, the protection and maintenance of the transformer are also important. Here we are introducing a simplified way for monitoring and controlling the transformer. This project provides a general description of the cooling system of the transformer. This will be done using the internet of things technology that is the future of all the electronic and electrical components. Later we have simulated a real transformer on COMSOL Multiphysics.

Although transformer oil is used as a coolant in transformers most of the time even the temperature of transformer oil reaches an extreme level. Therefore, High Voltage transformers work on the oil natural air forced (ONAF) cooling principle. Here temperature of the transformer is controlled by the switching of cooling fans. These fans turn on or off automatically. This could be done manually depending upon the intention of a transformer operator. But the problem here is that for the constant monitoring of transformer temperature an operator should stick to grid station all the time. Also, one cannot manually control the fans of the transformer from out of the grid.

The solution is that there must be an online way to monitor and control the transformer. That will be done via the internet of things [1]. In our prototype, we have used the ESP8266 microcontroller, which is a highly preferred controller for IoT projects. ESP8266 has a built-in Wi-Fi module [2]. It will provide an online platform that will keep the operator in touch with the transformer. Waterproof temperature sensor DS18b20 has been used to measure the temperature of transformer oil. A 5V DC, 8-Channel relay JQC-3FF-S-Z has been used to turn on/off 12V DC fans having a 1.68A rating. These fans will represent the actual cooling fans of the transformer. To increase the temperature of transformer oil a heating rod has been employed. This will create the same environment as that of the real transformer. To have access to the transformer, a mobile application has been developed and that mobile application will use cloud database as an intermediate station between mobile and microcontroller. This application will also allow its user to control transformer cooling fans, also it will show the status of fans in both automatic control mode as well as in manual control mode.

Simulation of the transformer has been done on COMSOL Multiphysics. In which we have first replicated the practical 132/11 kV transformer. Voltage stresses on windings have been measured using AC/DC module. Current density plots have also been drawn using the same module. Thermal analysis has been done using the joule heating phenomenon. Magnetic flux density plots and current density plots have been done to investigate stress on core, windings insulation, and rest of transformer body.

This project could be very much beneficial for those who want to have an online platform for the monitoring and controlling of transformers as well as other electrical types of equipment. This project can be installed on other electrical types of equipment such as a generator for which the operator wants to see the temperature of the generator to see whether the generator is overloaded or not. Also, it can be used for wireless communication and control.

Figure 1. Total heat source (W/m^3) in the winding

PROBLEM

The transformer is one of the most important components in an electrical power system. It plays a key role in continuous supply to the electricity users that's why it becomes essential to monitor key parameters of the transformer to ensure the continuity of electrical power. Many transformer manufacturing companies in Pakistan face problems of not being able to monitor the condition of their products continuously. These companies receive complaints from their clients regarding the reliability of the transformer, and they want to know the actual cause behind these problems. They need to have recorded data i.e.: the temperature of the transformer and some other parameters so that they can tackle the fake complaints. A transformer operator cannot keep an eye on the transformer parameters all the time at

the transformer site, so it might be needed to monitor and control the transformer from the remote end to prevent any disruption. In this way, one needs to monitor and control the transformer's cooling system from the far end. Moreover, there is limited control of the fans of a transformer and therefore, individual fans cannot be controlled. We may need one or two fans for a specific temperature to save power but due to the limitation of control, we can only set 2 to 3 output signals for fans. Also, the sequence of fans cannot be controlled. One group of fans runs every time at a specific temperature for a long time that reduces the life of fans. These are some of the problems the project has solved.

METHODOLOGY

We have used IoT [3] approach in this project. There are three main parts of the project:

1) Remote Terminal Unit
2) Cloud Database
3) Monitoring and Control System

REMOTE TERMINAL UNIT

The remote terminal unit is mounted on the transformer to monitor and control from the remote end. It consists of a microcontroller, sensors, relays or contactors, and a Wi-Fi module.

Figure 2. Methodology diagram

The microcontroller is the main component of this terminal unit and acts as the brain of this unit. It can be programmed as we desire to perform the actions. It continuously monitors the temperature through a digital temperature sensor and sends the data to monitoring mobile applications via a cloud database. The relays are connected to the microcontroller to perform the switching actions. Cooling fans are turned on or off automatically according to the temperature set values which we can be set as we desire. The microcontroller sends signals to the relays to control fans automatically. The microcontroller present in the remote terminal unit also receives control commands from the smartphone to perform the actions. The control actions are turning on or off cooling fans of the transformer from a smartphone through the manual control option in the mobile application.

CLOUD DATA-BASE

A cloud database plays an important role in an IoT [4] project. It is a database service built and accessed through a cloud platform and is very helpful in the modern age. It is a medium of communication between remote terminal units and a monitoring and control system.

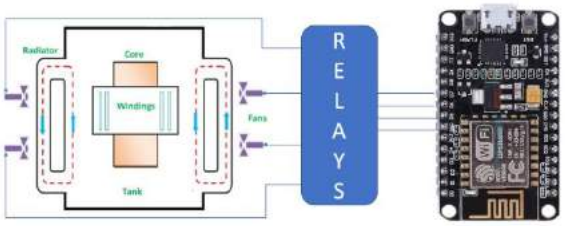

Figure 3. Fan controlling system

It stores data of the monitoring parameters of the transformer and sends it to the smartphone in real-time without any disturbance and delay. One just needs an internet connection to access this cloud-hosted database. Any operation can be performed securely through this platform, and it provides great flexibility.

Figure 4. Temperature transmitting system

We can store and synchronize data with this NoSQL cloud database. Data is synchronized in real-time and remains available even when the app goes offline. The mobile application gives a control command, and it is sent to the micro-controller via this cloud database.

MONITORING AND CONTROL APPLICATION

A mobile application has been developed which can be installed on any android phone. This application monitors the temperature of the transformer in Real-Time. It is connected to the cloud database and receives the data from the database. It shows the status of the fans who are running at that moment in real-time. We can also control the cooling fans of the transformer through this mobile application and

hence can control the temperature of the transformer. The number of fans running is known to us through this application. It provides a good user interface for the convenience of the users. A transformer operator just needs to install this mobile application and will have access to the transformer wherever he goes.

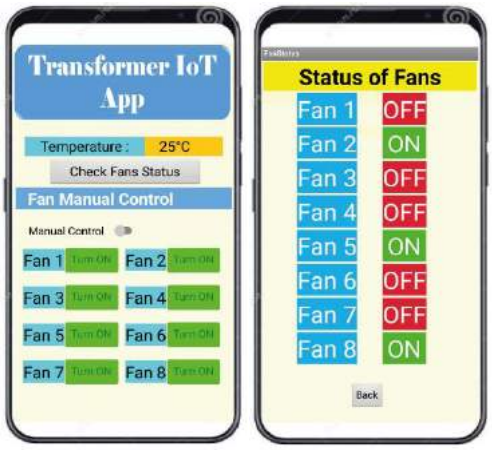

Figure 5. Application homepage and status of fans

CONCLUSION

A complete online temperature monitoring in real-time and fans controlling system with flexibility from the remote end has been achieved in this project. Transformer temperature monitoring has been made possible without being present on the transformer site. In this way, the load on the transformer can be guessed through its live temperature updates. The current situation of the fans has been made possible to see from anywhere if you have a smartphone.

The limitation of controlling the fans individually has been removed, now the fans can be controlled more flexibly. As there was a maximum of 2 groups of fans before because of the limited signals to the fans. So, this project has resolved that problem and has made flexible control of the fans so that the same fans don't turn on again and again.

The lifetime of the fans affects when they are continuously being turned ON or OFF. The control of the fans has been provided in a mobile app and a transformer operator can access them wherever he goes. There is a need for Wi-Fi on the transformer site to connect a microcontroller to the database and send the data to the mobile app to access monitoring and control of the transformer. That might be the thing to consider for investors otherwise it's a good future investment for the transformer.

FUTURE RECOMMENDATIONS

There are still some great opportunities for future work in this kind of project. Some other parameters of the transformer can be monitored online like power frequency, voltage level, Power factor, total power delivered, etc. And there are other components of the transformer that can be controlled online like the tap changer of the transformer. The data of the temperature values can be stored online to have an idea of the load changes over the period. And remedial work can be done easily by seeing the previous data. Many transformers can be linked to a system that will have all the transformers of a region, or any area and they all can be assigned unique IDs and can be monitored online, and one can have access to them by controlling them from a remote end. Any manufacturing company will have access to its transformers to tackle the fake complaints. The company can know the real reasons behind the faults of every transformer. So, there is a lot of work that needs to be done in this field for future projects.

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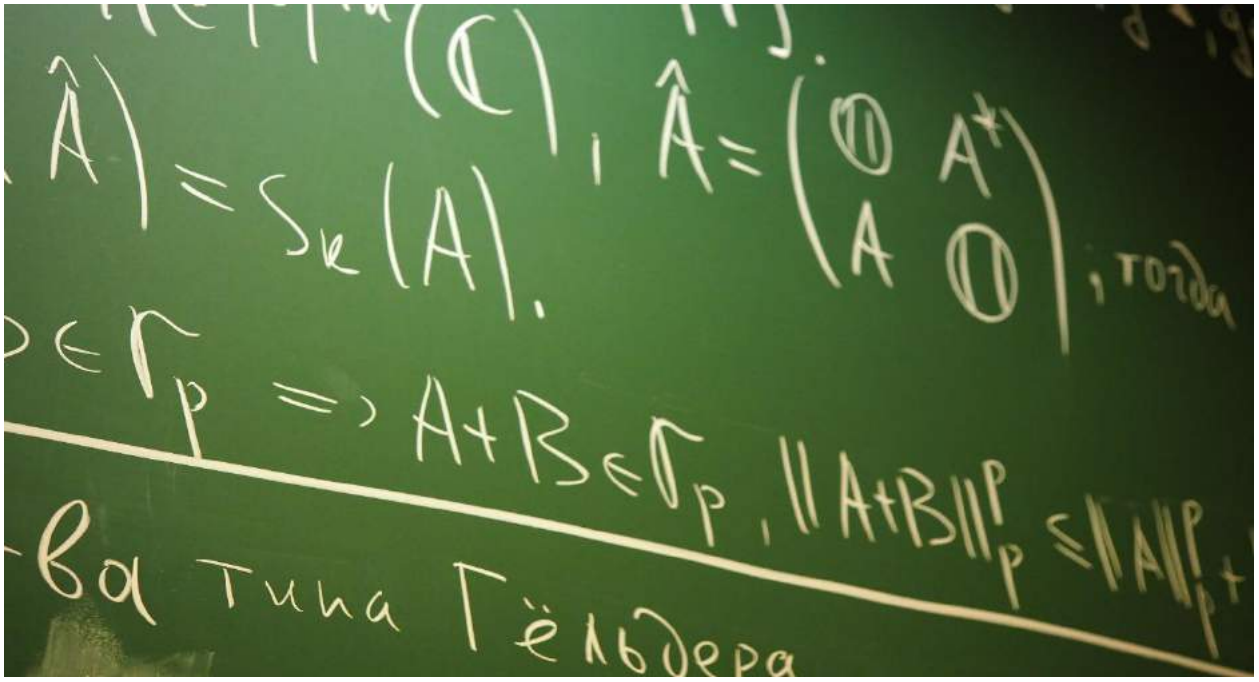

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Article 4

Application of Regression Techniques with their Advantages and Disadvantages

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Abstract- **Regression techniques are the most widely used statistical techniques employed on a large variety of optimization problems in the field of applied research. The basics of five linear and non-linear regression techniques will be reviewed along with their applications, advantages, and disadvantages to propose a way of selecting regression techniques for different types of optimization problems.**

Keywords— Linear regression, Exponential regression, Power regression, Polynomial regression, Gompertz regression

INTRODUCTION

Regression is a statistical method applied in the fields of engineering, business, finance, medical and other disciplines having the objective to find the correspondence between one dependent variable and a series of other independent variables. There are many regression techniques present in the literature, used for research purposes. In this article, the application, advantages, and disadvantages of following regression techniques in research are presented.

- Linear regression
- Exponential regression
- Power regression
- Polynomial regression
- Gompertz regression

Power regression method to predict rainfall in India was used by reference [1]. Reference [2], used the power regression method to study the effect of accumulated oxygen deficit.

According to the exponential power distribution, reference [3] developed Bayesian analysis for the linear regression model with random errors distribution. In reference [4], a comparison of estimating diffusive CH_4 by closed chambers using linear and exponential regression was made.

Reference [5], presented the bearing Residual Useful Life (RUL) estimation by proposing a new methodology by combining data-driven and model-based techniques. Estimation of bulk power systems using linear regression-based disturbance magnitude technique was presented by reference [6]. In reference [7], a multiple linear regression approach was used to forecast building energy performance. Reference [8], presented the use of multiple linear regression techniques with interactions to model and forecast hourly electric load. In reference [9], the energy efficiency of the commercial buildings was modelled using the fuzzy linear regression technique. In reference [10], polynomial regression analysis was used for the optimal design of novel pole pieces for the power density improvement of magnetic gear. In reference [11], considering weather feature selection and adjustment the holiday load forecast was done using the fuzzy polynomial regression technique.
Reference [12], presented the residual analysis of the uncertain Gompertz regression model and also the corresponding forecast value and confidence interval. In Reference [13], gompertz and neural network models for broiler growth were compared. In reference [14], gamma distribution generated dependence for bivariate gompertz model of likelihood estimation procedure was proposed. Reference [15], developed a regression model of the germination of fern spores using the gompertz regression technique.

LINEAR REGRESSION

In linear regression, modelling of the relationship between two variables is carried out by fitting a linear equation in accordance with the observed data, considering one variable to be an independent variable, and the other to be a dependent variable.

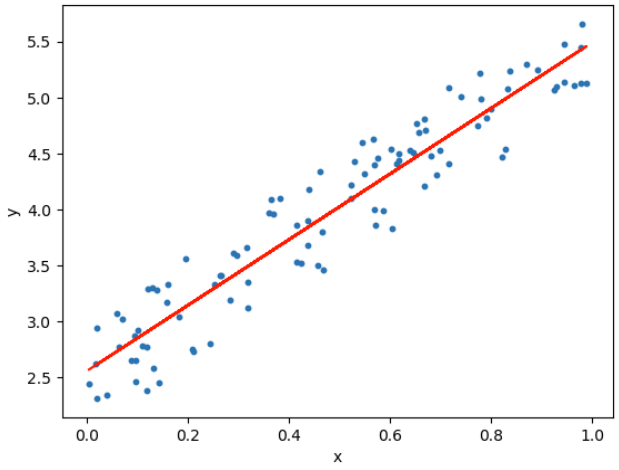

Figure 1. Linear regression curve

For example, one might want to determine a relationship between the weight of individuals to their heights by utilizing the linear regression technique. Before attempting to fit a linear model to the observed data, one should first check whether or not there exist a relationship of interest between the variables. To estimate the robustness of the relationship between two variables a scatter plot can be a useful tool.

$$y = a + bx \quad (1)$$

The canonical expression used for the linear regression technique is shown by equation (1), where y is the dependent variable, x is the independent variable, a is the intercept value (when $x = 0$), and b is the slope of the line. Figure 1 shows the linear regression curve.

ADVANTAGES OF LINEAR REGRESSION

1) Linear regression technique is a very manageable optimization algorithm that can give a robust solution. Models obtained from linear regression techniques can be implemented easily and efficiently on systems having low computational capacity as compared to complex algorithms.
2) The mathematical equation of the linear regression technique is very easy to understand, and its time complexity is much lower as compared to other machine learning algorithms.
3) Linear regression technique can be used to model linearly separable data sets and can be used to find the nature of the relationship among variables.

DISADVANTAGE OF LINEAR REGRESSION

1) The linear regression technique assumes that the data of interest is independent.
2) Linear regression may stick to under-fitting, a situation in which machine learning models fails to encapsulate the data of interest properly. It usually happened when the hypothesis function cannot fit the data well.
3) Most of the naturally occurring phenomena are non-linear therefore linear regression technique fails to fit complex data sets properly because it assumes that there exists a linear relationship among the input and output variables.
4) Outliers of data set are the irregularities or the extreme values that deviate from the data distribution. Linear regression is sensitive to these data outliers and can spoil the performance drastically and may lead to models with low accuracy.

APPLICATION OF LINEAR REGRESSION

1) Epidemiology
   Relating smoking to mortality and diseases came from the observational studies implementing linear regression analysis. For example, we have

a linear regression model in which cigarette smoking is the explanatory variable, and the dependent variable is the lifespan of an individual measured in years.

2) Finance
   Linear regression and the beta concept are used for analysis and evaluation of the systematic risk of funding. This comes directly from the beta coefficient of the linear regression model that relates the return on the investment to the return on all risky assets.
3) Econometrics
   Linear regression is used in economics as an optimization tool. In modern econometrics. fitting the line through data points reflecting paired values of the independent and dependent variables can be done using linear regression estimating model.
4) Environmental Science
   Environmental science finds a large range of linear regression applications. Environmental effect monitoring on fish and benthic surveys to estimate the effect of metal mine or paper pulp on the aquatic ecosystem uses linear regression techniques.

EXPONENTIAL REGRESSION

Estimating a model of the rapid growth or decay initially and then slowing down at the end can be modelled using exponential regression. The process of exponential regression involves finding the equation of exponential function that best fits a set of data as shown in Figure 2.

$$y = ab^x \qquad (2)$$

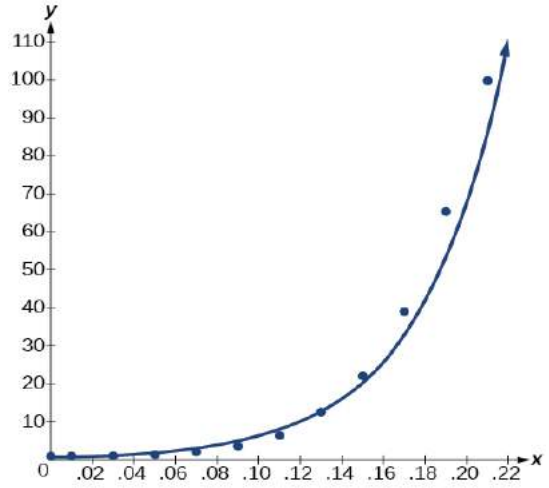

Figure 2. Exponential regression curve

Equation (2) shows the canonical exponential regression model, where $a \neq 0$. R^2 denotes the relative predictive power of the exponential model. Its value is between 0 and 1. If the value is closed to 1, the model is more accurate.

ADVANTAGES OF EXPONENTIAL REGRESSION

1) After the linear regression technique, the exponential regression technique is an easy one to understand and apply because only three data pieces are required for exponential regression.
2) It produces accurate forecasts. The forecast is accurate if the estimate of the difference between the actual projections and what has happened is lower.

DISADVANTAGES OF EXPONENTIAL REGRESSION

1) Exponential regression has the inapplicability of the constant failure rate assumption. For example, in the flat theory of the world, the hypothesis of a constant failure rate provides models that can be implemented and elaborated easily but may lead us away from the advantages that can be obtained by using models that represent real-world conditions more accurately.
2) It produces forecasts that lag the actual trend. Lagging is the side effect of the exponential regression process. It also neglects the ups and downs linked with random variation. But ignoring these random variations also allows us to see the underlying phenomenon, which helps in presenting data and making a forecast of future values.
3) Exponential regression cannot handle the trends well. It is best utilized for short-term forecasting and in the absence of seasonal or cyclical variations.

APPLICATION OF EXPONENTIAL REGRESSION

1) Population Growth
   Exponential regression is being used in finding the population growth rate. Most of the times scientists start observing a certain number of micro-organisms or animals and observe how the population grows. For example, if the population grows twice every 5 days, this can be represented as an exponential function.
2) Exponential Decay
   To solve an exponential decay problem is like solving a population growth problem but the difference is that population size may decrease instead of increasing and we could still be able to use the general formula of exponential regression we used for growth but with negative exponential power.

POWER REGRESSION

Power regression is one in which the output variable is proportional to the input variable raised to a power. Power regression formula is of the form

$$y = x^b \qquad (3)$$

Equation (3) shows the canonical power regression model, where x is the explanatory variable and b is constant. Its scatter plot resembles that of an exponential function opening upward or downward. Power regression will not allow an independent variable of 0. Power regression equation will be used to predict output values that lie within(interpolate) or outside(extrapolate) the plotted values. Figure 3 shows the power regression curve of $y = x^2$.

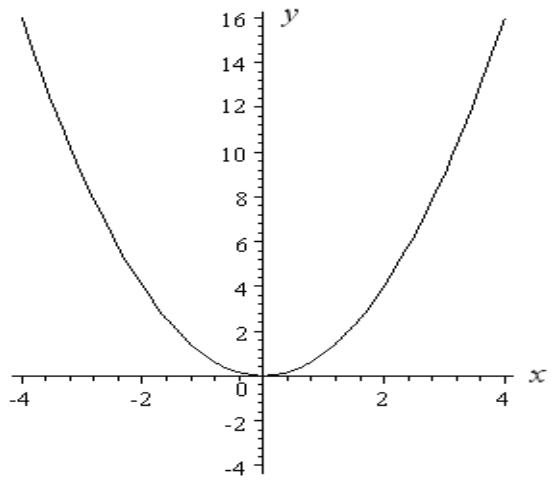

Figure 3. Power regression curve of $y=x^2$

ADVANTAGES OF POWER REGRESSION

1) In the power regression technique, a squared error is considerably minimized which can be neglected because of the power occurrence on the variable.
2) The power regression model fits better in your data if your data is curving at one point. In quantification, curving means that you reached the quantification limit, you saturated your detector, and the response is not anymore related to the concentration of your analyte.
3) Most of the real-world problems are linear over a very short range. Therefore, power regression techniques are used to obtain better results because their model is much close to real problems having the minimum error.

DISADVANTAGES OF POWER REGRESSION

1) The weakness of power regression is its parametric form, it has a very restrictive shape (symmetric around the maximum or minimum). So, these days many use generalized additive models which fit an underlying penalized smooth.
2) As the power of variable increases power regression technique is very hard to implement and complex to understand as compared to other basic regression techniques.
3) The Multi-collinearity of power regression technique increases the variance of the estimated coefficients and makes these estimates sensitive to minute changes in the model. As a result, the coefficient estimates become unstable.

APPLICATION OF POWER REGRESSION

1) Weather Forecasting
   Power regression techniques are highly used in weather forecasting to predict the rain as it provides a model which is very close to the actual model.
2) Environmental Study
   To study the effect of V O2 and accumulated O2 power regression techniques are used by researchers as it gives the robust solution.
3) Physiotherapy
   Power regression techniques are used to find the oxygen uptake by the person during cycling, running, and walking in real-time.

POLYNOMIAL REGRESSION

A special type of multiple linear regression is polynomial regression. The correspondence between the explanatory variable x and output variable y is modelled as an n^{th} degree polynomial in terms of x. Non-linear data cannot be fit by linear regression technique (under-fitting). So, we increase the model complexity and use the polynomial regression model, which fits such big non-linear data in a better way.

$$y = a_0 + a_1x^1 + a_2x^2 + \cdots + a_nx^n \qquad (4)$$

Equation (4) shows the canonical polynomial regression model. Figure 4 shows the polynomial regression curve.

ADVANTAGES OF POLYNOMIAL REGRESSION

1) Polynomial regression is independent of the size of the data set.
2) Non-linear problems are solved with good accuracy.
3) It gives the best approximation of the correspondence between the output and explanatory (independent) variables.
4) A large number of functions can be fit under it.
5) Many curvatures can be fit by polynomial regression.

DISADVANTAGES OF POLYNOMIAL REGRESSION

1) The occurrence of one or two outliers in the data set can seriously affect the results obtained in performing the nonlinear polynomial regression analysis.
2) The polynomial regression technique is sensitive to outliers.
3) For a good bias trade-off selecting the right polynomial degree is very important in analysis.
4) There are a small number of model validation tools for the detection of outliers in non-linear regression analysis as compared to linear regression analysis.

APPLICATION OF POLYNOMIAL REGRESSION

1) Medicine
   It is used to study the isotopes of the sediments, the rise of different diseases within any population and the generation of any synthesis.
2) Environmental Study
   It is used by environmentalists to predict the occurrence of events such as tsunami, thunderstorms, and sandstorms in advance to timely avoid their effects.
3) Archaeology
   Power regression techniques are widely used by archaeologists to predict the age of artefacts and how many years ago ancient civilizations were present.

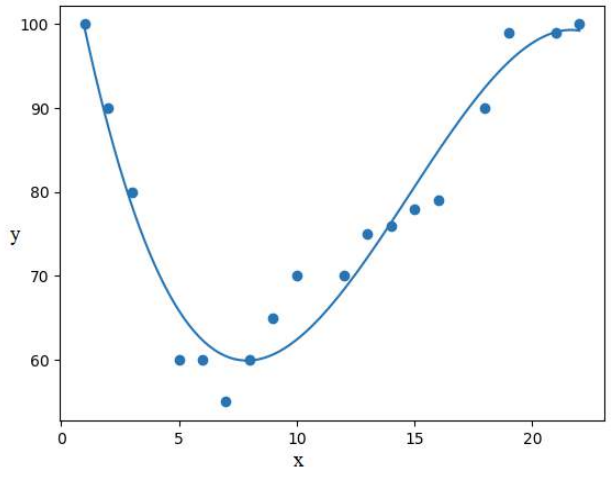

Figure 4. Polynomial regression curve

GOMPERTZ REGRESSION

The Gompertz regression is a mathematical model used for a time series, in which the sigmoid function shows growth as being slowest at the beginning and the end of a given period but very fast in the middle.

The canonical model of gompertz regression is shown by equation (5).

$$y = ae^{-be^{-cx}} \quad (5)$$

A commonly used optimization method is the non-linear regression technique, which can be conducted in R. Nevertheless, the regression of the gompertz function is non-linear and not a trivial matter because we must provide the initial values of the three parameters involved in the gompertz equation. The parameter a (asymptote) is obtained by applying the limit of the function as x approaches infinity, parameter b is the displacement along the x-axis, and finally, the growth rate is described by parameter c. There is only one parameter in the case of the logistic curve which gives an estimate of the initial value of the function, which is quite straightforward, whereas in the case of the gompertz function it has three parameters.

Figure 5 shows the gompertz regression curve.

ADVANTAGES OF GOMPERTZ REGRESSION

1) The gompertz curve makes them useful for the empirical representation of growth phenomena.
2) It gives a more accurate solution and a clearer picture of the real-world problems of forecasting and prediction.
3) It is used for rapid phenomena such as radioactive decay, bacterial growth, and gas expansion because of its highly exponential behaviour.

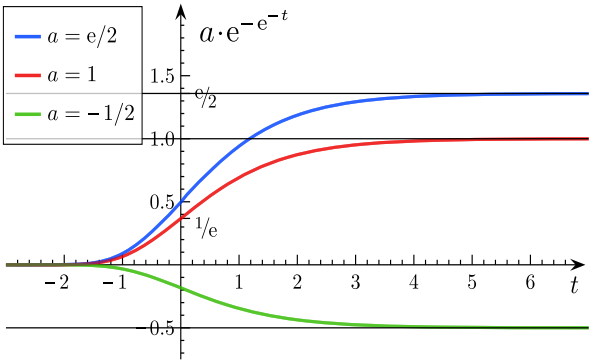

Figure 5. Gompertz regression curve

DISADVANTAGES OF GOMPERTZ REGRESSION

1) It is very hard to implement on problems because of its highly exponential nature.
2) For linear and quadratic problems, it does not give accurate results because of its high exponential nature.
3) There are a lot of applications in which the gompertz function is used but there also exist

many cases in which the gompertz function fails to fit the desire data set.

4) It has three parameters to initialize which makes it very difficult to start the regression process because careful initialization of these parameters is required, having very little margin to select them correctly.

APPLICATION OF GOMPERTZ REGRESSION

1) Biology
   Initially, the gompertz regression model was designed to describe the death rate and is now mostly used in the field of biology. It is useful to model many phenomena such as the increase in the number of cancerous tumours limited to an organ without, the increase in the number of individuals in a population. It is also used to model the logistic function of the increment in a bacterial colony or the spread of the number of infected people in an epidemic.
2) Geology
   It is used to forecast the total natural gas of different sites in the world. The principal objective at present is to examine the possibilities of using a gompertz type innovation diffusion process as a stochastic growth expression of natural-gas consumption and to compare our results with those obtained, on the one hand, by stochastic logistic innovation modelling.

DISCUSSION AND ANALYSIS

Regression techniques are the types of predictive modelling techniques that investigate the correspondence among two variables in which one is dependent and the other is an independent variable. Many regression techniques have been developed and many more are in process of making. I discussed five of them.

Linear regression is simple to implement but does not give accurate results. Power and polynomial regression are a little bit complex as compared to linear but give good results than linear regression. Exponential in contrast to them is difficult to implement because of its high complexity but gives more accurate results. Lastly, the gompertz curve is new, having double exponential in its function, that's why it is difficult among all five of them to implement but most accurate.

Depending upon the type of problem, choose the technique to get a robust solution. If accuracy is demanded, then go for complex techniques and if accuracy is not a big deal, then go for techniques having simple implementation.

CONCLUSION

Regression techniques are useful statistical methods that can be leveraged to estimate the degree to which independent variables are affecting dependent variables. These regression techniques should be implemented according to the limits defined on the given data set. One of the best ways to explore which regression technique should be implemented on the problem is to check the family of the variables involved in that problem.

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ALUMNI ACHIEVEMENT

Professor Dr. Suhail Aftab Qureshi

Professor Dr. Suhail Aftab Qureshi is one of highly esteemed and highly respected Alumnus of UET Lahore. His session at UET Lahore was year 1976, at the department of electrical engineering. Dr. Suhail Aftab did his MSc and PhD in power engineering from UMIST, UK.

Dr. Suhail Aftab served as a very prominent faculty member at the department of electrical engineering, UET Lahore, for almost 35 years. He received the best University teacher award from HEC in year 2003. He worked at several administrative posts at the University as well. He remained chairman of the department of electrical engineering at UET Lahore and served as dean of electrical faculty as well. He was elected as president of teaching staff association (TSA) of UET Lahore for 13 times.

Dr. Suhail Aftab remained a very active researcher during his professional career and published 174, international as well as local research papers. He supervised 250 MSc/MPhils, and hundreds of BSc electrical engineering thesis.

Some other prominent achievements, out of many, of Dr. Suhail Aftab are.

- 3 times holder of Overseas Research Student Award at UK.
- Author of 6 electrical engineering textbooks.
- Member governing body of Pakistan Engineering Council (PEC) for 5 times.
- President IEEEP at present
- CEO South Asian Electrical Concern.
- Vice Chancellor of University of South Asia, Pakistan.
- Director Quid -e- Azam Solar Plant Bahalpur (QASP).

ALUMNI ACHIEVEMENT

Professor Dr. Tahir Izhar

Professor Dr. Tahir Izhar is one of highly esteemed and highly respected Alumnus of UET Lahore. His session at UET Lahore was year 1978, at the department of electrical engineering, UET Lahore.

Dr. Tahir Izhar did his MSc in electrical engineering from UET Lahore and got his PhD in electrical engineering from University of Birmingham, UK. He also attained an MBA degree from institute of business and management of UET Lahore.

Dr. Tahir Izhar served as a very prominent faculty member at the department of electrical engineering, UET Lahore, for almost 34 years. He worked at several administrative posts at the University as well. He remained chairman of the department of electrical engineering at UET Lahore, at both main campus and KSK campus, and served as dean of electrical faculty as well.

Along with teaching as permanent faculty member at UET Lahore, Dr. Tahir Izhar also served as visiting teacher at University of Birmingham (UK), LUMS (Pakistan), GCUF (Pakistan), The University of Punjab (Pakistan).

Dr. Tahir Izhar remained a very active researcher during his professional career and published 54 international research papers. He supervised 3 PhDs, 49 MPhils, and 80 BSc engineering thesis.

As a consultant, Dr Tahir Izhar served the following.

- Consultant Shalimar Engineering for developing Leather Area Measuring Machines.
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- Consultant for “PEECA” for awareness campaign for Energy Efficiency, saving opportu nities, Green Building Codes, and introduction to ISO 50001 (Energy Management System).
- Consultant, Al-Khwarizmi Institute, UET, Lahore.
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Article 5

Design and Development of Microwave Based Non-Destructive Testing Device for Structural Health Monitoring

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Abstract- **This paper discusses the novel method of non-destructive testing, capacitive sensing. This technique is modeled using two metal plates for the electric field distribution and the experimental method proofs that capacitive sensing is used to inspect cracks in steel, cracks on the surface of the fiber-reinforced polymer, and sub-surfaces water and air voids in concrete structures.**
The real problem is that buildings are constructed in a timely fashion that these are not tested in any way and people instantly shift in newly constructed buildings.
This project will make sure the certainty of the life span, quality of the material or building and do quantitative analysis of the civil structure. The main purpose of this project is to reduce the mortality rate significantly by predicting of durability and life of the civil structure.

Keywords— Civil Structures, Non-destructive testing (NDT), Capacitive Sensing, Capacitive Imaging.

INTRODUCTION

From the inception of time, man has built civil structures to live. Somehow, everyone wants to have peace and take rest at that place and this process is continued and it will remain unknown. The major constructive materials were mud, steel, and wood. Figure 1 shows the visual representation of the civil structure made from ancient materials. Before steel, man has used wood and mud for many areas of life and especially for construction and it was known as the strongest material but then with the change of time, they shifted to steel and the days have come to

fiber-reinforced polymers and reinforced concrete.
The real problem is that buildings are constructed in a timely fashion that these are not tested in any way and people instantly shift in newly constructed buildings. There are hundreds of examples where buildings are collapsed due to lack of monitoring or testing i.e., a building in Timber Market Karachi, a building in Ashford Middlesex, Mumbai, and Dhaka.

Figure 1. Civil Structure built from mud, wood, and steel [1]

According to the National Crime Reports Bureau (NCRB), an average of 7 people die per day in the collapse of structures including buildings between 2001 and 2015 [2]. These incidents were an eye-opener, and it is realized that there is not a single testing service in Pakistan by which people could test civil structures before the disaster. According to the Seismic network of the Met Department of Pakistan, there are 2/3 active fault lines in different areas of Pakistan and divide the whole country into nineteen zones. So, the goal was to make non-destructive testing (NDT) device for structural health monitoring using capacitive sensing technique.
There are many NDT techniques i.e., stress wave, infrared thermography, radiography, and radar technique. The above technologies are ineffective due to very limited access and high price. This project describes the applications of non-destructive testing techniques for civil structures, capacitive sensing. Capacitive sensing is used to find out the cracks of steel, fiber-reinforced polymer, and concrete. This technique is modeled using two metal plates for the electric field distribution. This experimental method proofs that capacitive sensing is used to inspect cracks in steel, cracks on the surface of the fiber-reinforced polymer, and sub-surfaces water and air voids in concrete structures. 4. Initial trials on the in-house developed phantom were performed but pre-disaster trials on actual civil structures have not been possible due to the ongoing situation of COVID-19. The hardware setup was made but could not be tested. So, the system level simulation of non-destructive testing device for structural health monitoring of civil structure is implemented on COMSOL software.
The main goal of this project is to make a low cost and portable device for non-destructive testing of civil structure using Microwave based Non-Destructive Testing (NDT) technique and it also addresses the UNDP Sustainable Development Goals SDG- 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster Innovation) & 11 (Make cities and human settlements inclusive, safe, resilient, and sustainable) directly and UNDP SDG- 1, 8, 12 and 17 indirectly. This project will make sure the certainty of the life span, quality of the material or building and do quantitative analysis of the civil structure. The main purpose of this project is to reduce the mortality rate significantly by predicting of durability and life of the civil structure.

LITERATURE REVIEW

Non -Destructive testing consists of several methods. A few methods are discussed in [3]

- Ultrasonic methods
- Electromagnetic methods
- Electrical methods
- Electrochemical methods

In reference [3], the author has discussed three electromagnetic methods that are radar technique, capacitive technique, and infrared/thermography technique.

RADAR TECHNIQUE

The specific radar for civil engineering is GPR (Ground Penetrating Radar) and it is comprised of three parts: control unit, antenna, and survey encoder. GPR is the common technique used for NDT. A radar signal is sent into the material, calculating the two-way time and strength of the signal and encode it using the control unit. Antenna selection is one of the important factors in it. It is an active part of the radar system. Antenna frequencies depending on concrete structures vary from between 1 to 2 GHz and have three types: coupled horn and borehole.

CAPACITIVE TECHNIQUE

In the capacitive technique, the material is treated as a dielectric and two metal plates are attached with the material to make a capacitor. Since capacitance depends on several parameters as explained in the following formula.

$$C = A\varepsilon/d \qquad (1)$$

Where A is the area of the plates, ε is the permittivity of material and d is the distance between the plates. To keep area and distance constant, the capacitance becomes the function of permittivity of the material

which is different for all the materials so the capacitance changes material to material having the same set of plates. A parallel plate capacitor depends on three parameters as shown in Eq. (1), but it is not practical because it can't place the device on both sides rather only one side of buildings or structures are exposed for inspection so a co-planner capacitor can be used. The co-planer capacitive imagining technique is the most unique in the detection of defects within the concrete sample. By varying the positions of the electrodes, their electric field shapes vary. It is the fringing field that enters the concrete from which after getting the image the behavior of the electric field can be observed.

A capacitive setup is discussed in [3] for the sake of illustration which includes different sets of palates that are constructed using different kinds of materials i.e. PTFE (Polytetrafluoroethylene), granite, marble, PVC (Polyvinyl chloride), and limestone, which have permittivity 2, 5.6, 7.6, 2.95, 8.4 accordingly, these plates are attached with the device having capacitive sensor installed in it which monitors the capacitance of materials having different thickness and wirelessly transmits the data to the numerical tablet. It analyzes the data and shows results on screen from which the desired data can be collected.

INFRARED TECHNIQUE

The infrared technique is useful for NDT. IR technique works on the basic concept of the appearance of thermal contrast between a healthy area and the faulty one. It identifies infrared energy emitted from the object converts it into temperature and displays a picture of temperature distribution. IR is mostly used in the evaluation of bridge decks & sealing systems. But being an expensive method, this technique is only used by such kinds of firms that can afford it, that's why it is not going to use for NDT in this project. Its complete working detail is discussed in [3]. IR radiations from the camera are transmitted on the targeted object are reflected towards the camera, the camera receives the total flow of radiations which are coming through the atmosphere.

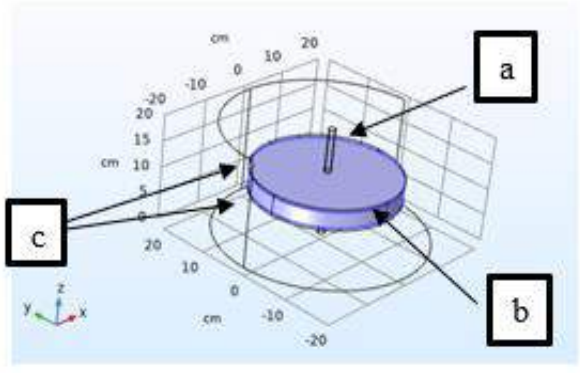

Figure 2. Parallel plate capacitor COMSOL model.

THE PROPOSED METHODOLOGY

As discussed in the last section of the literature review, there are several methods available for civil structure monitoring. Out of all methods, the capacitive method is easier to implement, cheap and the device can be made portable. So, the simulation of capacitive imaging effect is observed on concrete structures having different faults to test the feasibility of the system. The major analysis was on the CAD tool named COMSOL.

ANALYSIS ON PARALLEL PLATE CAPACITOR

The capacitance of the capacitor depends on the factors that are discussed in Eq. (1). To verify all these parameters, a parallel plate capacitor is simulated in COMSOL. The structure of a parallel plate capacitor constructed is shown in Figure 2.

In Figure 2, 'a' is specifying the terminal of the capacitor where the voltage can be applied. 'b' is specifying the dielectric medium of the capacitor. 'c' is specifying the two parallel plates of the capacitor.

Generally, the geometry of a parallel plate capacitor is designed by the arrangement of electrodes with the dielectric material. It can store a finite quantity of energy and it keeps storing energy till a dielectric breakdown happens. When two parallel plates are attached across a battery, the plates of the capacitor get charged and as a result, an electric field is created between them as shown in Figure 3.

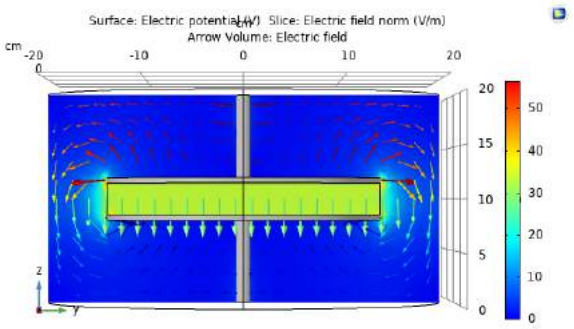

Figure 3. Fringing effect of Parallel Plate Capacitor

In the capacitive imaging technique, the fringing effect helps us to distinguish between the types of faults. The 2D Electric field pattern in Figure 4 is showing the fringing pattern of electric field lines. It is evident from the above observation that, electric field lines can travel both in straight & in a curved pattern. The curved pattern of field lines mostly emerges from the edges of one terminal & travels to the other terminal while the lines are closer to the center of the terminal travel in the straight pattern.

In COMSOL, the effect of change in dielectric material between the plates is observed by keeping

other parameters constant. Increasing the relativity permittivity of the material increases the capacitance of the capacitor due to an increase in the polarizability of the material as shown in Table 1 and a graphical representation in Figure 5.

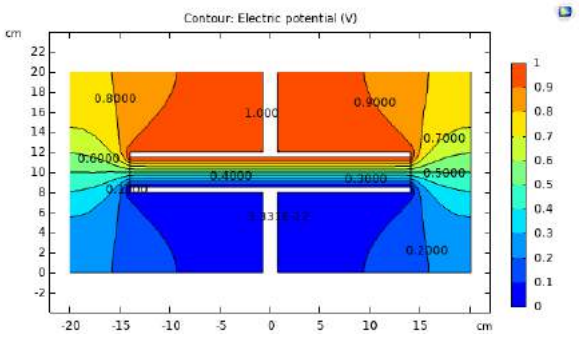

Figure 4. Electric Field Distribution across plates

Table 1. Effect of different dielectric materials

Sr. No	Material	ε_r	*A* (cm^2)	*d* (cm)	*C* (pF)
1	Air	1	314.15	4	13.73
2	Glass	4.2	314.15	4	43.45
3	Mica	6	314.15	4	60

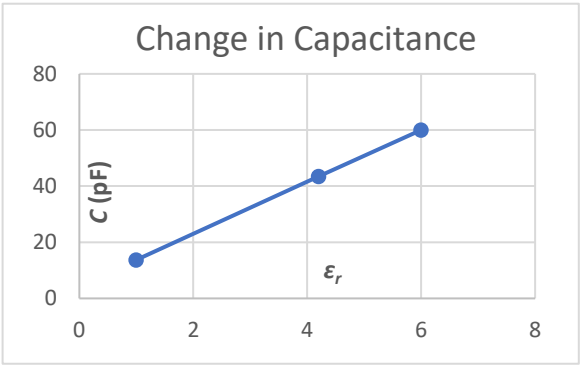

Figure 5. Relationship between permittivity and capacitance

2D PHANTOM DESIGN OF CO-PLANER CAPACITOR

The general method of using the capacitive imaging (CI) technique is to use co-planar electrodes. The electric field distribution varies when the change in orientation of the plates takes place from parallel to co-planar. A design of the capacitive imaging model approach in COMSOL is shown in Figure 6. It comprises two metal electrodes (in which one acting as ground), produces electric field distribution in the concrete sample material when the AC voltage is applied on the electrodes. The concrete sample can affect and alter the overall electric field intensity and impurity inside the sample (like the presence of faults) which are in the range of electric field distribution will also cause an impact. The change in the overall electric field will result in the change of induced charges which develops at the sensing terminal. This specific change in the electric field is important and helps in imaging systems used for faults detection. As the materials like water, concrete, steel rebar, and air voids & cracks possess very unlike electric properties that's why the electric field is affected differently by these materials. The change in electric field distribution also leads to capacitance change due to the presence of different faults inside the concrete.

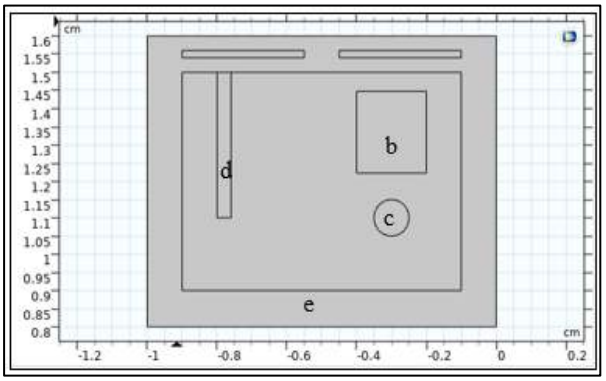

Figure 6. Capacitive Imaging model on COMSOL

In Figure 6, 'a' is specifying the concrete portion of FE (Finite Element) model. The relative permittivity ε_r of material equal to 6. 'c' is representing the steel bar. In this case, the relative permittivity of the material ε_r is equal to infinity (very high). 'd' is representing surface crack & "b" is representing hidden void within the concrete and 'e' is air which represents the environment around the civil structure.

EFFECT OF HIDDEN VOID IN THE PHANTOM

The air voids present in the concrete structure are dangerous as they are responsible for the major structural collapse. To predict any disaster going to take place, it is important to locate the major voids present within the structure. So, in this series of experiments on COMSOL, the capacitance of the concrete sample is observed with different areas of voids. As the relative permittivity of concrete is greater than air so when there is a void within the concrete so by increasing the area of the void, the capacitance will be decreased because the area of the void is increased. So, the greater the area of the void, the more it will affect the concrete structure as shown in Figure 7. Table 2 shows a quantitative analysis of changing area of air void on the capacitance and Figure 8 shows the graphical representation of this phenomenon.

EFFECT OF STEEL BAR IN THE PHANTOM

The steel bar also poses the danger to the concrete strength especially when corrosion takes place. Corrosion lowers the actual cross section of material structure. Table 3 shows a quantitative analysis of changing area of air void on the capacitance and Figure 9 shows the graphical representation of this phenomenon.

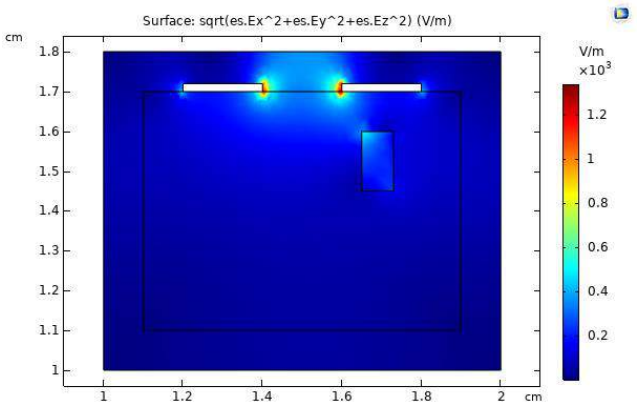

Figure 7. Field distribution having a varied void area in the structure

Table 2. Effect of air void on capacitance

Sr. No	*A* (cm²)	*C* (pF)	Effect by increasing
1	0.015	98.99	**Decrease**
2	0.012	99.9	
3	0.0075	101.18	

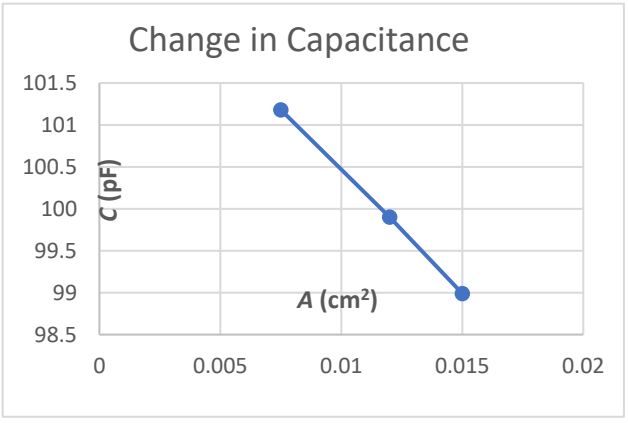

Figure 8. Relationship between the area of void and capacitance

Table 3. Effect of steel bar area on capacitance

Sr. No	*A* (cm²)	*C* (pF)	Effect by increasing
1	0.00785	134.37	**increase**
2	0.0153	137.38	
3	0.0254	140.37	

As the relative permittivity of concrete is greater than air so when there is a steel bar within the concrete then the capacitance is changed accordingly: by increasing the area of the steel bar, the capacitance will be increased because the area of concrete is decreased, and it is shown in Figure 10.

OVERALL EFFECT OF DEFORMATION IN THE PHANTOM

The combined effect of steel bar, air void, and surface crack within the concrete show that how capacitance is affected. It is observed that when there are all three parameters in concrete then a relative capacitance is achieved and, in this manner, the sensitivity of the device is measured as shown in Figure 11.

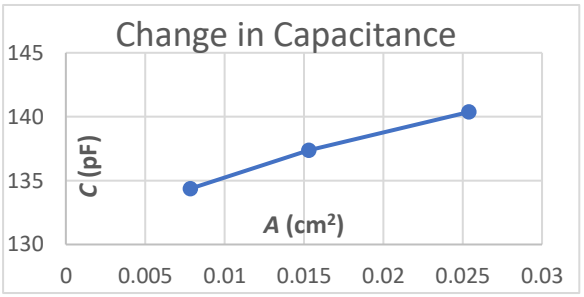

Figure 9. Relationship between the area of steel bar and capacitance

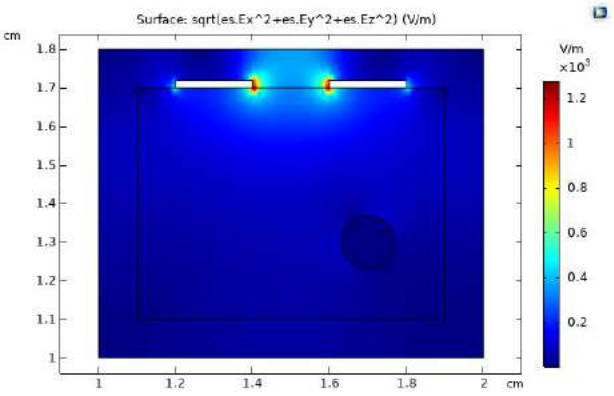

Figure 10. Field distribution having a varied steel bar area

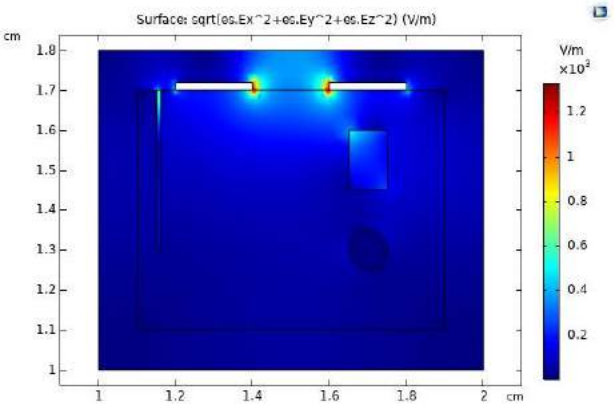

Figure 11. Concrete model having a crack, void, and steel bar at a time

CO-PLANER CAPACITOR 3D PHANTOM DESIGN

To make an actual model of a system, the 3D demonstration is required to make it possible, and it plays an important role. It helps to pre-evaluate the device structure and point out if there are any abnormalities lies. The final analysis of CI is observed by constructing a 3D model shown in Figure 12 in COMSOL.

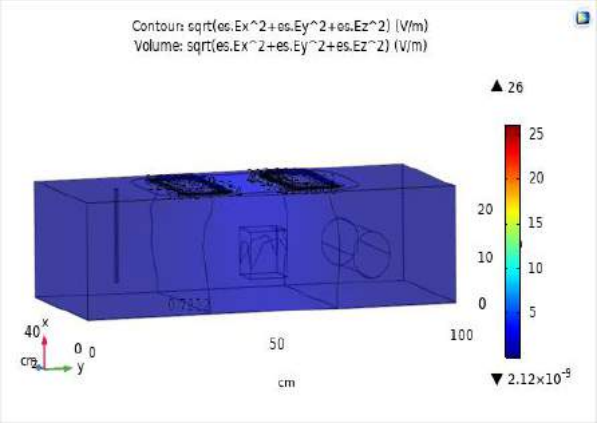

Figure 12. The overall effect will result in the capacitance of 31.0pF

The placement of Capacitive plates also plays an essential role in defining the value of capacitance. In the series of experiments, that were performed on COMSOL. It is observed that by changing the position of the plates, the value of capacitance also changes respectively, and it is shown in Figure 13.

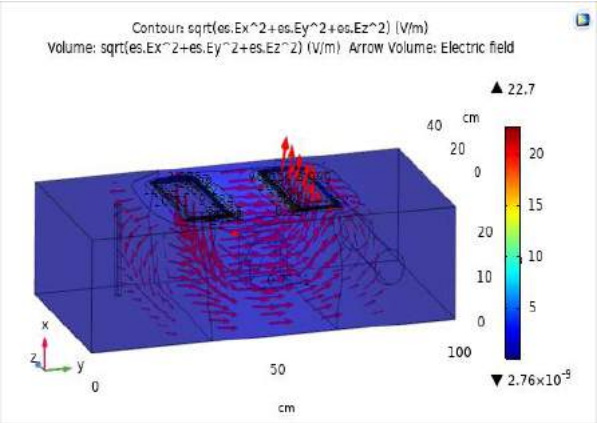

Figure 13. *Varying placement of terminals*

Here, it is noted that by decreasing the distance b/w the plates the capacitance goes on increasing. In this default alignment, the capacitive plates are separated by 10cm, and the capacitance observed is 30.95 pF. Now by increasing the distance between the plates, the fringing pattern of electric field lines appeared more to be curved, overall capacitance decreases, and the overall capacitance changes to 22.734 pF.

THE PROPOSED HARDWARE IMPLEMENTATION

A portable device is built using two metal plates, a battery, and an LCR meter which is contained in a container as shown in Figure 14. Metal plates are powered using a Lithium Polymer (LIPO) battery and a high-resolution LCR meter to make the device more sensitive. 3D Phantoms having different properties and faults are designed to mimic the actual properties and faults of buildings. All the phantoms are tested using the prototype to collect impedance data to build a complete database of all the possible faults. Now, the setup is ready to test any building to predict any possible disaster. Plates are attached to the building to mimic a coplanar capacitor where a building is considered as dielectric material which affects the capacitance of the capacitor. When a DC voltage is applied across the plates electric field lines pass through the concrete material due to fringing. This phenomenon shows the impedance of the overall setup on the screen of the LCR meter. When a device is scanned over the surface of the building, the impedance changes due to under surface cracks, air voids, water contaminants, and steel bars and change in impedance tells about the possible fault. Based on the capacitance change, the product can predict or classify the type of faults (air void, surface crack, steel bar) residing inside the material.

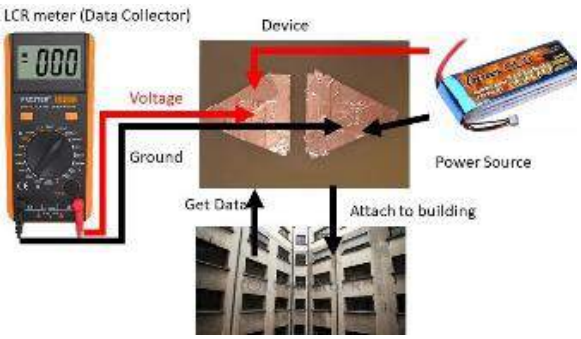

Figure 14. The proposed Hardware setup of the Capacitive Imaging device

Due to the ongoing situation of COVID-19, the hardware setup was made but could not be tested but the system level simulation of non-destructive testing device for structural health monitoring of civil structure is implemented on COMSOL software that is mentioned in detail in the previous section.

CONCLUSION

A low cost, portable, non-ionizing, and unique non-destructive testing for structural health monitoring devices for civil structures has been presented. Different phantoms with various types of faults such as air void, surface crack, steel bar breakage, water

content were scanned. These faults have been detected successfully using COMSOL simulation based on capacitive imaging technique. The results were totally in agreement with the previous studies on capacitive imaging techniques for structural health monitoring, but this device is a novel product for civil structures, and it is found unique, safe, handy, and innovative. The product has a high potential to attract investors and external stakeholders for the commercialization of this product after prototype testing and initial trials on the civil structure.

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Article 6

Power Line Carrier (PLC) Communication

Abu Bakar Abid, Qu Wentao, Liu Hao, Zhao Guix

Abstract- **Power line carrier communication is in use on power lines for the past several decades. The main use of power line carrier communication is in the implementation of pilot protection schemes for transmission lines. In the modern age of communication technologies, PLCC is an old technique but still today due to the high cost of other technologies, it is primarily in use for transmission line protection schemes implementation. In this paper, basic knowledge about working principles, connection, and use of power line carrier communication is discussed. In the later part, the PLC scheme implemented at Lahore Converter Station is also discussed.**

Keywords- Power line carrier, distance protection, line matching unit, pilot protection, transmission line

INTRODUCTION

Power line carrier communication is used in substations for major applications on transmission lines in protective relaying. A channel is used in line relaying so that both ends of a circuit are cleared at high speed for all faults, including end zone faults. A PLC channel can also be used to provide remote tripping functions for transformer protection, shunt reactor protection, and remote breaker failure relaying. Figure 1 shows a basic schematic for the PLC circuit [1].

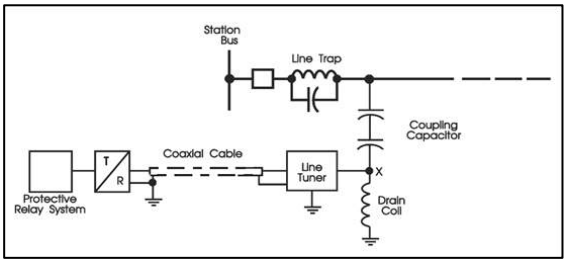

Figure 1. Basic power line carrier schematic

POWER LINE CARRIER COUPLING WITH POWER LINE

For coupling the carrier to the power line there is more than one way. To decide we have to consider economics, the efficiency of the technique, or the trade-off of both. It is possible the expensive best

technique technologically is not justifiable for the line being protected. Protective relay schemes use single-phase-to-ground coupling, which only requires one set of coupling equipment (line tuner, coupling capacitor, and line trap). Multi-phase coupling can be used to improve dependability but requires more equipment [2].

- Mode 1 Coupling (Out on two outer phases, in on the centre phase).
- Centre phase to outer phase (push-pull).
- Centre phase to ground.
- Outer phase to outer phase with ground return (push-push).
- Outer phase to ground (only on short lines).

Typically, used coupling schemes for PLC are discussed in the following sections.

SINGLE PHASE TO GROUND COUPLING

The Center phase is mostly used for coupling in single-phase to ground coupling. The reason behind this is that the centre phase provides most mode 1 coupling. If we use the outer phase, it will introduce more mode 2 and mode 3 coupling than we ideally want. Figure 2 shows an example of phase-to-ground coupling [3].

PHASE TO PHASE COUPLING

In some applications, dependability is a major factor. In the case of a critical transmission line and where the relay needs to get the signal for its tripping operation, the two-phase coupling is a more acceptable and secure technique. In a power system, the most frequent fault is the phase to the ground so in the case of this fault, if we use a two-phase coupling technique, we have a better chance of receiving the signal through the fault. Figure 3 shows the connection of phase-to-phase coupling [4].

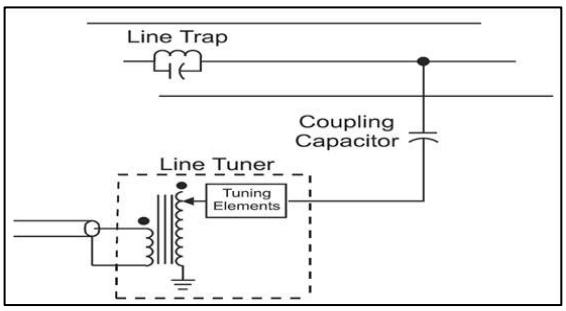

Figure 2. Single phase to ground coupling

In the case of two-phase coupling, a balance transformer is there to isolate the PLC signal and transmit it to equipment through one coaxial cable. Isolation prevents the PLC transmitters from mutually loading each other and from creating intermodulation distortion. Using Siemens make AKE-100 coupling unit phase-to-phase coupling with balanced transformer is shown in Figure 4. A3 is LMU and A1 is a balancing transformer for isolation [5].

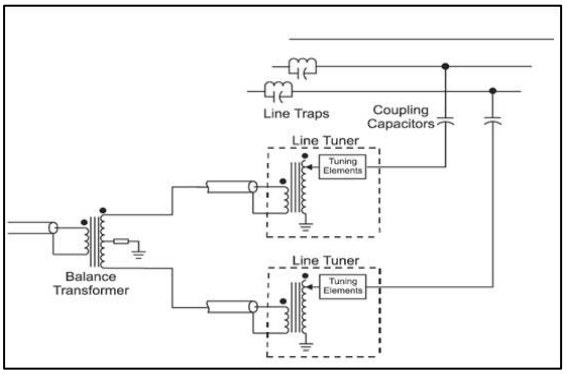

Figure 3. Phase to phase coupling

±660kV HVDC LAHORE CONVERTER STATION PLC SCHEME

At Lahore converter station two 500kV circuits are going towards 500kV Lahore Sheikhupura substation, two 500kV circuits are going towards 500kV Lahore South substation and two 500kV circuits will be going towards 500kV Lahore North substation in the future. Both Lahore South circuits use fiber optic for tele-protection and two Lahore Sheikhupura, and two Lahore North circuits use two sets of Power Line Carrier (PLC) and one set of SDH communication for each circuit. SELTA tele-protection equipment is used for this purpose. Phase-to-phase coupling is used, and PLC equipment is installed on two phases of each transmission line. On phase R and phase, Y. As discussed in the previous section two phases are used for increase in dependability and redundancy of the system, as most faults are single phase to ground so in case of fault on one phase the other phase carrier will be transmitted to the remote end for tele-protection action. Figure 5 shows the PLC configuration at the Lahore converter station. Figure 6 shows the configuration on one circuit. PLC is coupled on the red and yellow phases of the transmission line. Line trap and all the PLC equipment are installed on both phases.

As it is phase-to-phase coupling, both the coaxial cables are merged and come to indoor PLC equipment as one. Tele-protection signal implementation is done on two channels, channel one is used for line distance protection panel 1 signals and channel two is used for line distance protection panel 2 signals. Signals of both the channels are as follow [6]:

Channel 1: Line Distance Protection Panel 1 (Schneider Equipment)

- Four Binary Output Commands.

- Distance Protection Trip.
- Overvoltage Trip.
- Breaker Failure Trip.
- Spare

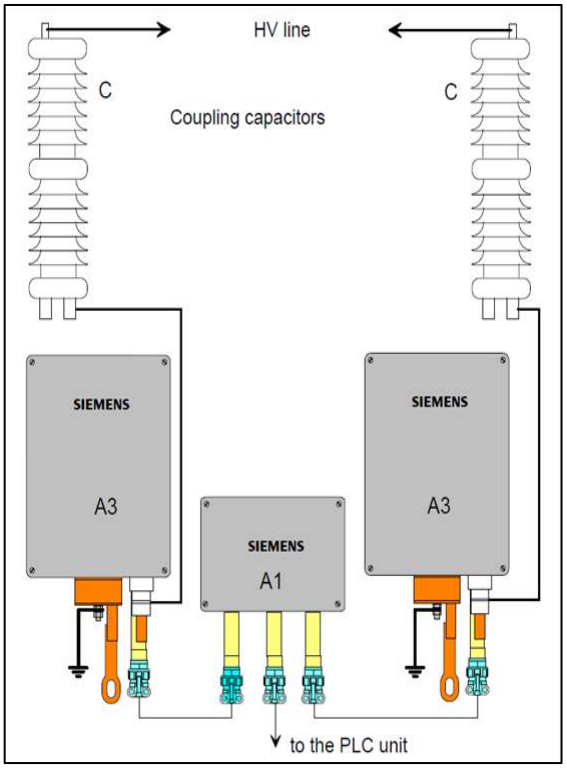

Figure 4. Phase to phase coupling with siemens make AKE-100 LMU

- Four Binary Input Commands.
  - Distance Protection Trip.
  - Overvoltage Trip.
  - Breaker Failure Trip.
  - Spare.

Channel 2: Line Distance Protection Panel 2 (ABB Equipment)

- Four Binary Output Commands.
  - Distance Protection Trip.
  - Overvoltage Trip.
  - Breaker Failure Trip.
  - Spare
- Four Binary Input Commands.
  - Distance Protection Trip.
  - Overvoltage Trip.
  - Breaker Failure Trip.
  - Spare.

At Lahore, converter station AKE-100 Siemens make a coupling unit that is used as a line matching unit. It is installed on a CVT pole where CVT is used as a coupling capacitor. As discussed earlier at Lahore converter station phase to phase coupling is implemented without matching transformer which is used in figure-2.3, therefore, two-line matching units are used one on phase red and one on phase yellow each.

However, at the Lahore converter station, the LMU units are coupled without a balance transformer through a coaxial cable as shown in Figure 7. A3 and A4 are AKE-100 Siemens make a line-matching unit, coaxial cable from A4 is going to the PLC equipment indoors.

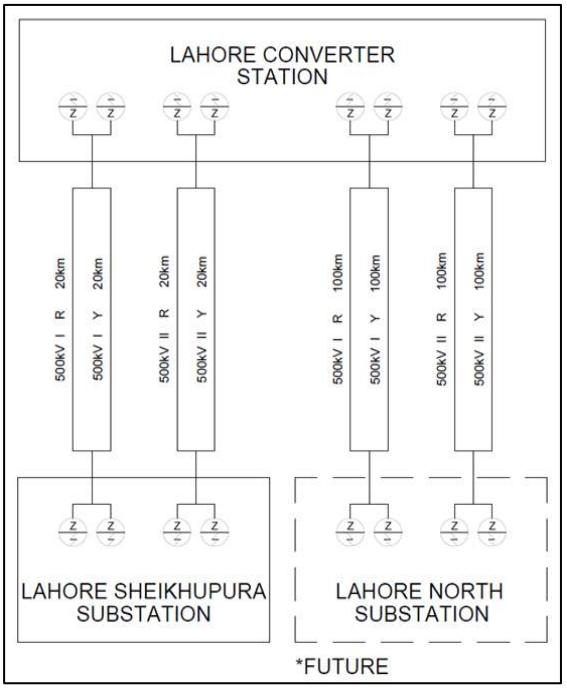

Figure 5. Lahore converter station PLCC connection

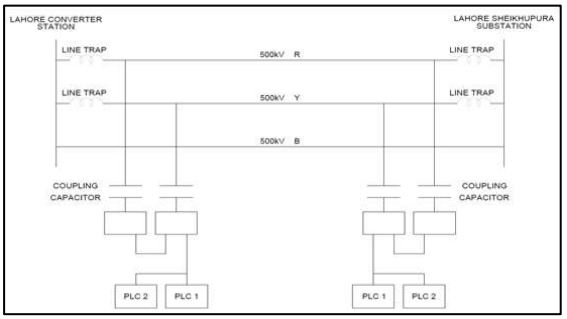

Figure 6. PLC connection on one TL

A3 and A4 are coupled through the coaxial cable as well [7].

Line traps are connected in series with high voltage transmission lines to block the high-frequency PLC signal from passing on to the bus bar and other transmission lines. The main component of the line trap is the main coil formed by a single layer or multiple layers of the coil. B4 line trap is a single layer product while B5 line trap is multi-layer. Coils from inside to outside decrease the number of winding cable circles and increase the diameter of the conductor, which gives mechanical strength with low weight and small size. Line traps are normally composed of the main coil, tuning device, and protective device [8].

The main coil of the XZK line trap is usually wound with a rectangular bare aluminum conductor with its turns supported by fiberglass spacers all of which are submerged in lacquer for good integration. The tuning device is composed of a capacitor, inductor, and resistor, which forms a resonance circuit with the main coil to block HF signals.

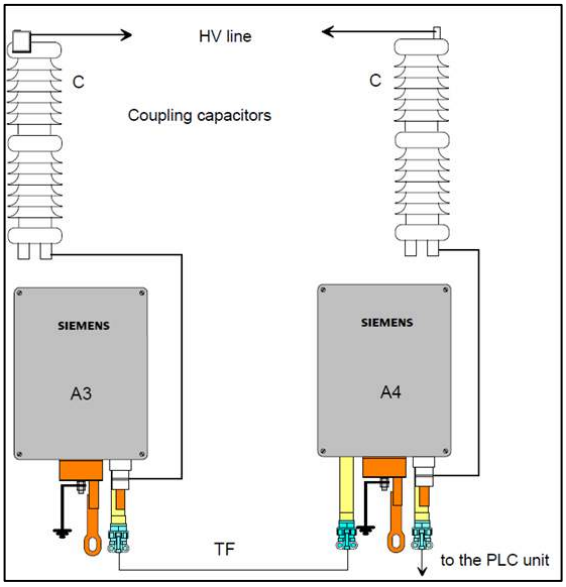

Figure 7. Connection of AKE 100 A3 to A4 for phase-to-phase coupling

HV polystyrene capacitors are employed in the tuning device. If it is desired to place more than two narrow-band frequency groups on the line, then one must use broadband coupling.

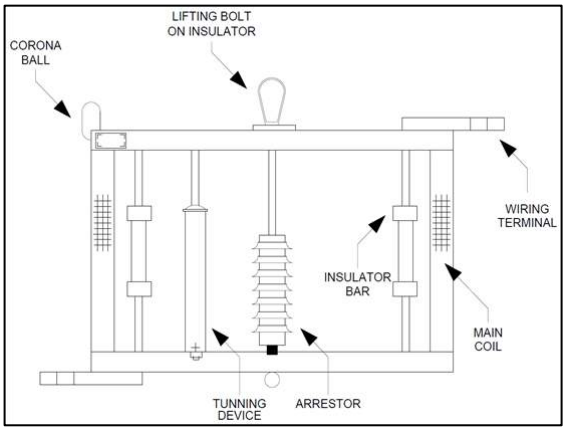

Figure 8. Line trap physical structure

At Lahore Converter Station, two channels are used so a wide-band line trap is used. Figure 8 shows the physical structure of the wide-band line trap and components installed in it [9].
A protective device is used to limit the lightning and switching over voltages applied to the line trap and a certain extent protect the tuning device and main coil.

Figure 9 shows the installation of a line trap and line matching unit in a 500kV AC yard. In the figure installation of hanging type line trap, CVT used as coupling capacitor and line matching unit AKE-100 is shown at Lahore converter station.

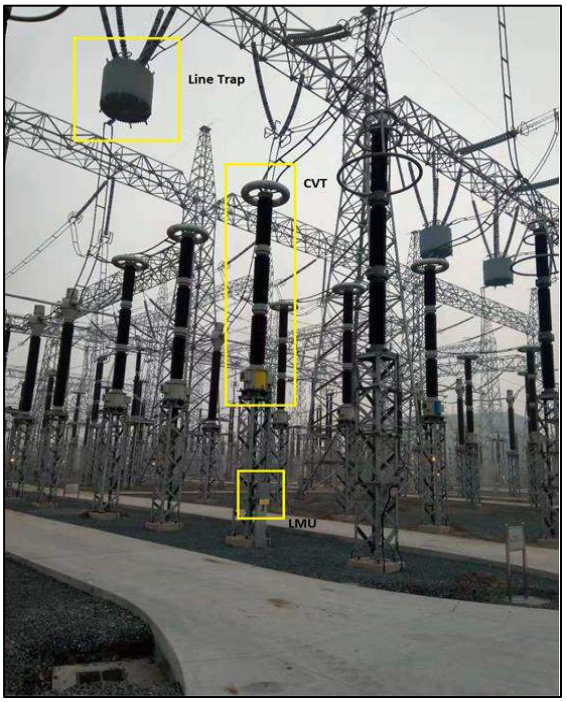

Figure 9. Installation of PLCC equipment in 500kV AC yard

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Article 7

Renewable Energy Systems: Challenges

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Abstract- **With the advent of the renewable energy system in our conventional grid systems, the complexity of the power system is increasing. These hybrid systems are facing new challenges, one of those is the data analysis of installed renewable energy systems to calculate actual load demand and maintaining load-generation balance.**

Keywords— Renewable energy, Hybrid system, Solar energy

INTRODUCTION

Global warming is one of the biggest challenges for the future of our planet. According to WMO, the six years from 2015 onwards were the warmest years on record and the global average temperature was 1.2C above the pre-industrial (1850-1900) level [1]. With all these facts regarding global warming, the importance of renewable energy resources and green energy increases significantly. Many developed countries have already shifted some of their generation load to renewable energy systems. But these renewable energy resources make the conventional grid system more complex and create new challenges for the engineers to overcome. One of these challenges is to calculate actual load demand and meeting generation/load balance [2].

PROBLEM STATEMENT

Renewable energy systems are installed as standalone or grid-tied systems. This article highlights the challenges associated with grid-tied systems. The most common and well-known issue is the harmonic content in the system. Engineers have designed many topologies to overcome this challenge. But apart from this, there is another challenge that is critical to be considered for the countries which are moving towards renewable systems. That is the estimation of energy being produced by the installed solar/renewable systems so that there would be a balance in energy generation and load demand. If we take the example of countries who have worked significantly in the installation of renewable systems, one of the biggest challenges to them is the estimation

of electricity production by grid-tied solar/wind systems. There are solar systems and micro wind turbines installed in most houses in these countries which contribute their electricity production in the main grid in case of lower load demand by that house. Now, this scenario creates a challenge for the engineers to estimate real-time energy demand as it is difficult to access and analyze data of all the solar systems installed and their contribution to the main grid. The wrong estimate can be a challenge to grid stability and efficiency as there should always be a balance in electricity generation and load demand. Although there are devices and software available for real-time data sharing from these distributed energy resources [3], this problem has administrative and planning challenges as well. Most of these renewable energy systems are installed by third parties so there is usually no central body to keep a record of actual solar/wind systems installed in households. Furthermore, even if the installed capacity is known, it is very hard to predict the actual generation of these renewable sources due to weather conditions. In such circumstances, accuracy in short term load forecasting is difficult to achieve. When the actual installed capacity is unknown then it is difficult to forecast the actual load demand of the system.

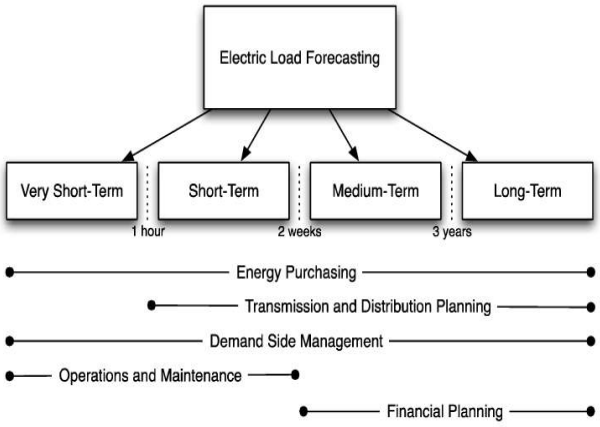

Figure 1. Load forecasting

CONCLUSION

The solution of the challenge mentioned above lies in two parts, one being the technical side which can be addressed by real-time communication and analysis of data from these individual solar systems to a central body so that real-time actual demand of energy could be known. Whereas the administrative challenge can be overcome by new laws and legislation for these decentralized systems. So, that every installation must have communication to the main grid. All the countries, who are moving towards renewable systems must plan a data system to cater for the challenge of analyzing and handling such large data sets of these decentralized renewable energy resources.

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ALUMNI ACHIEVEMENT

Professor Dr. K. M. Hasan

Professor Dr. K. M. Hasan is one of the highly esteemed and highly respected alumni of UET Lahore. He graduated in 1986 from the University College of Engineering and Technology Taxila (the then constituent college of the UET Lahore and now UET Taxila).

After his graduation, Dr. K. M. Hasan joined the Department of Electrical Engineering, UET Lahore in February 1987 as a lecturer. He earned the Commonwealth Scholarship and got his Ph.D. in Electrical Engineering from the University of Bradford, the UK in 1999. He served as a very prominent faculty member in the Department of Electrical Engineering, UET Lahore, for almost 34½ years. He worked at several administrative posts at the University as well. He remained Chairman of the Department of Electrical Engineering at UET Lahore from February 2019 to July 2021.

Along with teaching as a permanent faculty member at UET Lahore, Dr. K. M. Hasan also taught two courses at the University of Bradford UK. HE also served as a visiting faculty at UET RCET Campus Gujranwala, University of Central Punjab Lahore, and the University of the Punjab Lahore.

Dr. K. M. Hasan remained an active researcher during his professional career and published 34 international research papers. He supervised 2 Ph.D., 35 M.Sc, and over 50 Final Year Projects in the Department of Electrical Engineering.

As a consultant, Dr. K. M. Hasan has contributed to the design and development of a computerized leather area measuring machine, industrial electrification, and assorted industrial projects. He was an active team member in the preparation of PC-1 of the Gawadar Institute of Technology in 2004. On behalf of the PEC, he visited more than 20 universities for the accreditation of electrical engineering programs as a convener and expert.

His services as a dedicated teacher are very well received by his students during his long years of service. As the Chairman of, Department of Electrical Engineering, he led the department from the front and made significant and visible changes and improvements which will be remembered in coming years.

ALUMNI ACHIEVEMENT

Mr. Saquib Ahmad

Mr. Saquib Ahmad is the Managing Director for SAP in Pakistan. SAP is the market leader in enterprise application software. Since joining SAP in 2017, he has significantly expanded SAP's footprint in Pakistan, exceeding growth targets and hiring local talent to enable the digital transformation of customers in both the public and private sectors.

Mr. Saquib Ahmad has nearly 20 years' experience in delivering innovation and driving business value for customers in the Information Technology and Telecommunications industry in the region. Prior to joining SAP, he was Director of Sales & Business Development for Oracle. In this role, he was responsible for a sales team that qualified and built business opportunities in Pakistan and Afghanistan. He introduced new applications to these markets and strengthened Oracle's relationships with key clients.

Previously, Mr. Saquib Ahmad was the country director, Pakistan, and Afghanistan, for Comptel, where he determined the sales, partner, and business strategies to optimize revenue, order intake and cost of sale. He began his career with Nokia-Siemens, where he held a variety of roles, culminating in him being named Director of Sales, Middle East.

Mr. Saquib Ahmad holds a Master's in Business Administration (MBA) from the University of Management and Technology in Lahore and a Bachelor of Engineering in Telecommunication and Electronics from the University of Engineering and Technology in Lahore and was recognized with the Aizza-e-Sabqat presidential award for academic excellence.

To learn more about UET Alumnus Mr. Saquib Ahmad and SAP, log on to the following link of a detailed interview of Mr. Saquib Ahmad.

https://www.brecorder.com/news/40030866

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Article 8

Career Prospects in Business After Engineering

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***Abstract*— Career counseling assists you with understanding the obstacles in your career path. Subsequently, they additionally give their experiences that help to construct your certainty. Furthermore, they keep you refreshed with the most recent happenings in the picked profession ways and appropriately assist you with clearing your direction. It answers questions like: What's the best job search strategy for me? What kind of resources can I look forward to? Can you guide me step by step before we take this further? How do my job search materials look? or Is this the right time to change a career?**

***Keywords*— Career Decision, MBA, Management Sciences**

INTRODUCTION

Usually, most people after engineering feel truly baffled after they get done with their undergraduate studies. However, it is only wise to invest all your energies in things that are bound to return with interest. A Master of Business Administration is a vast program for business majors which is becoming quite a choice for people graduating as engineers. Preparing for leading positions, an MBA gives engineering graduates good prowess and expertise in managerial roles. Throughout many other industries, like engineering, law, and health care, business acumen is pervasive as described in [1]. While an engineering degree inculcates technical knowledge, fresh graduates work usually as associates and graduate trainees, but an MBA can help expedite the way up to better managerial roles, leadership positions, and promotions. Without an MBA however, with little or no managerial expertise, with only technical prowess, engineers usually get fed up and exhausted in roles requiring leadership traits.

CHOOSING BUSINESS STUDIES AFTER ENGINEERING

A degree in Master of Business Administration equips the professional with sound business acumen

and this, in turn, helps the individuals pace their way up in roles relating to business and technical knowledge. Engineers are usually loaded with knowledge in problem-solving and analytical skills, and they have amazing business ideas too. What lacks in them is the apt knowledge of leadership, decision making, better communication skills, and most importantly the management of finances as mentioned in [1]. Engineers are explicit builders and problem solvers having realistic business ideas, however, making these dreams into a reality is the true challenge, An MBA can help big jumps in the expedition of promotion and turning absolute dreams into reality; in bringing an abstract image to a real-world product; A reality.

However, if one really wants to remain in the engineering domain and still wants to have prior knowledge, a degree in engineering management is also a great choice. This keeps the individual in the technical field but at the same time enlightens with all the business and leadership jargon and rules. An MBA, nonetheless, is an expensive degree. It is quite an amount of money that is required to get this degree in this era of inflation. The cost of attaining this coveted acronym is no mere chump change. In this era where almost everything is overpriced and it's hardly possible for most to make the ends meet, an MBA has also gotten out of reach for many able candidates; according to [2]. An MBA at a storied institution in Pakistan is worth 20 lacs plus and that does not even include traveling, living, books, and medical facilities. Thence, it is suggested that you make sure you really can afford this expensive degree and that can you bear the monetary burden without affecting your mental health. However, if you make the decision, it is pertinent to mention how important the institution is and the reputation and status it has locally and internationally.

According to reference [3], you should think of getting an MBA if:

1) Moving into a managerial role has been one of your goals.
2) Budgeting and forecasting are parts of your current or future job.
3) Switching careers if engineering seems too dry for you.
4) If your job requires you to have better and advanced qualifications and degrees.

INFERENCE

Before you consider taking up a role as an MBA candidate, it is highly important to analyze your personality, career goals and ideals, current role, and the desired roles you might want to take up in the future. If you think, an MBA aligns with all of these, then you should not take another instant to go for it, but you must know that you should either go big or go home. After all, you have graduated with one of the hardest degrees, you are an engineer after all. You need to put all the problem solving and logical reasoning you learned during your time as an engineering graduate as mentioned in [4]. For if you have faith in yourself, you will be a triumphant hero at the end. You are supposed to be successful for being wrong is not any of your options. Once you have obtained your MBA engineering degree, it's important that you have an idea of what kind of profession you would like to go into. Job security and a healthy salary are key factors to consider, so keep a close eye on the job opportunities at your disposal for engineers with an MBA degree. In the end, you came this far not to only come this far. Have faith, work hard and even skies are not the limit. Good luck!

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Article 9

NEXTGENHEALTH: A Machine Learning Based Health Diagnostic System to Support COVID-19 Healthcare

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Abstract- **Amid the rise of Pandemic COVID-19, the hospitals of low resourced settings are overwhelmed by the substantial increase in the daily number of emergencies. This extra burden on hospitals is decelerating their performance. A machine learning-based self-diagnostic system coupled with a wearable module has been introduced. This system measures four vital signs of patients (heart rate, oxygen saturation, temperature, and respiratory rate) and feeds these values to a database. The database through a random forest-based risk model predicts the chances of having COVID-19 for each patient. With the increase in the number of subscriptions and subsequent increase in the data, the sensitivity and specificity of this system will improve.**

Keywords— COVID-19, Vital Signs, Heart rate, Oxygen saturation, Respiratory rate, temperature, STM32F407, Random Forest, Risk Model

INTRODUCTION

The world is currently facing multiple challenges concerning the health care industry. Developing and underdeveloped countries are especially vulnerable in this situation due to low resource settings, high population, and COVID-19 pandemic.

Many countries, especially in Africa and in the Eastern Mediterranean region, are yet very far from reaching the universal healthcare goals, according to

a report published by the World Health Organization [1]. According to the WHO report for Asia and Pacific, the United Nations (UN) informs that the COVID-19 pandemic will aggravate the inequalities among the countries [2]. The low resource settings have become more prone to difficulties due to this situation. As a developing country, with a frail healthcare system and a population of around 223.62 million [3], Pakistan is vulnerable to COVID-19[4]. According to official data, 6,791 doctors, 1,360 nurses, and 2,774 other hospital staff got infected with COVID-19 [5]. This situation leaves patients as well as health care workers in a very vulnerable situation. The current scenario demands the use of modern tools for diagnosis, prognosis, and treatment to maximize the social distancing and to reduce the load on doctors and nursing staff.

PROBLEM STATEMENT

The hospitals of developing and/or underdeveloped countries are facing a very difficult situation during COVID-19 due to a rapid increase in the number of patients, shortage of required staff, lack of required precautionary instruments, and COVID-19 testing facilities.

SOLUTION

This article is proposing a self-diagnostic application coupled with a wearable module to monitor basic vital signs of patients at their place of choice. The application will diagnose their chances of possible contraction of COVID-19, using their symptoms, through machine learning algorithms and neural networks.

METHODOLOGY

A wearable module for vital signs measurement is designed using low cost commercially available sensors. The values of these vital signs are measured, processed, and converted to a human-readable format using micro-controller STM32F407 [6]. Then these values are saved in a database alongside some other demographic features i.e. patient name, age, and gender. Then these all values of patients are fed in a random forest-based machine learning algorithm and a risk model is developed for diagnostic purposes. For the vital signs monitoring system, a set of clinically approved low-cost sensors is used. MAX30100 is used for heart rate, respiratory rate, and oxygen saturation measurement [7]. While LM35 is used for body and ambient temperature measurement [8]. These all sensors are mounted on a wearable module to measure basic 4 vital signs. The micro-controller STM32F407 processes the data to convert it into human-readable form. Then these vital signs are sent using wireless communication protocol through ESP8266 Wi-fi module [9] to the database opened on the communication device of a user. A database for this purpose is developed using MY SQL, Javascript, HTML programming languages, and an open-source database platform for the front end, C for the back end, and interfacing with the system's hardware. This database shows the values of 4 basic vital signs of the patient (heart rate, oxygen saturation, respiratory rate, and temperature). The upper and lower limit of these variables is also indicated alongside with each patient's test result to indicate each abnormality. The database saves each patient's test results concerning the patient's name and ID.

For the diagnostic algorithm, the data of 2500 volunteers including healthy and confirmed patients of COVID-19 from different hospitals of the country were collected. 70 % of the data was in raw form.

The time unit for heart rate and respiratory rate was fixed to avoid any discrepancy. Some out of the bound data/outliers were removed. After the pre-processing of data, it was divided into 75%/25% train/test sets. To avoid any kind of business, it was made sure that training data had an almost equal number of examples of all normal and abnormal vital signs. Moreover, patients were differentiated based on their Identification number. And not any patient's data was repeated either in train set or test set.

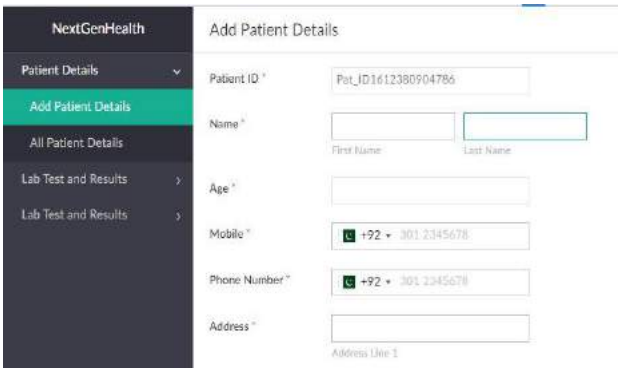

Figure 1. Patient's demographical detail chart

Figure 2. Database view of patient's vital signs

The features which were selected for this diagnostic model are all four measured vital signs (heart rate,

oxygen saturation, respiratory rate, body temperature, ambient temperature) and some demographic factors (age, gender, and taste sense status). All other features were removed to have a clean set of data. The final data set did not have any kind of missing data. After preprocessing, removing biases, selecting features, and checking for missing data, the data set was ready for diagnostic model application. The most suitable and appropriate diagnostic model for this problem was Random Forest Method concerning the accuracy, training speed, and vanishing gradient issue. The most important point in using the random forest method is to optimize hyperparameters in such a way that it provides the best possible model and minimum possible overfitting.

The different values were chosen for three hyperparameters i.e., estimators, maximum depth, and minimum sample leaf. The data set behaviour was tested against all these values. A C index greater than 0.7 both for the train and validation set was required. To get the most optimized hyperparameters the grid search method using C-index was implemented. The obtained values of the C index through most optimized hyperparameters are given in the following equations

$$\mathrm{C-IndexTrain} = 0.752546 \quad (1)$$

$$\mathrm{C-IndexValidation} = 0.7362 \quad (2)$$

After getting the desired C index (C, 0.7), the final model was tested on the test set. The C index value for test data was 0.71252

RESULTS

After computing the C index for test data, the Confusion matrix was plotted for calculating the sensitivity and specificity of the system.

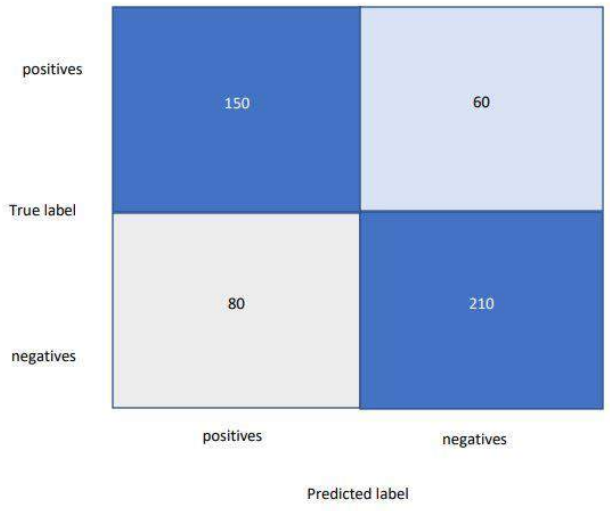

Figure 3. Confusion Matrix

$$\text{Sensitivity} = \frac{TP}{TP + FN} = \frac{150}{150 + 60} = 0.714 \quad (3)$$

$$Specificity = \frac{TN}{FP + TN} = \frac{210}{210 + 80} = 0.724 \quad (4)$$

$$Accuracy = \frac{TP + TN}{Total\ instances} = \frac{150 + 210}{500} = 0.72 \quad (5)$$

These calculations show that the accuracy of the system is 72%. It means that in 100 cases 72 times the result of the presented system will be accurate.

CONCLUSION

In this article, a low cost, unique and innovative system has been introduced which uses a combination of low-cost biosensors to measure four basic vital signs heart rate, oxygen saturation, respiratory rate, and temperature. These values are communicated to a database along with some other demographic features of patients including age, gender, and certain other symptoms. The pre-trained random forest-based algorithm compares the symptoms of the patient with other COVID-19 positive patient's symptoms and diagnoses the chances of possible contraction of COVID- 19.

FUTURE WORK

In the future, a big set of data for training and validation will be used. This will lead to better generalization of the algorithm.

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