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ELEKTRON

Transforming Humanity through Technology

A Publication of Department of Electrical Engineering
University of Engineering and Technology, Lahore.

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

In this issue, we have included two sections to appreciate our alumni and also our current students.

1. Alumni Achievement
2. Skills of Our Student

Through these two sections, our aim is to introduce our readers to the immense potential of our Alumni and also our currently registered students. I hope, this issue of Elektron will also gain your attention and appreciation."

Dr. Muhammad Salman Fakhar
Editor In Chief (faculty)
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Analysis on the Causes of Broken String of Composite Insulators of 500kV Linear Towers

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Abstract: In this research, the fault condition of the composite insulator of a 500kV line linear tower is analyzed. The reason behind the fault was obtained, and correspondingly preventive measures were put forward that must be taken. The case study was the insulator silicone rubber sheath's chemical composition and operating conditions. It was concluded that under the combined action of sheath damage, poor sealing, and yearly ageing as well as under the repeated movement of the corona, nitric acid, OH and COOH concentration, there might be penetrating cracks and holes in the sleeve, making the insulator mandrel in direct contact with the outside air, rainwater, etc. Using macro inspection, anatomical inspection, micro-observation and dye penetration test, infrared temperature measurement test and electric field simulation calculation are carried out on the normal phase insulator of the same tower, and the chemical composition of the insulator core rod is analyzed. It is concluded that the fault phase insulator sheath has defects, poor sealing and other problems, causing the mandrel to come into contact with the outside air, rainwater, etc. The mandrel will be corroded under the long-term action of the strong electric field, acid solution and humid air resulting in the insulator disconnection.

Keywords: mandrel, linear tower, epoxy resin, fiberglass, silicone rubber sheath, composite insulator.

1. Introduction

Generally, a composite insulator consists of three parts: metal ends, silicone rubber sheaths, and epoxy resin-impregnated glass fiber mandrels. The glass fibers in the mandrel mainly carry mechanical loads. Composite insulators have been widely used in high-voltage transmission lines due to their good pollution flashover resistance, lightweight and convenient operation and maintenance [1-3].

However, with the increased use of composite insulators, the probability of accidents is also increasing. According

to literature statistics and analysis, the on-site damage of composite insulators includes mechanical damage (including mandrel breakage or shed damage) [4-6] and electrical damage (lightning flashover or bond interface breakdown) [7-8]. The fracture of the mandrel can cause the insulator to break the string. This kind of accident has serious consequences, leading to the tripping accident of the single suspension string linear tower, which seriously impacts the safe operation of the power grid. In this paper, the reasons for the disconnection of the composite insulator of the linear tower of a 500kV line are studied and analyzed, and preventive measures are proposed.

2. 500kV Linear Tower Composite Insulator Broken String Overview

On December 3, 2018, the working staff inspected line faults and found that the middle phase (B phase) composite insulator of the #72 tower was broken. The intermediate phase conductor fell to the ground. As shown in Figure 1 and Figure 2. The tower type #72 is SZT42-33, the tower insulator is designed with a single I-string, the model is FXBW-500/210, the rated mechanical load is 210kN, the structure height is 4360mm, and the hanging time is May 26, 2006, and the production time is March 2005.

Figure 1 Middle-phase insulator fracture

Figure 2 The wire has fallen to the ground.

2.1 Visual inspection of composite insulators with broken strings

Broken string insulators had 84 sheds, and the fracture is located between the 5th to 6th sheds at the high voltage end. The fracture surface of the mandrel at the fracture is not neat like the tip of a brush, the root is powdered, and the cover is carbonized black. There is one crack and perforation at the fracture, and the sheath is severely powdered. From the 1st shed on the high-voltage end to the 15th shed, there are cracks and perforations in the sheath under the shed, 18 cracks and 17 perforations, and no perforations and apertures were found above the 15th shed. The details are shown in Figure 3-6.

Figure 3 Fracture and mandrel at the fracture

Figure 4 Umbrella cover powder

Figure 5 Jacket crack

Figure 6 Sheath Perforation

2.2 Anatomical inspection of composite insulators with broken strings

The insulator was dissected along the high-voltage end to the low-voltage end, as shown in figure 7, and it was found that the length of the deterioration channel was about 2.3 meters. Part of the fiberglass colour turns black, and part turns reddish brown. The interface between the sheath and the mandrel is loosely bonded, and the sheath becomes brittle and hardened.

Figure 7 The mandrel appears pulverized and carbonized.

3. Infrared temperature measurement test

An infrared temperature measurement test was carried out on the A-phase and C-phase insulators of a 500kV line. First, a voltage of 500kV for 30min was applied. As a result, the voltage dropped to the highest operating phase voltage of 318kV, and the temperature of the insulator remained stable for 30min. The ambient temperature of the test was 7°C, and the humidity was 40%. The field test results show no abnormal temperature rise in the A-phase and C-phase insulators of a 500kV line. As shown in Figures 8 and 9.

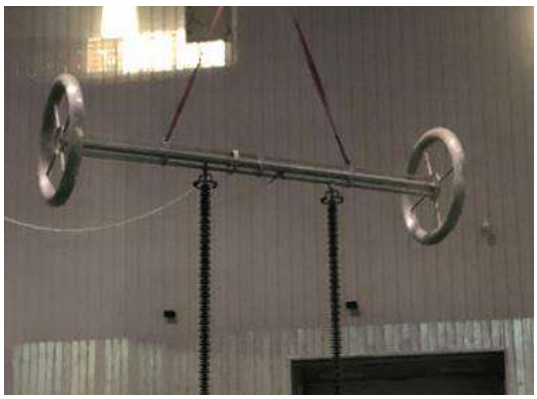

Figure 8 Test diagram of insulator with applied voltage

Figure 9 Insulator infrared temperature measurement test diagram

3.1 Electric field simulation calculation

A model for calculating the electric field of the insulator was established based on the size drawing of the equalizing ring. The dielectric constant values of 3.5 and 5 were assigned to the silicon rubber and mandrel, respectively. The ball head was subjected to the peak operating voltage while the ball socket was grounded, and the solution domain was considered infinite. The overall potential and field strength distribution of the insulator was examined using the established model, and it was found that there were no significant abnormalities, as depicted in figure 10.

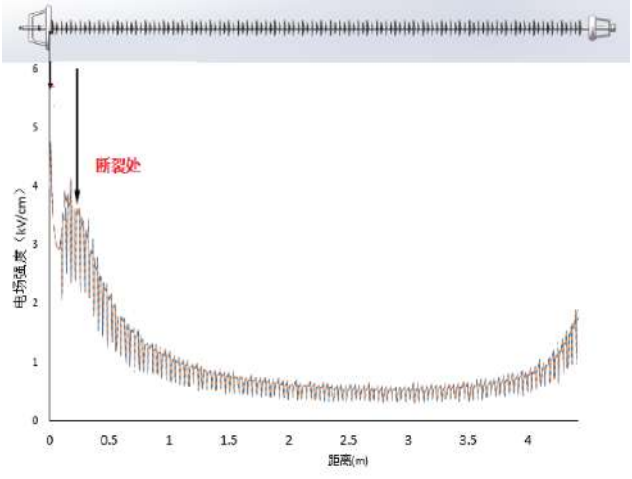

Figure10 Electric field calculation diagram

3.2 Dye penetration

To conduct this testing, three samples were collected for each insulator of the #72 tower's A, B, and C phases. These samples were processed to meet the test's size and style requirements. A test container tray was prepared with a layer of glass balls of uniform diameter, into which a 1% violet methylene dye in ethanol staining solution was poured. After 15 minutes, the samples were observed to determine the penetration of the paint. The results indicated neither phase A nor phase C showed any signs of dye penetration, meaning they met the standard requirements. However, the B-phase sample showed dye penetration throughout the piece along the interface between the mandrel and the sheath, indicating that it did not meet the standard requirements. The results of the dye testing showed that the interface between the faulty insulator mandrel and the sheath had failed, and the sealing was not tight.

3.3 Microscopic observation

Scanning electron microscopy (SEM) was used to examine the fractured mandrel to observe its microscopic morphology. A dispersive energy analyzer (EDS) attached to the SEM was used to analyze the elemental composition of the micro-area sample. Low and high-magnification images of the fracture are presented in Figures 11 and 12. As shown in Figure 11, the glass fibers have detached from the epoxy matrix, exposing the threads fully. The glass fibers were significantly damaged and broken, with numerous fragments adhering to the surface of the broken glass fibers. Figure 12 provides a more detailed magnification of the broken glass fiber and the concentrated area of debris. It reveals that the surface of the fractured fiber is densely covered with protrusions and particles.

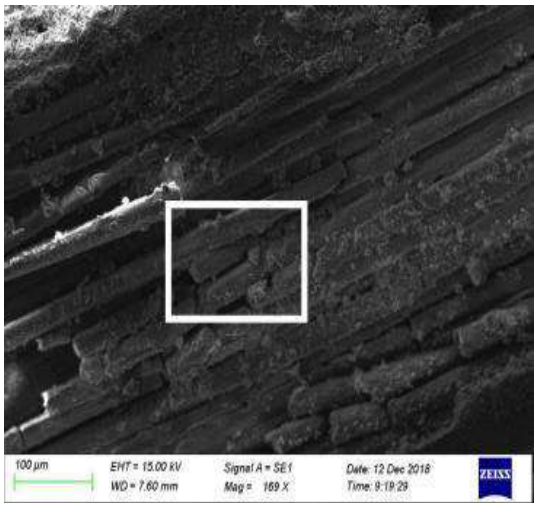

Figure 11 Microscopic appearance of fracture initiation position at low magnification

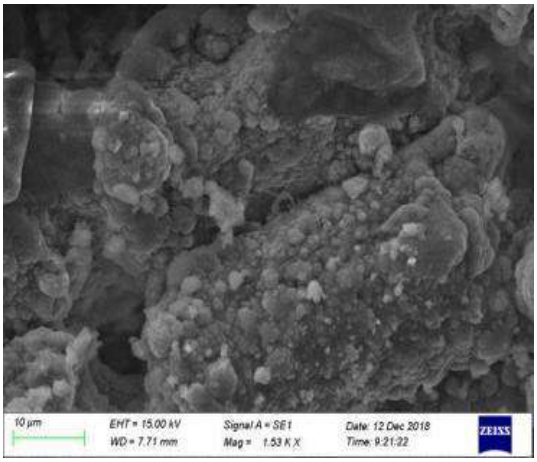

Figure 12 Microscopic appearance of fracture initiation position at high magnification

Upon conducting trace element EDS analysis of the glass fibers and surface fragments, it was found that the primary characteristics present in the details and glass fibers were O, Si, Ca, Al, and small amounts of Na and Mg. However, no C element was observed. This indicates that the epoxy resin matrix has been entirely decomposed in the cracking corrosion area of the mandrel, and the fragments consist mostly of scattered glass fibers. Analysis of the solid part of the mandrel using SEM microscopic morphology and Energy-Dispersive X-ray Spectroscopy (EDS) element analysis revealed that the glass fiber was severely damaged by electrical corrosion, resulting in fractures and an uneven surface. Another observation was that the mandrel had cracked, and the epoxy resin matrix was decomposed under the influence of the electric field and moisture, leading to the glass fiber losing its protective coating.

4 Analysis of the causes of broken strings of synthetic insulators

4.1 Analysis of sheath perforation and crack

The insulator sheath of the composite insulator is composed of silicone rubber material, which mainly consists of polydimethylsiloxane ([(CH3)2SiO] n) and includes a proportion of carbon black and Al (OH)3 filler [9]. Upon examining the faulty insulator (B phase) and the non-faulty insulators (A, C phase) of the same tower, it was observed that the sheath of the faulty insulator had penetrating cracks and perforations between the sheds. In contrast, the non-faulty items did not have such defects. Eighteen synthetic insulator sheaths from six-base iron towers on the same line were inspected, and no penetrating cracks or perforations were found. The faulty phase composite insulator was found to have sheath damage defects during production, handling, and installation, bonding failure issues at the interface between the mandrel and the sheath, and poor sealing quality.

In wet environments, the interface between the mandrel and the sheath in composite insulators with defects can quickly allow moisture to penetrate and fill the entire interface [10]. As a result, the electric field on the inner surface of the sheath at the radial cross-section of the air gap is much higher than the electric field on the outer surface. This creates wear that results in cracks and holes, generating ozone. In addition, during corona discharge, high-energy electron beams act on water molecules in the air, causing free -OH that then combines with the chemical bond on the surface of the silicone rubber material to produce -COOH and associative -OH. Under high humidity conditions, more water molecules are in the air, resulting in more associative OH and COOH during the ageing process, further increasing the ageing degree [12]. Over time, surface cracks and holes gradually appear [13].

While normal phase insulators may also face ageing problems during extended operation, faulty phase insulators are more susceptible to ageing issues due to bonding failure at the interface between the mandrel and the sheath, poor sealing quality, and repeated exposure to corona, nitric acid, -OH, and -COOH. These factors, combined with sheath damage and poor sealing, can result in penetrating cracks and holes in the sheath.

4.2 Analysis of Causes of Disconnection

The mandrel in a composite insulator can experience problems such as sheath perforation and cracks, leading to direct contact with external media such as air and rainwater. This can form a black carbonized channel along the white hydrolysis channel on the mandrel's surface under the electric field's influence. As time passes, the carbonized medium can rapidly develop in the direction of the electric field, leading to the failure of the interface between the glass fiber and the epoxy resin in the carbonization channel. This causes the glass fiber to become loosely arranged, and many damaged epoxy resin

matrices remain around the glass fiber.

When the carbonization channel of the mandrel rod becomes long enough, it can cause a difference in the gradient of the inner and outer potentials of the composite insulator sheath. This can cause the sheath to break down and form a sheath damage hole, forcing the inner and outer possibilities of the sheath to be consistent. Partial discharge at the interface can continue, and when the carbonization channel becomes long enough, the sheath can break down again and form a sheath damage hole. This process can repeat, resulting in the formation of multiple punch holes on the composite insulator sheath and an increase in the number of cracks. Therefore, constructing carbonized channels is an important factor in insulator penetration of cracks and perforations. Cracks and holes are often concentrated at the high-voltage end of the insulator due to the strong electric field strength.

During long-term operation, the mandrel can come into contact with external media, such as air and moisture, causing moisture to diffuse from the outside to the inside. This can lead to swelling, hydrolysis, and plasticization of the mandrel epoxy resin matrix. Larger wet mismatch stress can cause interface de-bonding, cracking, and other phenomena. Periodic moisture absorption and dehumidification processes can cause matrix fatigue, generating micro-cracks and micro-holes in the matrix and interface. When defects such as micro-cracks, micro-holes, or interface de-bonding and cracking occur inside the mandrel, it can further promote moisture intrusion and increase the amount of moisture.

Nitrogen is in the air, and elements such as silicic acid and sulfur exist in the synthetic insulator. Under the influence of a strong electric field and moisture, they can electrochemically react to form an acid solution. Under long-term exposure to the acid solution, strong electric field, and humid air, the alkali oxides in the mandrel glass fiber can chemically react with the acid solution and other substances. The glass fiber will gradually break down due to the electrochemical reaction. When the fracture surface becomes significant, and the total bearing capacity of the unbroken glass fiber cannot withstand the comprehensive load force, such as the dead weight of the wire and the vibration of the wire, the mandrel can be pulled off as a whole, resulting in the insulator breaking. The fracture surface is irregular, and the fractured end resembles the tip of a brush, indicating that the mandrel is not brittle but rather a rotten fracture.

5 Precautions

There is a need to strengthen the infrared detection of composite insulators if local overheating is found, replace them in time, carry out the double-string transformation of composite insulators for transmission lines, strengthen the whole process management of composite insulators in transportation, construction, acceptance, maintenance and other links, especially not to damage the mandrel sheath, prevent the insulator sheath from being pecked by birds and strictly control the production process of composite insulators to ensure qualified quality.

6 Conclusion

The main focus of this research is to analyze the circumstances of poor sealing of a faulty phase insulator. After ageing year by year and under the repeated action of the corona, nitric acid, OH and COOH, the sheath has penetrating cracks and holes. As a result, the core rod carbonization channel is formed. The difference between the inner and outer potentials of the insulator sheath can cause the sheath to break down, resulting in more damaged holes and cracks. This causes the mandrel to contact the outside air and rainwater. During the long-term operation, the water diffuses into the inside of the mandrel, and the mandrel is corroded under the long-term action of the acid solution, strong electric field, moist air, etc., the epoxy resin constituting the mandrel is decomposed, and the glass fiber gradually begins to break due to the galvanic reaction. To summarize the scenario, the insulator gets cracked when the general gravity of the broken glass fiber cannot reach the comprehensive load force, such as the wire's self-weight and vibration.

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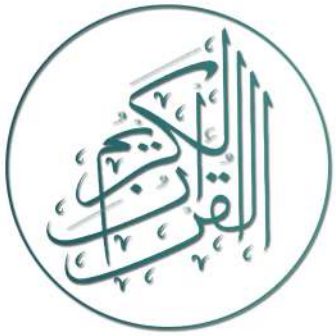

الَّذِىْ جَعَلَ لَكُمُ الْاَرْضَ فِرَاشًا وَّالسَّمَآءَ بِنَآءً ۖ وَّاَنْزَلَ مِنَ السَّمَآءِ مَآءً فَاَخْرَجَ بِهٖ مِنَ الثَّمَرٰتِ رِزْقًا لَّكُمْ ۚ فَلَا تَجْعَلُوْا لِلّٰهِ اَنْدَادًا وَّاَنْتُمْ تَعْلَمُوْنَ ﴿٢٢﴾

Who has made the earth your couch, and the heavens your canopy; and sent down rain from the heavens; and brought forth therewith Fruits for your sustenance; then set not up rivals unto Allah when ye know (the truth). ﴿22﴾.

This picture is taken from "https://www.world-energy.org/article/26079.html"

Introduction to Smart metering and its prospects in Pakistan

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Abstract: Electricity theft and irregular billing pattern is the biggest problem for conventional power system, which still rely on conventional energy meters. The world economy lost 89 billion dollars annually due to electricity theft, losses, inappropriate power management and irregularities in static energy meters. Most developed countries are using smart energy meters to decrease electricity theft, increase remote control over consumer electricity usage patterns and penalize defaulters in Pakistan; it is challenging to replace conventional meters due to cost issues and lack of technology. This article states different types of meter reading methods and their comparison, as the importance of SMART Meter over other conventional Meters based on its components – static meter, communication module and disconnection relay. SMART meters are useful for monitoring, theft prevention, and energy management. Also, Various aspects of the Energy Market of Pakistan and possible measures to tackle the implementation barriers in terms of these Smart Meters have been discussed.

Keywords: Smart metering, conventional meters

1. Introduction

Electrical power is most important for the development of the country. Social structure and industrial survival depend of a country upon on the uninterrupted electricity service provider or utility. In Pakistan's Energy sector, it has been estimated that around one-third of supply costs pertain to distribution costs and losses [1]. Pakistan loses billions of rupees every year due to electricity losses, electricity theft and power mismanagement. Utilities in Pakistan (like in other parts of the world) are always keen to improve their cash flows and provide the best services to their customers. The primary objective of all companies is to earn a profit, grow business and provide the best service to their customers. However, this objective cannot be achieved unless the company has sufficient revenue to provide these services and run their day to day expenses. Similarly, all utility companies provide different services to their consumers and charge accordingly. In the case of the electrical utility company, different types of meter reading modes are available. Choice of a particular reading mode depends upon the philosophy & strategy of the company, particular area and,

available technologies etc. These modes are discussed in detail in the subsequent sections.

A. Modes of Meter Reading

Different meter reading methods have been adopted depending on the installed energy meter. Conventional metering systems do not support remote meter reading, as they do not have any communication module. In accordance with conventional and smart metering, there are three modes of meter reading, namely:

- Manual Meter Reading (MMR)
- Automated Meter Reading (AMR)
- Advanced Metering Infrastructure (AMI)

1.1 Manual Meter Reading (MMR)

Manual meter reading (MMR) has been used for conventional static energy meters. In this method, utility personnel physically visit the site and record manual meter reading, which is converted into soft form and sent for billing. There are certain problems associated with this mode of meter reading, as detailed below:

- Human Error
- No Theft Detection Mechanism
- Time-consuming process
- Extra human effort is required.

1.2 Automated Meter Reading (AMR)

In this method, the meter transmits its data to the utility on-demand or periodic basis. However, the utility cannot give any instructions to the meter, e.g. change of tariff, disconnection, and reconnection. This technology allows the utility to obtain billing data remotely without physically visiting the site and record manual meter reading[2]. The following are the advantages of Automated Meter Reading (AMR).

- Low operation cost
- Reduction of losses

1.3 Advanced metering infrastructure (AMI)

AMI is a two-way communication between meters and utility companies. The meter transmits its consumption detail, alarms, data profiles, balance availability, etc., to the utility. Similarly, the utility can instruct the meter for disconnection/ reconnection, tariff change, firmware upgradation etc. AMI uses the same communication technologies, i.e., RF, GSM and PLC [3]. Based on available meter reading modes, consumers can be billed through a prepaid or post-paid billing system.

2. Smart meters

In the early day, electromechanical meters were used, which work on the principle of electromagnetic induction. However, their features were limited to only up-to-KWH reading. Later on, static energy meters were introduced. The functionality of these meters included KWH reading, KVARH reading, MDI reading, TOU Tariff etc. However, it was required to physically visit the site for a meter reading. The third generation of meters is called SMART meters. The generation process of meters can be explained with the help of the following diagram.

SMART is an acronym for Self-Monitoring Analysis and Reporting Technology. This smart energy meter there has a communication module and disconnection relay. Hence, we can say that;

$$Smart\ Meter = Static\ Meter + Communication\ Module + Disconnection\ Relay$$

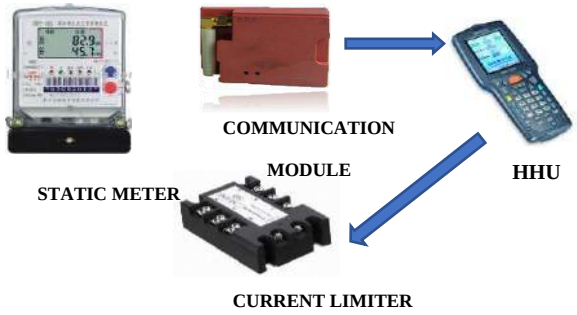

Figure 1 Component of a smart meter [5]

3. Smart meter prospects in Pakistan

It has been noticed that a decrease of 11-15 % in energy consumption is due to increased awareness of usage [4]. The lesson of these early deployments is that if you better inform customers about their energy use, they will change their usage patterns to conserve energy; this is demand-side management (DMS). According to a survey, the world economy wastes more than 89 billion dollars per year due to electricity theft, irregular billing, and physical destruction of traditional electricity meters. However, it is not easy to replace the existing traditional metering

system because of their implementation challenges, such as infrastructure cost issues, installation complexities, acceptance, universal interface, network coverage problems, security, privacy, health and availability of Smart Grid station issues that occur during the implementation. In Pakistan, the government initiated a project to install Smart Meters at a small level in multiple phases with the collaboration of USAID [5]. However, the government faced many barriers and challenges in the early stages of the project.

Therefore, many countries adopted (Smart Meters) to decrease their losses. These are used for automatic meter readings, and their features make them very useful for monitoring, theft prevention, and energy management.

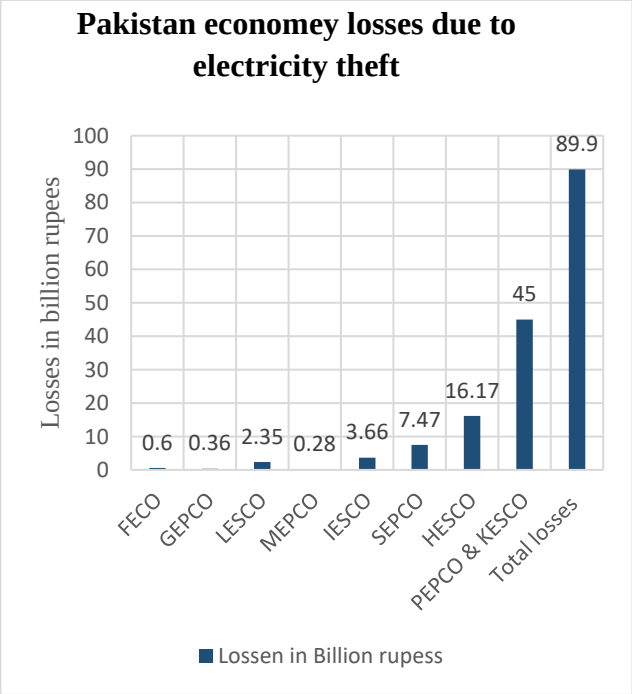

Figure 2 Electricity theft in Pakistan Source: Statistical department WAPDA House

Different DISCOS already adopted AMR Smart Metering Strategy on a small scale through their resources. For Example, LESCO executed the AMR project, including successfully installing more than 20,000 smart meters with financial implications as described in table III. LESCO lost 45,720,33 units due to electricity theft before the installation of AMR. After the installation of AMR, 16,707,207 units were lost due to the Automated meter reading LESCO saved 319 million [6].

Units lost before AMR meters installation	45,720,333
Units lost after AMR meters installation	16,707,207
Unit Improvements after AMR meters installation	29,013,126
Savings @ Rs 11/unit	Rs 319 Million

Table I LESCO Case study, Source: Statistics Department, WAPDA House Lahore

Reasons for Failure of Implementation of AMR Projects:

Despite the achieved benefits and financial savings mentioned above, the energy sector in Pakistan failed to implement Smart Metering on a large scale. Some of the reasons may include

- Lack of awareness
- Deplete financial resources
- Lack of international funding
- Complexities involved in the implementation of smart metering
- Political uncertainty
- Hindrance/Resistance from users.

Recently many DISCOs, as per directions of the Power Ministry, included Smart Metering projects in their 05-year business plan for 2022-2027. Initially, it will be installed on high-loss feeders and industrial consumers. In the second phase, it will move towards domestic and commercial consumers. If the Smart metering project, unlike in the past, is implemented successfully on a large scale, then it will likely reduce losses and improve Disco's financial position and hence government exchequer.

4. Conclusion

Smart metering is the best solution for a utility to earn more revenue and decrease its debts. The staff engaged for disconnection / re-connection in case of non-payment of energy bills may be engaged to provide better services to the consumers through system maintenance. Meter reading and statement distributing staff will not be required for the Smart Metering system, which ultimately reduces the overhead expenditures of the Company. This system can easily achieve Energy Conservation and Load Management. Wrong readings and consumer complaints would be resolved automatically.

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[6] source; statistics department, WAPDA House Lahore

Power Systems Simulation Research Lab

The Power System Simulation Research Lab (PSSR Lab) of the Electrical Engineering Department was developed at the department of Electrical Engineering, UET Lahore, in 2020, with funding from Mr Hasan Jafar Zaidi, CEO of Power Planners International Pvt. Ltd, Mr Imtiaz Hassan, CEO, Shark Innovation Labs Pvt. Ltd, Mrs Professor Rukhsana Fakhar and Mr Najeeb Ahmad, CEO of Hitachi Pakistan Pvt. Ltd. This lab was a brilliant initiative towards progressing the graduate level research and studies as a product of the wonderful Industry-Academia bridging. The lab is directed by Dr Muhammad Salman Fakhar, Assistant Professor, who initiated the plan of this research lab and got funding from the mentioned industries. The lab is co-directed by Dr Syed Abdul Rahman Kashif, Associate Professor.

The PSSR lab in UET offers an original and creative environment and approach to solve some of the world's operational challenges in power systems optimization, operations and control by using modern simulation tools like MATLAB, PSSE, PSCAD, and Homer while incorporating the dimension of artificial intelligence, like metaheuristic optimization techniques, machine learning, deep learning and expert systems.
Since its birth, the PSSR lab has successfully conducted two PhD theses and six MS theses, and as a result, 23 research articles have been published, out of which 16 are impact factor journal publications. The following research problems have been worked on in this lab.

- Short-Term Hydro Scheduling and economic dispatch problems by applying Machine Learning, Conventional and Metaheuristic Optimization Algorithms.
- Optimal scheduling of neural network-based estimated renewable energy Nano grid while incorporating the socio-techno and environmental constraint.
- Modified Multilevel Inverter Systems for Grid–Tied Distributed Energy Systems and on Hybrid Cascaded Inverters for Solar PV applications.
- Batteries state of charge optimization using metaheuristic optimization algorithms.

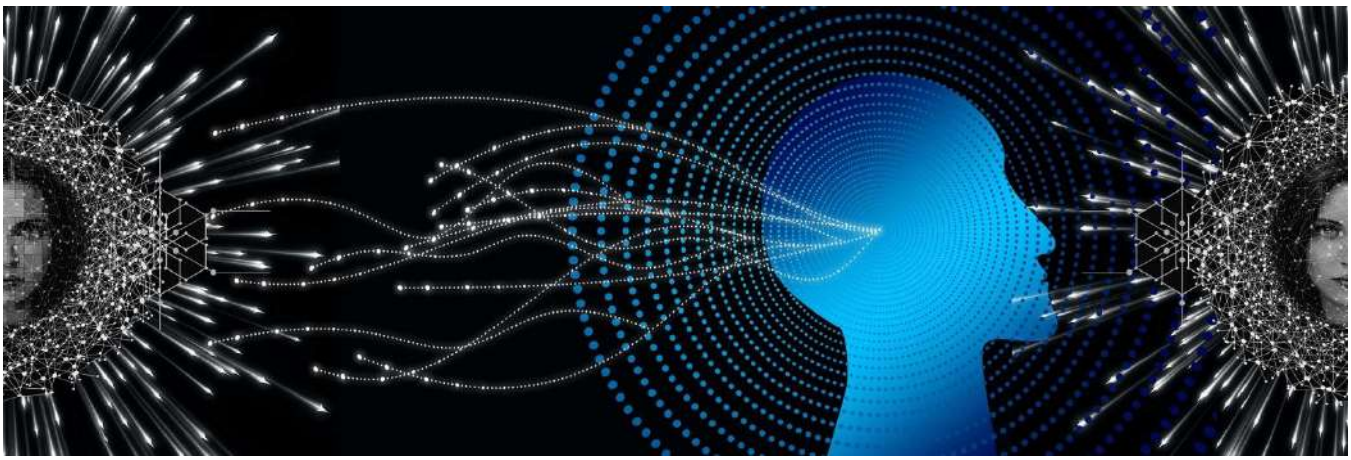
Some challenging problems in the domains mentioned above have been successfully solved, and further research is being carried out. Three PhD scholars and ten MS students have worked in the PSSR lab.
The PSSRL has sufficient space with proper design and ventilation. The positive lab environment helps the students to think critically and enhances their knowledge to complete a research study.

The PSSR lab has been progressing, and the faculty and students are working with hearts for the progress of the research lab. The next aim is to develop collaborations with industry to solve industrial research problems. The lab team highly welcomes partnerships with the industry.

Research Publications from Power System Simulation Lab (PSSRL):

Research publications of PSSRL are uploaded on Power System Simulation Lab's page on Research Gate. You can access these research publications by following the link given:

https://www.researchgate.net/lab/Power-Systems-Simulation-Research-Lab-Muhammad-Salman-Fakhar.



This picture is taken from "https://pixabay.com/illustrations/artificial-intelligence-brain-7420667/"

Review of Improved Security system using facial recognition and PIR Sensors

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A**bstract**: Home security is emerging as the top concern for families around the globe. In the past decade, numerous strategies have been utilized to limit the intrusion of an unauthorized individual. Since most of the male population, especially the aged in Pakistan, have long beards and moustaches while females cover their faces, face detection is a struggle. The motivation of this study is to create appropriate door security employing face detection and identification stronger based on a custom dataset. The PIR sensors help validate the object's presence, making it different from earlier methods. The method enables the owner to allow permission to the person seeking access.

Keywords: Home security, face detection, identification, PIR sensors

1. Introduction

Home security is a need in our lives and a top concern for many families worldwide [1]. The motivation for adapting the home into a smart home is gaining more attention for security purpose [2] as various incident, including theft, break-ins and unwanted intrusion, takes place without warning. This calls for installing a security system that can stop unauthorized access to the home [3]. Any security system's most crucial feature is accurately identifying residents to provide access. One of the most sensible methods of human authentication is probably face recognition [2]. The prior door security system more focused on the typical door lock, password, and facial recognition [4]. Face identification is reflected as a worldwide available biometrics system [5]. Biometric identification of faces uses a similar recognizer that people use to differentiate one person from another. Facial recognition employed in banking, door locks and other application can be effectively spoofed by utilizing an excellent video of individual faces [6], gaining more concern for the security purpose to deny accessing authentication [7]. Recently computer vision algorithms have made significant contributions to object detection [8], recognition [9] and classification [10]. Similarly, the YOLO X algorithm is deployed for image recognition [11]. Identify the applicable funding agency here. If none, delete this. The purpose of this study is to make the security techniques involving face recognition stronger. We can incorporate the detection model [12] for facial recognition [13] technology and the use of a PIR sensor

to detect actual human beings instead of video for door security locks to enhance the performance of the door lock system. The PIR sensors [14] enable the machine to understand that the person in front of the camera is the actual person who wants to gain access, and the captured video is also being generated for the owner of the terrain in real time. Besides that, the homeowner is also privileged to give access to the home.

2. Literature Study

A smart security door system based on Energy Harvest suggests a security system that uses a motion sensor to detect intruders [15]. This system consists of a magnetic system that gets unlocked by OTP and generates energy by moving the door to operate the system [16]. IoT home security system uses a camera for video surveillance. It allows the door to be controlled from any location by sharing videos through Wi-Fi and allows the host mobile application or PC with registered credentials [17]. IoT-based door systems can also be unlocked using Verilog. The home's entrance door will only be unlocked if the user slides the correct secret codes on the slide switches of the Altera DES-115 Trainer Board [18]. Bluetooth technology for doors is also used in home security. People use speech technology to swiftly unlock the door which can be helpful for handicapped people [19]. A smart observatory system intended to practice computer vision methods like detecting objects, detecting motion, and detecting faces to distinguish the area of interest from the recorded video, requiring less human interaction and intervention [20]. An IoT-based security system for residents includes biometric authentication, plate recognition, and a movement detection system developed [21]. In-House surveillance systems are also in use for security purposes. A device O-AIDS is designed to operate as an in-house smart surveillance security system, using micro-controllers, Internet Protocol cameras, SMS notifications, PIR, Alarms, and smart displays to detect intrusion [22]. Security systems capture the images of intruders and send the message to the host mobile application [23]. RFID and keypads are also being used for security purposes. If the value of the reading ID card is true, Arduino allows entering the secured pin. If the pin is matched, the solenoid lock style will be unlocked. The solenoid will be locked if the pin is wrong [24]. In a Smart observation system based on Images and Distant Entrance Lock Switching, the researchers discuss a system that clicks a photo, and the taken image is labelled using a facial recognition service that labels the person based on the images uploaded by the system's user/s via a mobile application beforehand [25]. GSM (Global System for Mobile Communication) and GPRS (General Packet Radio Service) can also be integrated with IoT Home security systems. Researchers presented a low-cost system having various features like alarming in case of intrusion detection, capturing images from the camera, alert notification through GSM, password protection through the keypad, automatic door lock after unlocking, and power backup in case of any power failure [26]. A system with a distinctive undetectable inner locking system is implemented in the main gate and is run by accomplishing two verification steps for security. The fingerprint to run the inner locking system is held inside a main gate and is not visible to people until the main gate is opened. Even though the main gate is unlocked, the since-pinned pin of the RFID-based main pin or Bluetooth-based master pin after the successful verification.

3. Summarization of Table

For the determination to prevent the unauthorized person from accessing the tracery, the previous door security system emphasizes the standard door lock, password, and buzzer-based system. However, many practitioners have also employed sensors to detect and prevent unknown people, limiting the security system concept. Besides that, similar to the biometric system to differentiate, the Facial recognition method for every individual face is too implemented by some researchers. Regrettably, the current facial recognition method can be easily spoofed using high-resolution videos of individual faces. To prevent such intrusion, we proposed a state- of – art method using Face detection with PIR sensors. The motivation of this research is to create a stronger security technique involving face recognition. The PIR sensors help to confirm the presence of the real object instead of any picture and video, which makes it unique from the

previous techniques. Our method enables the owner to allow permission using the real-time capture video of the person. Additionally, our method uses edge computing to enhance the computer's performance with every calculation at the device edge instead of performing all the calculations centrally.

4. Proposed Methodology

The article presents a novel approach using face detection to enhance the door security system. This face detection system consists of a PIR sensor to highlight the presence of the actual person with the camera capturing the video streams, as mentioned in figure 1 below. The captured video is passed through the face detection algorithm to detect the face of the person granting access to the door. The algorithm employs the mix-up method for the data augmentation, including the decoupled head for the separation of localization and classification that helps to enhance the iteration speed of the defined algorithm, which is also necessary for the end-to-end operation. Moreover, the model is based on the fee anchor design, which compacts the prediction quantity. In addition, the algorithm picks one positive sample for each object in order to manipulate the regularity of the baseline. This optimistic sample, representing the object center, ignores even other high-rate estimates. Moreover, unlike the prior version, the modern face detection algorithm includes three basic novelties, such as decouple head, anchor free, and advanced labelling assigning strategy, which provides better performance in speed and performance. For this purpose, we have trained the model on the local custom dataset. The dataset contains tens or hundreds of diverse face images developed for face recognition. The dataset contains thousands of pictures with multiple identities, including men with beards and ladies covering their faces, which is a challenging point and training our model. Since other dataset does not contain men having a beard and long moustache. Our dataset tries to apprehend that limitation so that the model can identify those people too.

5. Methodology of focus point

Developing a custom dataset aims to overcome the already available dataset's limitations. The prior generated dataset contains characters mostly without a beard or moustache. To fully benefit from the different object detection and recognition algorithms, especially in Pakistan, or to fully and accurately function, there is a need to develop a custom dataset.

1) Most male population in Asia, specifically in Pakistan, have beards on their faces. Additionally, the person above 50 years mostly has long beard.

2) Beside detecting and recognizing the men faces, the model also needs to localize and identify the female faces. However, with the prior dataset, the algorithm might not properly work.

3) Since the most population of female in Pakistan covers their faces, the system might get confused about either recognizing it face mask or a female face

4) The cover faces might create ambiguity in detecting and identifying the faces, especially for security purposes.

5) Moreover, the previous dataset also limits containing faces with long hair, since in the modern day, most people having long hair, irrespective of being male or female, also limit face detection performance.

6. Conclusion

The door security system is the present concentration for many homes to prevent unauthorized access to their tracery. Traditional door locks, including password-based ones, have been widely adopted by researchers in the past. The motivation of this study is to create a trustworthy door security system using face recognition technology similar to the biometric system to discover the unauthorized user/ person. For this purpose, we proposed a state-of-the-art algorithm on the custom dataset for detecting and recognizing faces. The PIR sensors help to confirm the presence of the real object instead of any picture and video, making it unique from the previous stat- of –art techniques. In addition, the home's owner has the right to grant access to the house.

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وَهُوَ الَّذِیْ مَدَّ الْاَرْضَ وَجَعَلَ فِیْهَا رَوَاسِیَ وَاَنْهٰرًا ؕ وَمِنْ كُلِّ الثَّمَرٰتِ جَعَلَ فِیْهَا زَوْجَیْنِ
اثْنَیْنِ یُغْشِی الَّیْلَ النَّهَارَ ؕ اِنَّ فِیْ ذٰلِكَ لَاٰیٰتٍ لِّقَوْمٍ یَّتَفَكَّرُوْنَ ﴿۳﴾

And it is He who spread out the earth, and set thereon mountains standing firm and (flowing) rivers: and fruit of every kind He made in pairs, two and two: He draweth the night as a veil o'er the Day. Behold, verily in these things there are signs for those who consider! ﴿3﴾

This picture is taken from "https://www.pexels.com/photo/alternative-alternative-energy-clouds-eco-energy-433308/"

Smart grids/Microgrids and Rural Electrification

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Abstract: More than one billion people in rural areas still need more energy access, and connecting them to power grids is impossible. The DC microgrid is an excellent option for this. It offers distributed grid voltage control and uses droop-voltage control for the power-sharing scheme to adjust the bus voltage when the supply is low and the demand is high. Losses can be kept to a minimum if storage is dispersed across all households; lithium-ion batteries can be utilized for this because of their high energy density. Since the microgrid architecture includes photovoltaic (PV) panels, batteries, and inverters, there is also space for cost optimization. Improving the microgrid's architecture can cut costs by up to 20%. A new microgrid system is also suggested, which maximizes the microgrid's efficiency while having a low installation cost. A quick summary of all the enhancements made to the DC microgrid to make it possible to install it in rural areas is presented in this article.

Keywords: Microgrids, Lithium-ion batteries, Photovoltaic.

1. Introduction

A large chunk of the population still doesn't have access to electricity, even in the 21st century. Most of them live in rural areas; they have to use some fossil fuels to light lamps, contaminating the environment. These areas are included in plans to connect them to the central grid. Still, there are many connectivity issues, i.e., theft and losses, and most importantly, the grids cannot bear their load. There are many Operations and Management (O&M) issues connecting rural area loads with central grids. PV systems are affordable and offer higher efficiencies, voltage stability, loss reduction, and higher-quality power to users, making them ideal for rural electrification. We can operate microgrids in island mode or connect them to the main central grid. [1], [2]

Most appliances use DC voltage, so if the transmission is done in DC voltage, the losses can be decreased significantly as there will be no conversion losses in the

system. Droop control is implemented, and when the demand exceeds the supply, the Power Management Units (PMU) smartly control the system's power needs by using more stored power and reducing its dependence on the source. Lithium-ion batteries store energy, and their great efficiency decreases losses. This enables the microgrid to expand even further without encountering any significant obstacles. [3]

In [4], the author discusses other losses faced in the transmission system and then discusses the problems faced by the microgrids without storage devices. The author also discusses the importance of distributed energy storage and how it affects the electrical grid. To this end, they have compared various batteries, and the findings indicate that lithium-ion batteries perform better in multiple environments. A big problem in rural areas is that the load is not constant, and it is very difficult to maintain the efficiency of inverters. In [5], the author has proposed two methods to maintain efficiency by adding loads when the demand is low, and the second method is to design an inverter with high efficiency at low loads.

2. The System Description

The key system components of the microgrid are described in detail. The dc microgrid has three major elements of infrastructure.

I. The grid-connected photovoltaic cells must be performed at their maximum efficiency by the source converter. It is also in control of identifying and repairing grid issues. The recommended range for grid voltage is 360 to 400 Vdc. The functionality of the source converter includes overvoltage protection and fault mitigation. To minimize line losses and adhere to the new standards for high-voltage dc power in data centers, a distribution voltage with a range of 360 to 400 V is employed.

II. The fanout nodes (as shown) serve as branch points for the microgrid's power supply to a neighborhood group of residences. They serve as the grid's earthing sites as well.

III. Home PMUs The PMUs are in charge of distributing grid voltage regulation and supplying electricity for 12 Vdc domestic batteries and appliances in this way.

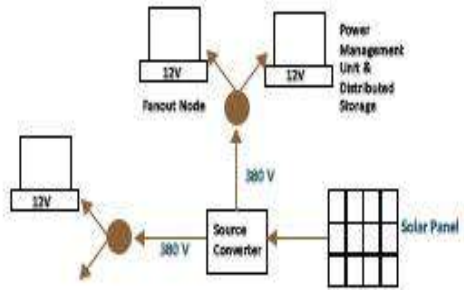

Figure 1 An architectural design of a DC rural MG that uses a 380VDC transmission bus and converts voltage to 12VDC for domestic use. Inspired from [3]

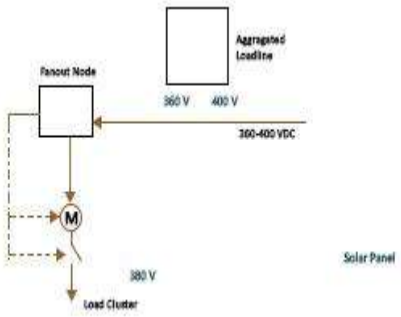

Figure 2 Block representation of a fanout node. Inspired from [1]

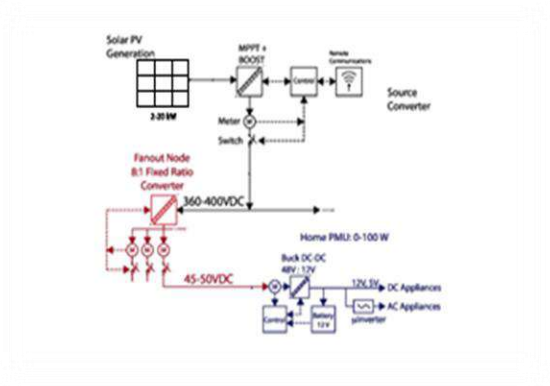

Figure 3 Overview of the DC microgrid system. The microgrid's primary functional components are the source converter, fanout nodes, and residential PMUs. Inspired from [1]

3. Distributed Voltage Control

One of the key elements of our DC microgrid is the distributed control of the grid voltage. This enables instantaneous notification of power availability in the source converter and on-the-fly power-sharing across the connected PMUs. Similar methods have been

investigated to provide quick signaling of information on power-sharing in DC microgrids. The source converter allows the voltage to operate in a range of 360–400 VDC. The PMUs have a customizable power profile by internal characteristics and data from digital communications (load-line).

4. Storage Based on Batteries

Photovoltaic (PV) panels, inverters, and batteries are components of microgrid architecture, and there is room for cost reduction. Important parts of DC microgrids are storage units, often based on batteries. Depending on the application, different battery models exist, including electrochemical, mathematical, and electrical models. The electrochemical model relates design parameters with macroscopic (voltage and current) and microscopic (concentration distribution) data. It is mostly utilized for the design features of batteries.

5. Overall System Efficiency

The system-wide utilization statistics and data from the solar controller on photovoltaic energy production allow us to determine the entire system's efficiency. This estimate of the system's overall efficiency is calculated as the difference between the AC power supplied to power the system electronics and the user loads and the DC power provided by the solar power controller. Our data shows that overall system efficiency rises as the inverter's capacity factor rises. The inverter capacity factor is roughly 30% at locations with freezers and high daily loads, and we observe overall efficiencies of 0.88 to 0.90.

6. Cost Minimization

By the use of PV panels in microgrid installation, Cost will be reduced. Because different sensitivity variables are selected, and the optimization procedure is performed for each of them. The sensitivity variables are global solar radiations, AC, and DC loads. The bio generator and diesel generator's scheduled operation carry out the various case studies. The bio generator is planned to run for the period since its operation varies depending on the biomass feed (animal excrement) available. The diesel generator kicks on when resources are few, or an emergency arises. Additionally, both cost more than PV panels.

7. Microgrid Management and Monitoring

Three issues are of main importance:

I. Budgeting:
This problem has to do with raising money to s upport project progress. The potential for each zone may be taken into account while designing various finance strategies

II. Status and identification:
Creation of "custom-designed" solutions for each area

III. Technical assistance and auditing during O&M:
This offers expert advice to communities once projects are finished as needed. Auditing is regarded as a control measure to keep an eye on the microgrid's efficient and responsible operation

8. Scope of Dimensions of Research in this Area

By improving the chemistry of batteries or inventing new batteries, we can reduce the cost of electricity to customers in the future.

I. By boosting or raising no load and low load power utilization of inverter can bring down the storage and generation needs and reduce the cost of electricity

II. There is a wide area of research in cybersecurity to protect the microgrids

III. In case of disaster, the microgrids can provide electricity

IV. The goal of getting a 100% electrified village can be achieved by commercializing the research.

9. Conclusion

The goal of advancing grids is essential given the global trends toward new technology and its development. Before an integration strategy for the lithium-based energy storage system in a dc-base MG system is recommended, the safety of floating charge for a high voltage series-connected lithium-ion pack and integrating the lithium-based battery into a multi-renewable energy source are discussed.

DC MGs are useful for obtaining the efficiency improvements required to make rural microgrids

economical. To maintain grid voltage under various operational circumstances, a distributed voltage-control and droop voltage-control strategy is presented in this work with its analytical explanation. In this way, efficiency improvement and system optimization can be achieved.

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High-Frequency Centre of Excellence (HFCE)

(Introduction)

The High-Frequency Centre of Excellence (HFCE) is being established in Room 124a-EE department at UET Lahore. The objectives of the high-frequency centre of excellence are to boost the competitiveness and expertise in the following key areas related to high-frequency design/applied Electromagnetics:

- Antennas design, development and measurements
- Active and passive RF circuits design
- 5G wireless technology

The goal is to make UET HFCE the virtual centre of excellence. For this purpose, the following activities have been planned:

- **Planning and Inception of Research Projects at EE wireless communication Lab**

  The first phase is dedicated to planning and quick start of research projects at this centre. In this phase, the available lab resources (equipment/instruments and software etc.). At the wireless communication, the lab will be fully functional, and the measurement capabilities of this lab will be determined. Moreover, each lab faculty member will plan two research projects related to their interests. The concerned PI will be responsible for managing the project team, financial resources from the university/industry and the smooth conduction of the entire project within the defined project duration.

- **Departmental and interdepartmental Seminars**

  These seminars intend to attract the attention of students and researchers in different departments of UET Lahore. These seminars will be mainly application oriented to create the interest of senior UG students and PG students in selecting their FYPs and thesis/dissertations etc., related to research topics offered at HFCE. Such seminars will be advertised through the relevant platform, and chairman EE will be requested to make the attendance of senior UG students compulsory at these seminars. It is suggested that each faculty member of HFCE will deliver at least two workshops related to their research interests and lab projects. EE alums in the USA will also be engaged through their presentations and webinars associated with RF and antenna design research.

- **Co-ordination with different wireless manufactures**

  This activity is intended to anticipate the requirements of this manufacturer regarding novel techniques and measurements for their intended products designed for different applications. This activity will ensure the relevance of projects planned at UET HFCE, enabling us to interact with the industry to conduct joint research projects. The integrations and collaboration with these stockholders can be assisted by EE alums in these industries.

- **Research collaboration with national and international HF research groups at different academic institutes and industries.**

  To avail the measurement facilities and share the research expertise, the research collaboration with the following Universities and Industries has been planned in the initial phase.

  - The Antenna Research Group (ARG) at the University of Colorado Boulder, USA
  - Antenna and radio frequency research group, Sabanci University Istanbul, Turkey
  - Applied Electromagnetics Laboratory at King Fahd University of Petroleum and Minerals (KFUPM) Saudi Arabia.
  - The Research Institute for Microwave and Millimeter-Wave Studies (RIMMS) at NUSTSEECS, Islamabad, Pakistan
  - National Institute of Electronics (NIE), Islamabad, Pakistan
  - The Space & Upper Atmosphere Research Commission(SUPARCO), Lahore, Pakistan
  - Air Weapons Complex, Pakistan

  The details mechanism for this activity will be devised soon, and this collaboration will be extended.

- **Comprehensive analysis of different software to judge their capabilities and limitations**

  This activity is intended to compare the capabilities and limitations of HF software that different research groups use for RF and antenna design in universities and related industries.

- **Comparison of different measurement facilities, especially for antenna measurements**

  This activity will deal with the comparison of different measurement facilities which are being used for the evaluation of RF and antenna prototypes. The required facilities for projects being carried out at HFCE will be determined so that these facilities can be availed at the premises of collaborators.

- **Training and education, including the RF and antenna-related course offering at UG and PG levels**

  It was decided in the meeting that courses related to RF and antenna design should be offered to final year EE students and PG students, too, so that the students who opt for these courses can be involved actively in research work at HFCE through semester project, final year projects(FYPs) and thesis/dissertation etc.

Research Opportunities at HFCE

Excellent Research opportunities are available for students at all levels (BSc, MSc and PhD) to research high-frequency engineering (antennas, RF circuits and systems etc.) for advanced wireless applications, including 5G and 6G.

These opportunities include some of the following benefits:

1. Personal desk with core i7 Computer.
2. Active research supervision and guidance for Final year projects(FYPs) and thesis/dissertation opportunities for EE students
3. Supportive research environment to enable researchers to work individually and as a team member
4. Opportunities to write and publish research papers in top-tier IEEE Journals and international conferences
5. Collaboration with renowned local and international research groups and industries through the High-Frequency Centre of Excellence (HFCE)
6. Guidance and Funded opportunities for their future Master's and PhD studies abroad
7. Future opportunities to work as a researcher on industry-funded projects with a monthly salary.

Highly motivated EE students (BSc, MSc and PhD) and EE graduates from any HEC-recognized university are encouraged to visit my office with a CV as soon as possible for these opportunities. Interested students/graduates must email me (haq.nawaz@uet.edu.pk) with a CV to schedule a meeting for these opportunities.

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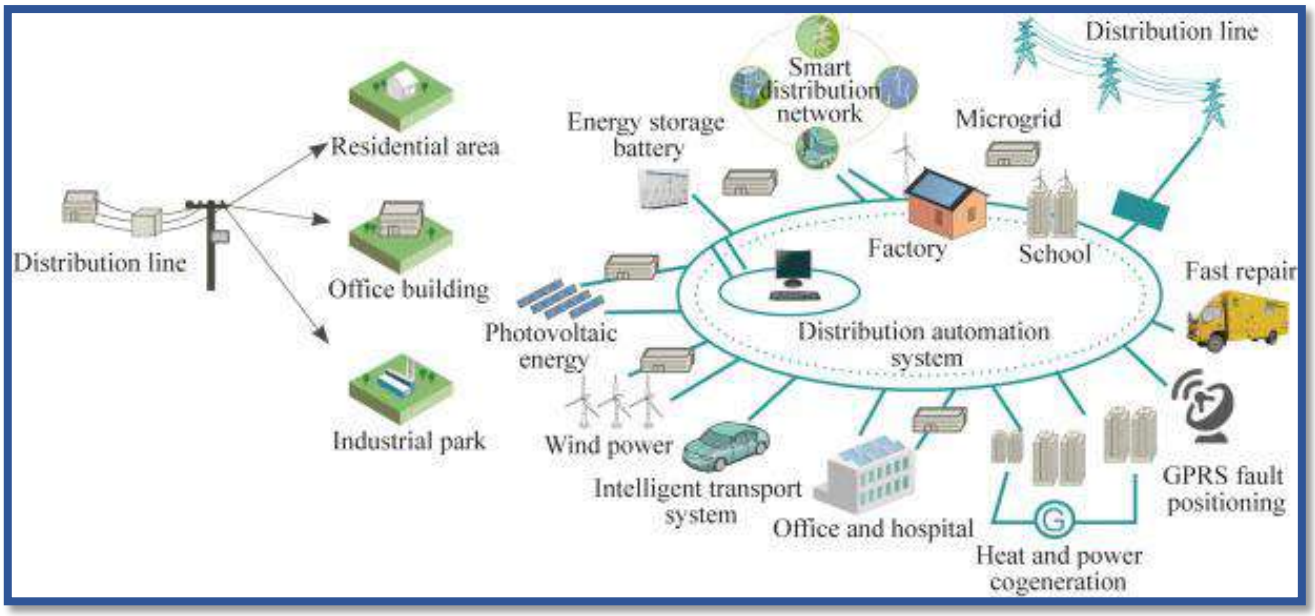

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Distribution Automation: A review of concepts, features, and perspectives

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Abstract: This article summarizes the concepts behind distribution automation (DA), its features, pros and cons. Moreover, the role of optimization is also highlighted in the current and future work regarding the narrated concept. This review highlights the perspectives of the utility and the consumers on DA. It also encapsulates the vitality of automation in the distribution portion of power systems. The deployment of the latest optimization techniques can further increase the reliability of the system and can aid in the optimal placement of electronic equipment.

Keywords: distribution automation (DA), concepts, features, perspectives, optimization

1. Introduction

Due to the incremental energy demand, the manner of distribution has become essential in the quest to save resources and fulfilling the ever-increasing requirements. Improving the electric service reliability, efficiency, and quality is a dynamic problem for utilities which usually is tackled via distribution automation (DA) by implementing flexible control of distribution systems. Inter-operable and flexible operation and technological innovation are the hour's needs [1]. The advancements in Information and Communication Technologies (ICT) have encouraged the role of the DA system as controller and operating system of substations and feeder equipment. Due to advancements in communication technology, today's distribution automation system (DAS) is not only a remote controller but also a highly dependable, flexible, and self-healing system, mostly in the power network and related subsystems, providing rapid, real-time, and appropriate actions to events [2].

Integrated technology performs data collection and decides and implements the control based on analysis of the acquired data [3]. Previously, there was no or limited communication between the consumer and the supplier via passive management such as tappings, relays, reclosers and shunt capacitors [1]. Over time, active management has overtaken passive control to achieve the benefits of distributed generation genuinely in terms of cost and simplicity [1]. The article covers concepts, features and perspectives, along with the role of optimization in the upcoming sections.

2. Concepts

DAS remotely monitors, coordinates and operates distribution equipment in real-time. DA is challenging because of multiple installation points and various devices installed at the premises. It broadly involves load management, automatic meter reading, demand-side management and service monitoring to enhance efficiency, economic productivity and reliability [1]. DA deploys remote fault indicators, smart relays, automated switches, feeder monitors, processors, and communication networks to make the system efficient, automated and reliable [1]. This aspect has ensured human safety and activation of control techniques involving voltage and power control, switching and protection. Moreover, such a system does not require human presence in remote locations to monitor, coordinate and control power systems [1].

DA deploys high-speed communication networks and microprocessors to respond immediately to faults and load changes. The concept behind DA is to increase the extent of the connection between consumers and utility by using ICTs [1]. Moreover, intelligent electronic devices (IEDs) and high-precision automatic measurements and monitoring decrease cost and human intervention. So, customers receive better quality and uninterrupted energy supply [3]. Distributed generation has emphasized the importance of the DAS as, instead of extending the system, it can tackle unequal loadings and power flows via smart power flow and load balancing techniques [1].

3. Features

DA has several features that build a smarter grid and supply management. The advantages accrue in the areas of investment, disruption, and customer service and the areas of operational cost savings as well.

- **Security and Reliability** – DA has benefits such as enhanced awareness of potentially dangerous circumstances, improved physical and digital security, safeguarded personal information, reduced energy use, and complete independence from outside power sources [3].
- **Power quality** – The substation remote terminal unit (RTU) and the feeders' power monitoring environment keep customers happy by preventing power outages [4]. Power quality is also improved by fewer and shorter outages, cleaner power, dependable administration of distributed generation in tandem with load management, and the use of microgrids [3].
- **Cost reduction** – Real-time monitoring across the distribution feeder allows the end user to watch his energy consumption patterns, apportion usage and assign responsibilities to first-line supervisors with daily operations people to reduce overall expenses [4].
- **Energy efficiency** – To lower demand prices, real-time control is invaluable as part of an automated, all-inclusive power management system. Power sources can be optimized with dedicated load-shedding preservation algorithms considering electricity prices [4].
- **Environment conservation** – Protecting the environment entails reducing the emissions of pollutants like greenhouse gases, cutting back on power from inefficient sources, and boosting the utilization of renewable energy sources [1].
- **Compatibility** – Flexible architecture that can accommodate products from multiple manufacturers is essential to a successful distribution automation system [4].

4. Perspectives

DA can be perceived through multiple levels and dimensions such as utility, consumer, and overall national level.

- **Utility** – DA system is intelligent, sensitive and has reduced human interference, all of which goes towards decreasing the cost of operation and controlling the behaviour of the consumers [1]. In the modern approach, ethernet switching on the station level with a human-machine interface and RTUs allows a gateway to the control centre. Furthermore, IEDs are installed at the process level linked to the measuring devices and relays [1]. The challenges in this regard include installation and accuracy assurance of electronic equipment and communication protocols. They also include cyber security, database management, cost-effective purchase of modern equipment and tariffing at the consumer's end [3].
- **Consumer** – DA system provides reliable and secure supply to consumers. Consumers are more up-to-date about the ongoings on the utility level. Automation at the consumer's location includes remotely reading meters and connecting or disconnecting services [1]. The challenge in this regard includes the bi-directional flow of supply. Enough awareness and handling of automated equipment can be a challenge for service providers, and mishandling can cause errors in automation. A reliable, secure, trusted relationship between consumer and utility is a key challenge in distribution automation [5].

On the national scale, there is no universally applicable answer. The economic and political climates, as well as the social agendas of individual nations, may lead to the adoption of a variety of models. Integrating the technical and business policy decisions is essential to speed up the creation of technologies, establish standards, and introduce efficient solutions [5].

5. Role of Optimization

As the measurements made by sensors deployed in the DA system are a bunch of data that needs to be communicated properly to make control decisions, the

loss of data packets can be a major issue along with delivery speed and safety level detection [6]. Different optimization algorithms have been deployed with the communication protocols to decrease the data packet loss via optimized communication strategies in various other problems [7]. Different nature-inspired optimization algorithms [8] and their hybrids can be applied to maximize the quality of the reception of data packets and their delivery speeds or rates.

As reliability and protection are important features of DA, the accuracy of data communication by sensors is necessary, and its absence can cause faulty or late operations of protection equipment. In addition, optimization algorithms have been used in the optimal placement of devices [9]. The sensors can be optimally placed using the latest optimization algorithms to reduce cost and increase efficiency.

6. Conclusion

This article highlights the ideas, characteristics, merits and demerits of implementing automation at the distribution level. DA boosts the utility's effectiveness, productivity, and performance while providing consumers with increased quality and dependability. In emerging countries, the desire to improve operational performance and efficiency of the distribution system is driving the use of DA. This write-up signifies the present and future global demand for distribution automation and points out the areas requiring further research.

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Figure 1 This picture is taken from "https://digitalbulls.wordpress.com/2015/12/30/troubleshooting-your-computer-running-slow-problems/"

Hammering the DRAM Memory

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Memory: In a computer system, memory is where data is stored. The data could be the instructions written in the form of a program or values stored in the program variables during computation. Memory is composed of bit cells arranged in rows and columns. Figure 1 shows bit cells arranged in 4 rows and three columns. Each bit cell can either store a one or a 0 representing some information. There are three types of memory; DRAM, SRAM and ROM. DRAM stores data as a charge on a capacitor, while SRAM stores data using cross-coupled inverters. ROMs are volatile, i.e. their data gets lost when power is turned OFF, while RAMS are non-volatile since they retain their data without electrical power.

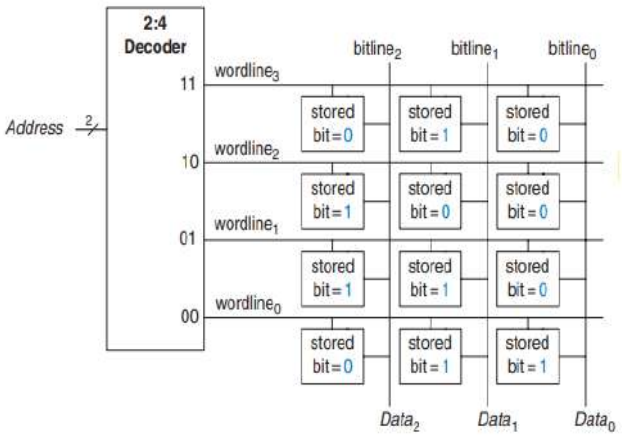

Figure 2 Memory Structure [1]

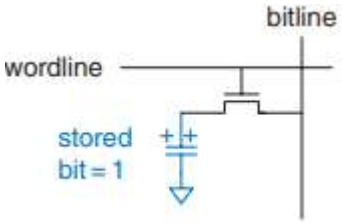

Figure 3 Bit Cell Components [1]

Working Principle of a DRAM

In a DRAM, a bit cell consists of an nMOS transistor and a capacitor, as shown in figure 2. The word line is first enabled to store or write a 1, which switches the nMOS transistor ON, thus charging the capacitor. A fully charged capacitor is said to hold the bit 1. Similarly, the word line can read the data, which turns the nMOS transistor ON, and the capacitor charge appears on the bit line. The procedure to write or read bit 0 is similar. In short, enabling the word line causes data to be read from or written to the bit cell. The read operation destroys the bit value stored in the bit cell; hence the bit value must be rewritten after every read. Since the charge on the capacitor gets leaked away, the bit cell must be refreshed, i.e. read and rewritten even when the DRAM is not read.

The Row Hammer Problem

Practically, all the rows in a DRAM are not electrically isolated, i.e. accessing one row could cause the adjacent rows to be partially accessed. This corrupts the original data present in the adjacent rows. This phenomenon is called Row Hammering or bit flipping. In figure 1, assume bitline2 is 0. Now if row 1 is accessed, rows 0 and 2 would also become accessible, and the stored bit 1 in the bit cell present in row 2 and column 2 would convert to a 0 when the capacitor discharges. A simple program shown in figure 3 could easily "Row Hammer" the DRAM memory.

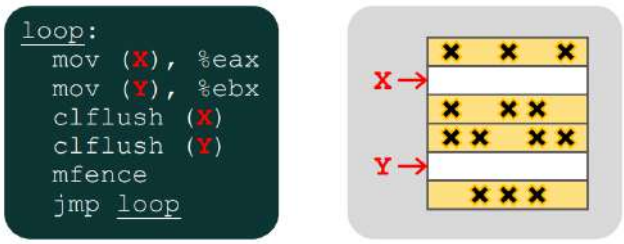

Figure 4 Bit Cell Components [1]

Electrical isolation becomes harder to achieve as the DRAM cells are brought closer to each other to increase memory density. Row Hammering has serious implications on the upper layers of the hierarchy shown in figure 4. Row Hammering could allow hackers to hack into a computer system or Android phones and even degrade machine learning algorithms' performance. Modern DRAM chips have been shown to suffer from Row Hammering, as shown in figure 5. Many solutions have been implemented to eliminate Row Hammering, but they must be more effective. The APPLE company, for example, increased the refresh rate of the memory. A group of researchers implemented Probabilistic Adjacent Row Activation (PARA) technique to eliminate Row Hammering.

Conclusion

DRAMs and, in general, memories are vulnerable. More research is required to increase memories' security, safety and reliability. The field of computing has many unresolved challenges hence presenting research opportunities. This article highlights one of the challenges.

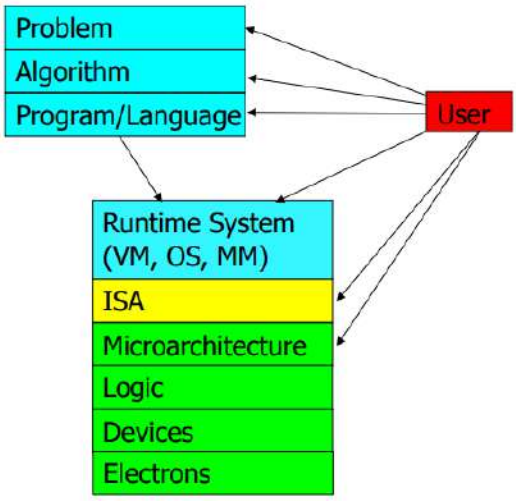

Figure 5 Layers affected by Row Hammering [1]

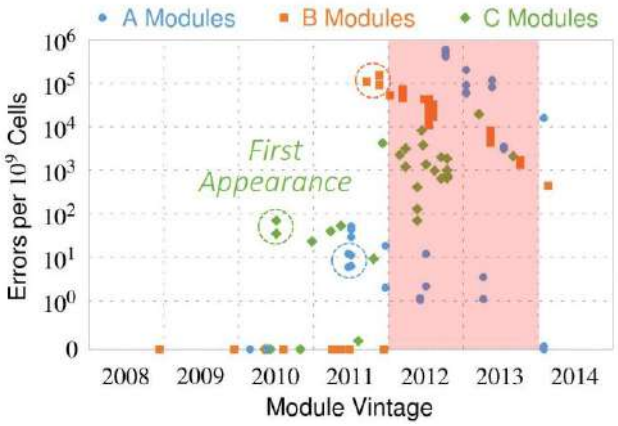

Figure 6 This picture is taken from [1]

1. Reference

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