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Substation Management and Control in Distributed Power Grid Through IOT

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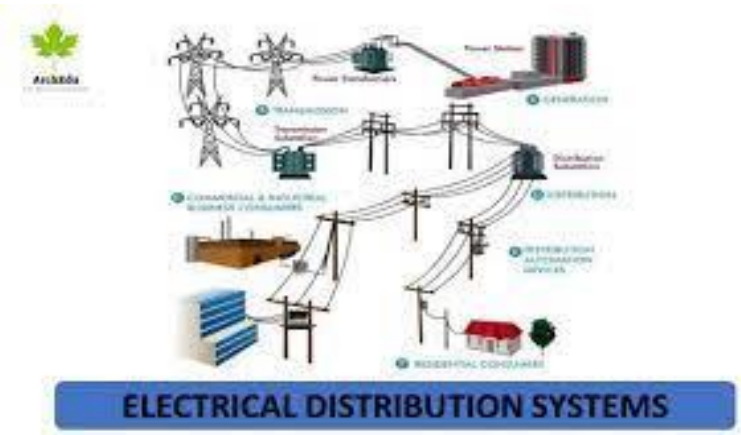
ABSTRACT-
As the evolution complexity of distributed system automation substation has become a need for utilities to improve the efficiency and functionality of power being delivered. The proposed project which is IOT based monitoring and controlling of substation will help the companies, by ensuring their local-substation faults are immediately realized and reported to their concerned department via IOT, to provide decreased intensity intrusion. The measured parameters will be sent as Notification messages. Electrical parameters like current, voltage will be compared continuously to its rated value to help protect the distribution and power transformer from being due to overloaded.

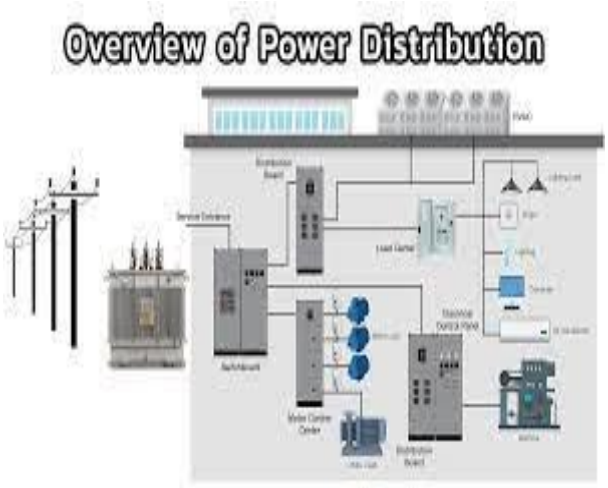
Keywords: IOT, Current, Voltage, Short-Circuit, Arduino, Fault Detection, Relay.

1. INTRODUCTION

The prevention of challenge in the electrical power distribute supply system, as well as the adoption of modern maintenance practices, is vital for electrical companies. So, there is the search for continuous improvement of performance and power supply quality indexes. In many large companies they are free to choose their electrical energy supplier and use the voltage level at the delivery point to negotiate prices. In new management they permit customers to request reimbursement foe energy interruptions. With the new measurements and specific services for each setup they are monitored separately, which means that even small substations they need to be monitored because they may give the accrual of fines against the distribution company.



All the specification has been forced power distribution companies to check maintenance and strategies of their equipment and seek out actions that will allow them to reduce and prevent faults and maintenance is taken by intensifying the practice of predictive maintenance. Any how to enable to implement predictive maintenance, control and constant monitoring of equipment is required to predict faults and safe the equipment maintenance.Only with monitoring the information collected in real time from equipment it is possible to establish maintenance based on real time conditions. Equipment monitoring systems are often regulated and taken by electric energy distribution companies to give information for predictive faults. When the equipment is designed carefully and installed with sufficient monitoring sensors, these systems provide continuous data for the correct analysis. Due to high cost of equipment, maintenance, implementation, network, and purchase and maintenance fees , this type of system is not viable for small and medium sized substations.



Normal substation measurement system generally detects a single substation parameter, such as power, current, voltage. while some ways could detect multi parameter is too long and testing speed is not fast enough.

The main Performance of the device itself gives instability, poor antijamming, capability, low measurement accuracy of the data, or even state monitoring system should not effect. Some of the disadvantages are serious frequency interference with the increase in distance the signal attenuation serious, load changes brought about large electrical, noise, if we use power carrier communication to send data, the real time, reliability cannot be guaranteed.

In this proposed project it is based on the application of the Internet of Things (IoT) for substation monitoring and controlling. The monitoring of substations using IoT will give the distribution network local faults and display them on a web server for remote monitoring and on power station LCD. This will help to prevent faults and damage to power system equipment from unfavourable conditions and maintain the power supply continually. The microcontroller Arduino UNO, with the help of various sensors like LM35 fire sensor, conductivity sensor LM358P, voltage sensor, buzzer, and other devices like ESP8266 Wi-Fi module we can detect and control faults in the power system.

With the above requirements we can allow a distribution substation system to detect all operating parameters operation and send them to monitor centre in time.

The new Android smart application”mobile telnet”
helps to give notification to the control operator.

Also, the Ac bulb goes off immediately whenever there is a fault detection in the system. In this way the operator can react immediately and save the equipment from damage. The LCD and also in smart phone it also shows where exactly the fault has been occurred so that the operator can immediately turn off the at that particular area of the substation equipment.

2. RELATED WORKS

A. Interference of compromised synchro phasor units within substation control networks.

In existing project they used components as Network instrumentation, such as synchro phasor units, as part of the substation automation for improving monitoring and control. In system the measurements are taken within a substation network, however, it gives manipulative false data injection. Each compromised network should compulsorily be checked through a malware agent at a larger scale, which will increase the automate intrusion process. Also, the falsified measurements sent to control centres will misguide the operators' decision making. This is main disadvantage of this project.

B. Frequency control of future power systems.

With the usage of more renewable energy resources, it gives a challenge in frequency control of future power systems, it monitors the possible challenges and new control methods of frequency in future power systems. many types of loads and distributed energy resources are evaluated. Existing project gives a model representation of a population using water heater device. Their side frequency response is measured in real time changing variable which gives the balance between production and demand, and it provides a dynamic or non-dynamic response to the changes in the frequency.

This service is taken f from generators, except for those generators which provide MFR. In addition is provided from the demand through a competitive process.

C. Resilient Protection System through centralized substation protection.

Power systems are experiencing drastic evolution with the introduction of renewables. These evolutions produce new challenges in protecting, controlling, and operating the distributed power stations. In order to protect the power stations, it is important to develop new methods that are immune to the new characteristics, and they should also avoid relay mis operations. This paper introduces a new dynamic state estimation-based centralized protection scheme (DSEBCPS) at a substation level. The system gives dynamic state estimation-based protection for individual zones known as "setting-less relays" to secure their operation against hidden failures.

The DSEBCPS communicates with the relays via the station bus and obtains information from each zone, such as phasor quantities and breakers/disconnects status. This information is processed by the DSEBCPS to estimate substation topology and states.

D. Design and implementation of a substation automation unit.

With the increase of distributed energy resources this will help to gather the EV connected to the grid, bringing new problems to distribution system operators. Also, with the increase in renewable sources new challenges are produced.

To support Distributed Substation equipment and to face such new challenges a new solution should be produced to help in implementation of substation automation units. This project supports the development of smart distribution systems. The monitoring and control functions of solution are focused to reduce faults in the substation.

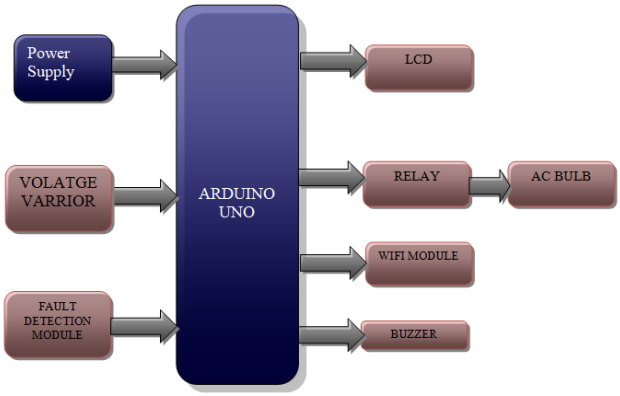
Thus, this solution allows us to increase the performance and to reduce the system complexity. An automation unit is placed before transformer in proposed solution.

E. Smart Substation.

As the smart substation are continually getting evoluted the more challenges are being formed. A smart substation is typically implemented with a combination of smart primary high-voltage equipment secondary devices. Based on the communication protocol, the functionalities, such as the information sharing and interoperability among smart electric equipment, are realized in smart substations. It is given in the basis of the development of smart grid and represents the future development trend of substation technologies.

3. BLOCK DIAGRAM

The following figure shows the block diagram of the proposed project hardware equipment. In our project we use AURDUINO UNO as the main microcontroller which connects various sensors and components.



POWER SUPPLY: All Arduino boards need electric power to function. A power supply is what is used to provide electric power to the boards and typically can be a battery, USB cable.

A power supply adapter that provides from 7 to 12V of DC is required.

VOLTAGE VARIOR: A voltage regulator is a device used to maintain a constant voltage level in an electrical circuit. It is commonly used in various electronic devices to ensure stable operation, protecting them from fluctuation in input voltage.

FAULT DETECTION MODULE: A fault detection module is a component designed to identify and signal the presence of faults or abnormalities in a larger system or process. These modules are commonly used in industrial automation to ensure safe and reliable operation by detecting issues.

LCD: It stands for Liquid Crystal Display.it is a flat panel Display technology commonly used in electronic devices. LCDs work on monitors and tablets.

RELAY: A relay is an electromechanical switch which is used to operate by an electrical current. It consists of a coil and one or more sets of contacts. When a current flows through the coil, it generates a magnetic field that attracts or repels a metal armature, causing the contacts to open or close, thus completing or interrupting a circuit.

WIFI MODULE: A Wi-Fi module is a hardware component that enables devices to connect to a wireless local area network (WLAN) and communicate with other devices or access the internet. These modules typically incorporate Wi-Fi radio, microcontroller, and associated components onto a single integrated circuit or module.

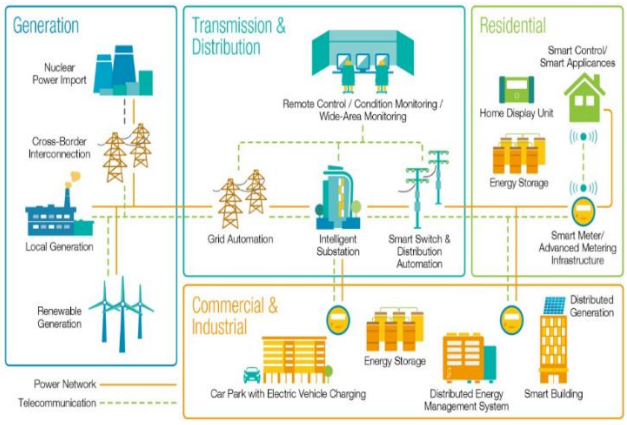
BUZZER: A buzzer is an electronic component that produces sound when an electrical current is applied to it. It typically consists of a coil of wire wound around a magnetic core, a diaphragm, and a housing.

When current flows through the coil, it creates a magnetic field that moves the diaphragm, producing sound waves.

AC BULB: An AC bulb is a type of light bulb that operates using alternating current (AC) electricity. These bulbs are designed to work directly with standard household AC power outlets, typically operating at voltages of 110V or 220V, depending on the region.

4. METHODOLOGY

Distributed Substation monitoring systems using IoT technology has bought new way in electrical infrastructure which can easily be managed and maintained. These systems consist of a network of sensors throughout the substation which helps in continuously collecting data on various parameters such as voltage, current, temperature, and humidity. These sensors can be in both ways that is connected wirelessly or via wired connections, depending on the requirements of the substation and functionalities. There are many sensors used in the proposed project such as voltage sensor. Conductivity sensor, flame sensor. The collected data acquired through sensors is then transmitted to a device within the substation, which processes the information before relaying.



In the Existing project cloud-based monitoring platform was developed, using the cloud the data is captured and sent to the operator. In another method we used Machine learning algorithms is used to detect the patterns, behaviour, and equipment faults. In the proposed project we use iot method which helps the operator to find the faults in the equipment by displaying faults on the LCD and buzzer form. In this project we can also find historical data and visualize the faults pattern. This real time monitoring not only improves operational efficiency but also enables proactive decision-making, reducing damage to equipment.

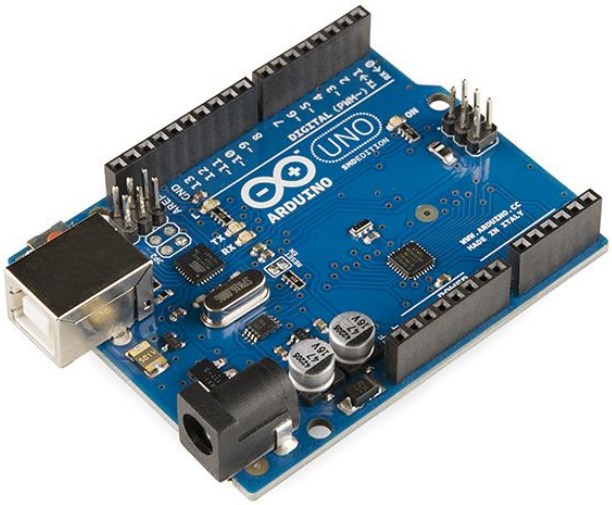
Moreover, IoT-based substation monitoring systems offer scalability and flexibility, allowing for the increase of additional sensors and functionalities as needed. This real time monitoring system also helps to keep the data safe and secured preventing from all types of cyber-attacks Overall, these systems provide companies and electric operators with a solution to prevent damage of equipment, increase efficiency of power distribution and reliability.

Substation monitoring systems using IoT (Internet of Things) technology represent a easy approach in managing critical electrical infrastructure. These systems begin with the deployment of a network of sensors throughout the substation. Sensors such as voltage sensor, conductivity sensor fire sensor helps to

get real time data. These sensors can be connected through wired or wireless. They are the main equipment to give real time data.

The collected data is then transmitted to a operator typically located within the substation premises. If at all there is any fault in the certain part of the equipment such as low voltage, fire the operator gets message notification depending on the specific

On the fault so that the operator can instantly react to the situation, meanwhile the system gets turn of by switching on the relay switch. In this way it helps the operator to take decision effectively.

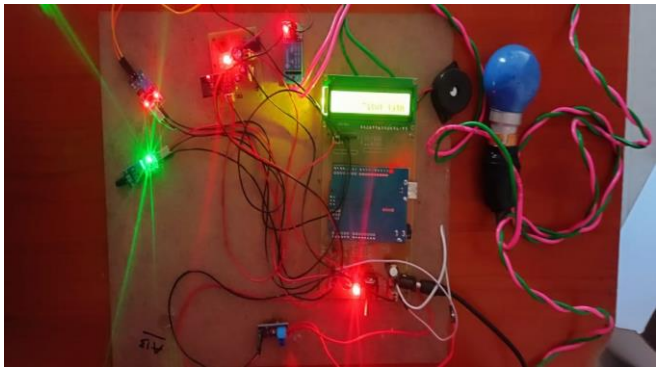


One of the main advantages of IOT is it helps to give real time data and give reliable results. We can use the monitoring platform from anywhere with an internet connection, allowing them to oversee multiple substations efficiently. This remote accessibility gives efficient decision-making and timely intervention in the event of abnormalities or emergencies. Additionally, IoT-enabled systems support remote control functionalities, enabling operators to remotely adjust settings, perform diagnostics, and execute commands without the need for physical presence at the substation.

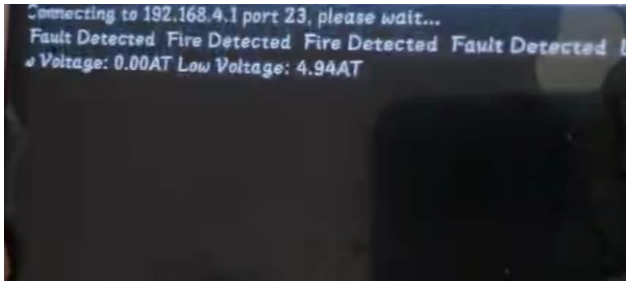
5. V. IMPLEMENTATION AND RESULTS

Implementing substation management and control of a distributed system within the power grid using IoT and Arduino Uno involves a detail approach. Firstly, hardware components like Arduino Uno act as the central microcontroller unit, interfacing with sensors to monitor parameters such as voltage, current, and temperature. We use Wi-Fi module to send message notification to operator.

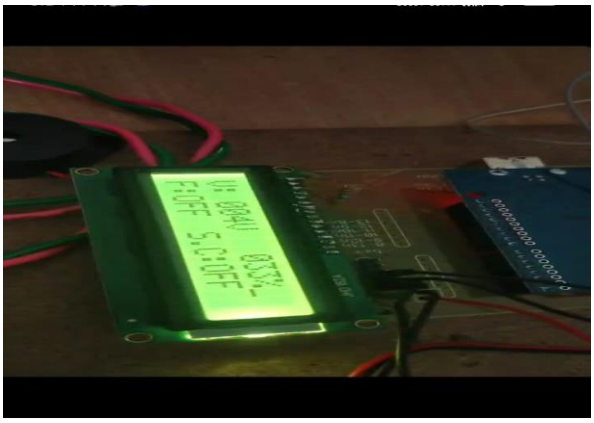
Relay switch is used to turn off/on the system depending upon their fault occurrence, Buzzer is used to alert the operator in case of fault occurrence,



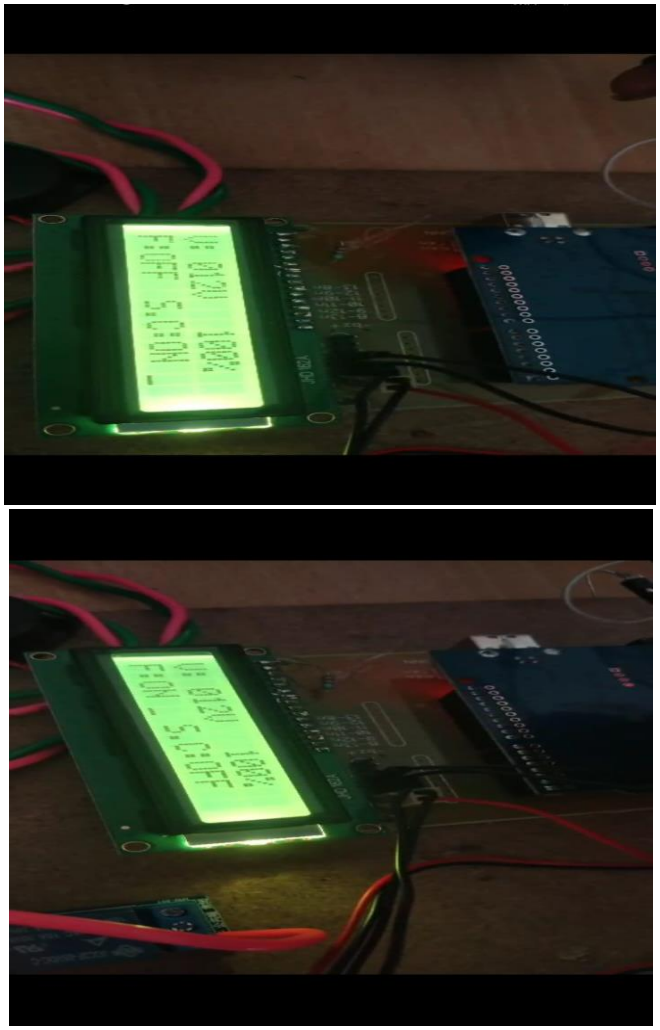
Actuators consists of remote-control capabilities, used in the Arduino Uno to execute commands for actions like switching power lines or resetting equipment. Integration of IoT communication modules facilitates real-time data transmission to a designated platform. Through custom software development, the Arduino Uno collects sensor data, communicates with the IoT platform, and executes control logic based on received commands.



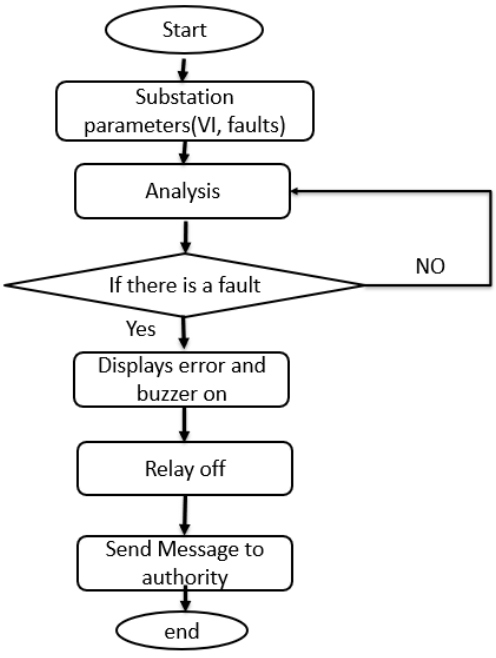
Through Wi-Fi module we can allow operator gets a notification if there are anu faults in the system This framework enables efficient fault detection, remote monitoring, and responsive control, enhancing overall system reliability and operational efficiency. Upon deployment, rigorous testing ensures functionality, and subsequent analysis of results informs ongoing optimization efforts. The implementation holds the promise of improved grid management, reduced downtime, and enhanced safety across distributed substation network.



We observe that initially the bulb is ON indicating there is no fault in the substation network. Also, the right amount of voltage and current are being flowing the system also there are no fire or short circuit in the system. When their low voltage flowing through system it shows voltage value and drop percentage on the LCD



Whenever there is a short circuit, fire detection, or less voltage is been flowing through the system immediately we get the message in our app through Wi-Fi module also it specifies what the error is.



6. CONCLUSION

The proposed project" Substation management and control of distributed power grid through IOT" helps to increase advance in technology, smart systems allow technicians, administrators, and managers to monitor and control the performance of devices from a safe distance. The monitoring system is very important when working in the field of three phase system: some users and companies use smart monitoring software programs. Equipment in substation can be prevented from damage. This real time monitoring system helps to improve the power quality which is being distributed. There will be uninterrupted power supply to the households, factories.

7. FUTURE SCOPE

In future of substation management and control in distributed power grid systems using IoT can be developed using IoT technology where substaion can be developed samrt technology. Real-time monitoring and control capabilities enabled by IoT sensors will help in evolution of grid management, allowing operators to control power flow and voltage levels remotely. In future we can also use our system to monitor the health of the equipment and predict the future problrms which reduces thr damage costs. Integration of renewable energy sources will be streamlined, with IoT facilitating better management of fluctuating generation patterns. Data analytics and machine learning algorithms will drive optimization of grid operations, from load forecasting to demand response.Ensuring more focus on safety by cybersecurity and interoperability will be increase paving the way for a secure and seamlessly interconnected grid infrastructure. In essence, the future of substation management and control in distributed power grids using IoT promises enhanced efficiency, reliability, and sustainability in the energy sector.

REFERENCES

1. S. Kimura, A. Rotta, R. Abboud, R. Moraes, E. Zanirato, and J. Bahia, "Applying IEC 61850 to Real Life: Modernization Project for 30 Electrical Substations," proceedings of the 10th Annual Western Power Delivery Automation Conference, Spokane, WA, April 2008.
2. L. Ayers and D. Dolezilek, "Using Dynamic Real-Time Substation Information to Reinvent Asset Management," proceedings of the 3rd Annual Western Power Delivery Automation Conference, Spokane, WA, April 2001. .
3. R. Bernardes and F. Ayello, "PQMS – Power Quality Monitoring System: Improve Power Systems Through IEDs," proceedings of the 20th Annual International Conference on Electricity Distribution, Prague, Czech Republic, June 2009.
4. "Advancements in Centralized Protection and Control Within a Substation," in IEEE Transactions on Power Delivery, vol. 31, no. 4, pp. 1945-1952, Aug. 2016.
5. P. Dong, L. Xu, Y. LinLin,d M. Liu, "Multi-Objective Coordinated Control of Reactive Compensation Devices Among Multiple Substations," in IEEE Transactions on Power Systems, vol. 33, no. 3, pp. 2395-2403, May 2018.
6. Q. Huang, S. Jing, J. Li, D. Cai, J. Wu and W. Zhen, "Smart Substation: State of the Art and Future Development," in IEEE Transactions on Power Delivery, vol. 32, no. 2, pp. 1098-1105, April 2017.
7. A. Angioni et al., "Design and Implementation of a Substation Automation Unit," in IEEE Transactions on Power Delivery, vol. 32, no. 2, pp. 1133-1142, April 2017.

8. H. F. Albinali and A. P. S. Meliopoulos, "Resilient Protection System Through Centralized Substation Protection," in IEEE Transactions on Power Delivery, vol. 33, no. 3, pp. 1418-1427, June 2018.

9. ACKNOWLEDGEMENT

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