Iot Based Single Phase Distribution Line Monitoring and Theft Detection

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Abstract- **This paper proposes an innovative IoT-based solution for monitoring distribution lines and detecting theft in electrical distribution networks. The convergence of IoT and GSM technologies enables real-time data collection, remote monitoring, and efficient communication, empowering utility providers and consumers alike to make informed decisions about energy usage. This project aims to design and implement a sophisticated smart energy meter system that not only monitors consumption but also incorporates advanced theft detection mechanisms, contributing to the overall sustainability and security of the energy and the monitoring of Distribution transformer include such as temperature, oil condition, voltage, Humidity etc, allows for the early detection of faults or abnormalities in the transformer's operation, such as overheating, insulation degradation, or load imbalance which help in detecting these issues early and can prevent costly failures and minimize downtime to ensure the longevity and reliability of distribution transformers in electrical power networks. The detection of line to ground Fault by IOT and GSM technologies enables utilities to repair it quickly which provide better services leading to increased customer satisfaction and loyalty.**

Keywords- IOT, GSM, Ardunio, Transformer Parameter and Protection, Line to Ground fault, Energy Meter, Theft Detection, Security Enhancement, Cloud Based Data Storage.

I. INTRODUCTION

In recent years, the global demand for energy has been escalating at an unprecedented rate, necessitating the development of innovative solutions to monitor and manage energy consumption effectively. In this context, the integration of Internet of Things (IoT) technology and Global System for Mobile Communications (GSM) into smart energy meters has emerged as a promising avenue to revolutionize energy monitoring systems. The convergence of IoT and GSM technologies enables real-time data collection, remote monitoring, and efficient communication, empowering utility providers and consumers alike to make informed decisions about energy usage. This project aims to design and implement a sophisticated smart energy meter system that not only monitors consumption but also incorporates advanced theft detection mechanisms, contributing to the overall sustainability and security of the energy grid.

In the contemporary era, the global community faces a significant challenge in the form of an energy crisis. Contrary to conventional beliefs, the key to a viable solution does not solely lie in increasing energy production but rather in the prudent utilization of existing energy resources. Effectively addressing the energy crisis requires careful monitoring of energy consumption and the prevention of wasteful practices. In an effort to meet the ever-increasing demand for energy on a worldwide scale, the incorporation of Internet of Things (IoT) technology and worldwide System for Mobile Communications (GSM) into smart energy meters is a forward-thinking strategy that has the potential to revolutionise the way in which we monitor and control energy use. Both consumers and utility suppliers are able to make well-informed decisions on their energy use by

the Internet of Things (IoT) and Global System for Mobile Communications (GSM) technologies. These technologies permit real-time data collecting, remote monitoring, and efficient communication. The another objective of the project that is being discussed by Anurag Singh, Mayank Sharma, Sumit Singh, Shivrani, and Mr. Santosh Kumar, who are all members of the Department of Electrical Engineering at Axis Institute of Technology and Management in Kanpur, is to create a comprehensive smart energy meter system. This system is designed to not only monitor energy usage but also contain sophisticated procedures for detecting theft, which will ultimately result in an improvement in the energy grid's overall sustainability and security [1, 2].

The contemporary world is confronted with the significant obstacle of an energy crisis, the resolution of which might be found not only in the enhancement of energy production but, more crucially, in the effective utilisation of resources that are already under existence. It is essential to have efficient energy management, which necessitates careful monitoring in order to prevent behaviours that are inefficient and the utilisation of energy without authorization. Especially in countries like India, where consumers are uninformed of their real-time energy consumption for the majority of the month, the periodic nature of traditional billing systems presents a substantial obstacle to the achievement of this objective. It is conceivable to make a dramatic shift towards more responsible and informed energy use if consumers are given the ability to monitor their energy consumption in real time through the use of mobile phones or laptops. This kind of connectivity has the potential to bring about a transformative transformation in energy management by enabling consumers to control their energy consumption from any location in the world. This could ultimately result in a more efficient and environmentally friendly energy future [3, 4].

In order to enhance the dependability, efficiency, and safety of distribution networks, the Internet of Things-based system that is being suggested for monitoring electrical distribution lines and detecting theft is intended to be implemented. The system promises various benefits, including more accurate billing, provide a real time protection of transformer against over loading and the early detection of Line to ground Fault help to improved grid management, and a large reduction in revenue losses due to theft. These benefits are achieved by lowering expenses and increasing customer satisfaction. These bigger goals of constructing smarter grids, integrating renewable energy sources, and fostering a sustainable and secure energy environment are all aligned with the project's objectives. The implementation of this effort constitutes a significant step towards the establishment of an energy ecosystem that is both intelligent and efficient, and which is able to satisfy the ever-changing requirements of our constantly developing society [5, 6].

Installation of smart energy meters that are equipped with Internet of Things capabilities for the purpose of real-time data collection and transmission, integration into a centralised system for the purpose of ensuring seamless device communication, and utilisation of advanced analytics and machine learning algorithms for the purpose of analysing patterns of energy consumption are all components of the methodology that will be utilised for this project. This strategy not only helps in identifying abnormalities and possible thefts, but it also improves the capabilities of detecting thefts by incorporating tamper-proof features and GPS tracking, which helps to ensure that the integrity of the energy distribution network is maintained. A further benefit of the project is that it makes it easier for customers to monitor their energy consumption in real time, which encourages responsible consumption and active participation in the prevention of theft [7].

II. OBJECTIVE

The objective of the project "IoT Based single phase Distribution Line Monitoring and Theft Detection" is to Create and implement an Internet of Things (IoT) based system for real-time monitoring and protection of distribution Transformer, detection of electrical distribution line faults and electrical theft. By detecting the electrical theft in distribution line , the alert will be send to utilities for unauthorized access or Power hooking and meter Tampering in distribution lines. This will help reduce economic losses due to power outages and energy theft, resulting in cost savings for utilities . The project will also aim to optimize energy distribution by analyzing usage patterns and predicting demand, enabling utilities to adjust supply accordingly this will lead to a more efficient and sustainable energy ecosystem. The project also enhance customer experience by providing real-time energy usage insights and enabling personalized energy management plans. This will empower consumers to make informed decisions about their energy consumption. The implementation of this system promises a multitude of benefits, including enhanced accuracy in billing, improved grid management, and a substantial reduction in revenue losses due to theft. As technology continues to advance, the project's future implications extend to the development of smarter grids, increased integration of renewable energy sources, and the creation of a more sustainable and secure energy landscape. This endeavor represents a significant stride towards achieving a more intelligent and efficient energy ecosystem that meets the evolving needs of our rapidly advancing society.

III. BLOCK DIAGRAM OF PROJECT

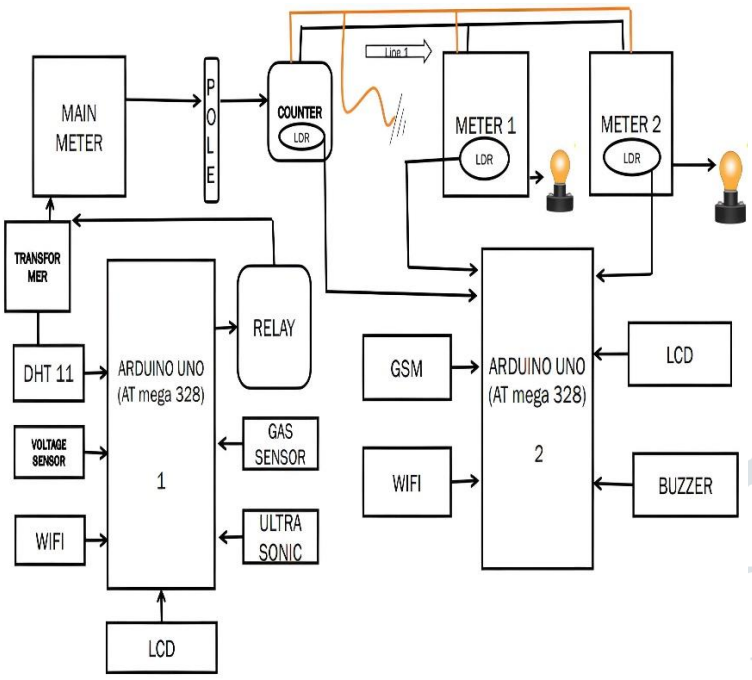

Fig.1 Block Diagram

IV . HARDWARE COMPONENTS USED

- ARDUINO UNO
- LCD DISPLAY (16X2)
- SINGLE PHASE ENERGY METER (X3)
- LDR SENSOR
- DHT11
- GAS SENSOR(MQ-135)
- VOLTAGE SENSOR
- WIFI MODULE(ESP-01)
- GSM 900A
- 1 CHANNEL RELAY
- ADOPTER(5V)
- SWITCH
- BULB
- HOLDER
- TRANSFORMER
- RESISTOR(10K)
- JUMPER WIRE
- BATTERY
- PRESET(100 K)

V. METHODOLOGY

The IoT and GSM-based smart energy meter monitoring and theft detection ,transformer monitoring and protection project follows a comprehensive methodology to ensure efficient energy management and curb unauthorized usage. The project begins with the installation of smart energy meters equipped with IoT capabilities, allowing real-time data collection and transmission. These meters are integrated into a centralized system that leverages Internet of Things (IoT) technology, enabling seamless communication between devices and the monitoring infrastructure. Additionally, the inclusion of GSM (Global System for Mobile Communications) technology facilitates remote monitoring and control, ensuring that relevant stakeholders receive immediate notifications in case of suspicious activities. To enhance theft detection, the project incorporates tamper-proof features in the smart meters, such as anti-tamper seals and intrusion detection sensors. These measures aim to safeguard the integrity of the metering infrastructure and promptly alert authorities in the event of any tampering attempts. Moreover, the system utilizes GPS tracking to pinpoint the location of meters, further aiding in the identification of potential theft incidents. The project also emphasizes user-friendly interfaces for consumers to access and monitor their energy consumption data in real-time. This transparency not only promotes responsible energy usage but also empowers consumers to actively participate in the prevention of theft within their communities. The proposed project is provide real time status of transformer health parameters. Temperature, voltage and current of transformers are monitored and send over internet .The live tracking of these parameters can be done using IOT technology from anywhere around the world .This is cost effective in nature. Thus the responsible authority can access information on any power failure or maintenance.

The implementation of the proposed Internet of Things-based system for monitoring electrical distribution lines and detecting energy theft incorporates a sophisticated variety of technologies and approaches, with the goal of building an energy distribution network that is more dependable, efficient, and secure. The utilisation of smart energy meters that are outfitted with Internet of Things (IoT) capabilities is the fundamental component of this system. These meters make it possible to continuously monitor and analyse the amount of energy that is being consumed in real time. In order to avoid unauthorised access and manipulation, these meters are designed to be extremely safe and tamper-proof. They come equipped with sophisticated encryption and intrusion detection

sensors. The system ensures that there is no disruption in communication between the meters and the central monitoring infrastructure by including technology that is based on the Global System for Mobile Communications (GSM). This allows for fast alerts and notifications to be sent out in the event that any irregularities or potential theft occurrences are discovered.

A centralised platform that receives and processes data from the smart meters is utilised by the system in order to accomplish the goals of thorough monitoring and theft detection. This platform makes use of machine learning algorithms to conduct an analysis of consumption habits, while simultaneously creating baseline profiles for each individual user. The use of these profiles makes it possible to identify deviations from the typical patterns of electricity use, which may reflect the possibility of theft or the unauthorised use of electricity. Machine learning assures that the system will continue to increase its accuracy and efficacy in detecting theft over time. This is accomplished through the use of machine learning.

In addition, the system that is being suggested combines environmental and transformer health monitoring components. These components include sensors that measure not only temperature and oil condition but also voltage and current. The monitoring of these metrics is absolutely necessary in order to spot defects or abnormalities in a timely manner, which reduces the likelihood of costly failures or downtime occurring. The incorporation of these components shows the holistic approach that was taken with the project. This strategy goes beyond the detection of theft and ensures the longevity and dependability of distribution transformers as well as the complete electrical power network.

Consumers and utility providers are able to gain access to real-time data regarding energy usage, transformer health, and environmental conditions thanks to the user interface of the system, which has been designed to be user-friendly and easy to understand. Because of this transparency, consumers are given the chance to make educated decisions regarding their energy consumption, which in turn promotes efficiency and sustainability. Additionally, utility providers can make use of this data to increase customer happiness, optimise grid management, and reduce operating costs. This can be accomplished by delivering accurate and timely billing that is based on real-time usage data.

VI. RESULTS

The Internet of Things-based system that was deployed for the purpose of monitoring electrical distribution lines and detecting energy theft produced substantial results, demonstrating the potential of integrating sophisticated technologies in order to improve the efficiency and security of energy distribution networks. The capability of the system to deliver statistics on energy consumption in real time was one of the most notable outcomes this system achieved. Due to the fact that this capacity offered a level of transparency that was previously unattainable with standard metering methods, it completely revolutionised the way in which consumers interact with their energy consumption. Consumers now have the option to monitor their patterns of energy consumption directly from their smartphones or computers, which enables them to make educated decisions that will optimise their usage and avoid waste that is not essential. Fig. 2 shows project image.

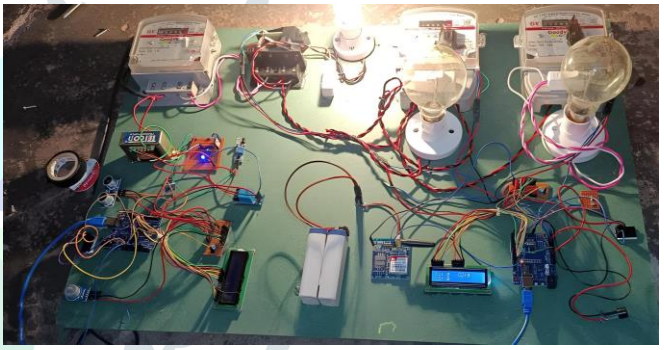

Fig.2 Hardware Image.

The effectiveness of the system in identifying and combating energy theft was another significant accomplishment of the implementation of the system. The system displayed a high degree of accuracy in spotting abnormalities that are indicative of theft. This was accomplished through the utilisation of smart meters that were fitted with tamper-proof features and the installation of machine learning algorithms to analyse consumption patterns. Not only did the rapid detection and warning mechanism result in significant cost savings for utility providers, but it also contributed to the overall fairness and integrity of the energy distribution system. This was in addition to the fact that it greatly reduced the incidence of unauthorised energy consumption.

In addition, the monitoring of transformer parameters and environmental conditions that was performed by the system provided extremely helpful insights into the operating status of components that are essential to the infrastructure. Through the early detection of potential problems, such as overheating

or insulation degradation, timely maintenance interventions were made possible, which resulted in the prevention of costly failures and the reduction of downtime. The need of preventive maintenance in guaranteeing the durability and dependability of electrical power networks was brought to light by this particular component of the system.

When viewed from the point of view of a utility provider, the adoption of an Internet of Things-based system resulted in improved grid management capabilities. The extensive and accurate consumption data that was collected through the smart meters allowed for more exact demand forecasting and capacity planning, which in turn ensured that energy output was closely linked with the requirements of consumption. Not only did this optimisation of resources result in an increase in the efficiency of the energy grid, but it also prepared the way for the incorporation of renewable energy sources, which contributed to the sustainability of the energy landscape.

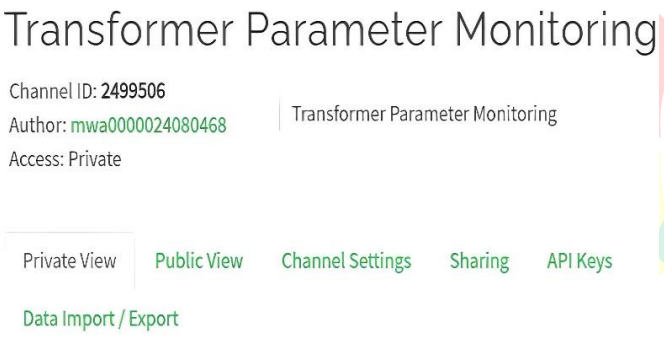

Fig.3 Transformer Parameter Dashboard

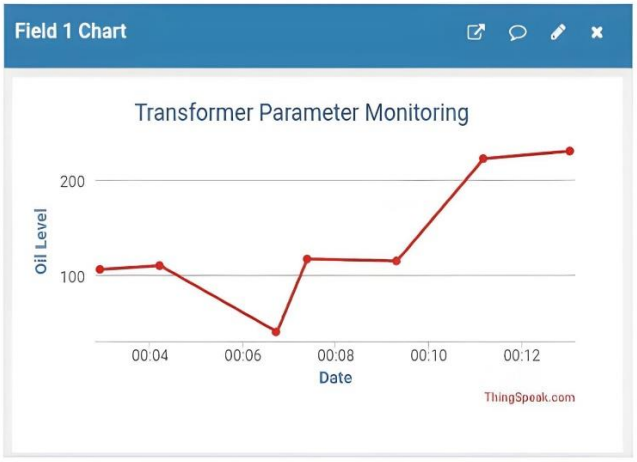

Fig.4 Transformer Oil Level

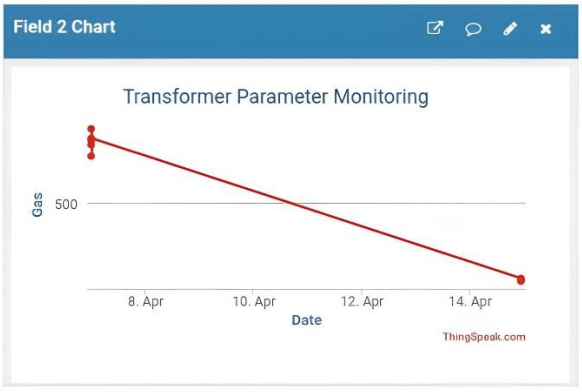

Fig.5 Gas Detection

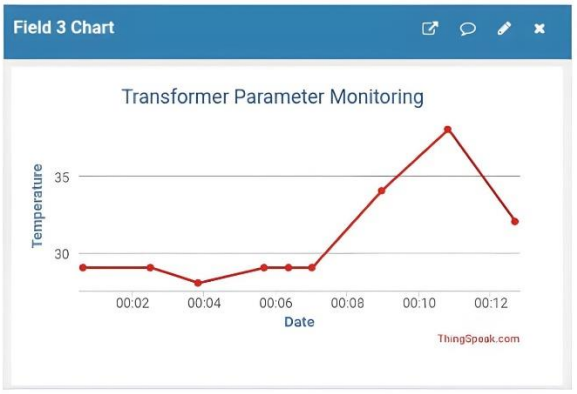

Fig.6 Temperature Monitoring

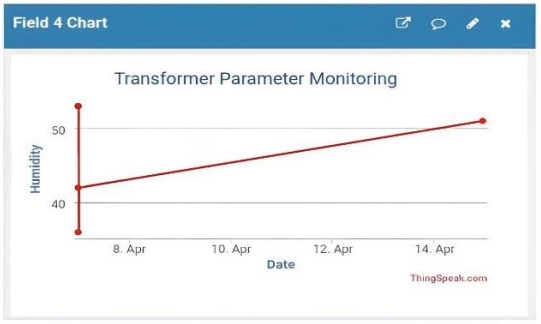

Fig.7 Humidity Level

Fig.8 Lamp Indication Of Overloading of Transformer

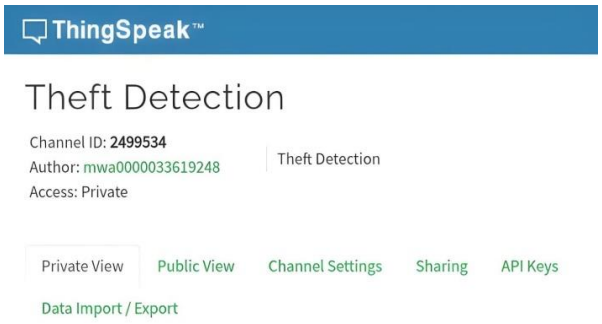

Fig.9 Electrical Theft Dashboard

Fig.10 Theft at Meter 1

Fig.11 Theft at Line 1(Counter)

Fig. 12 Theft at Meter 3

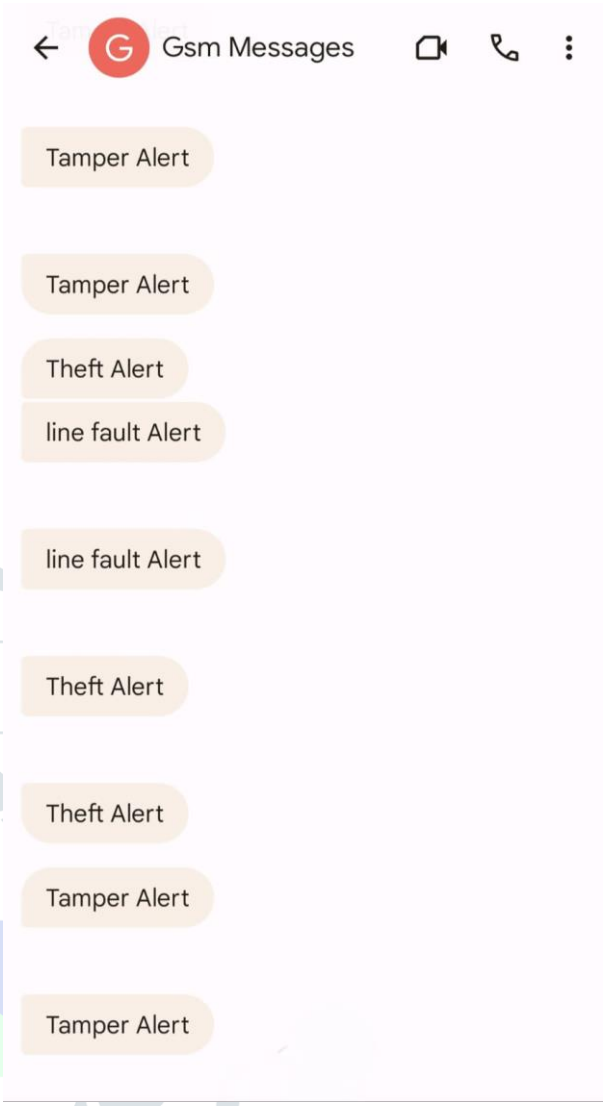

Fig.13 GSM Messages
(L-G Fault, Meter Tamper, Electrical Theft Alert)

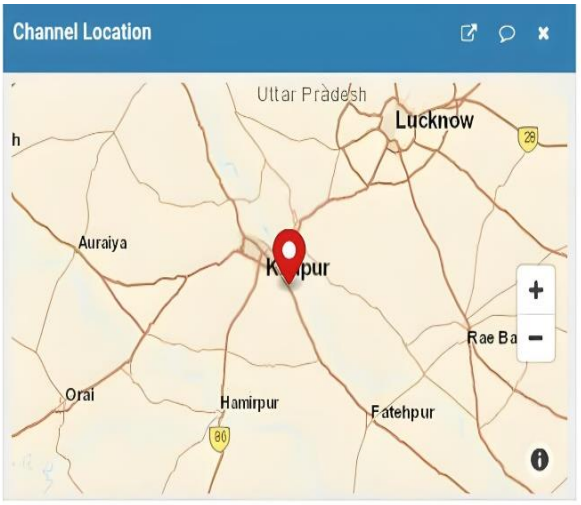

Fig.14 Hardware Location

VII. CONCLUSION

The implementation of the IoT and GSM-based Smart Energy Meter Monitoring, Line to Ground Fault and Theft Detection system, Transformer Monitoring and Protection marks a significant advancement in the realm of energy management and security. Through the integration of Internet of Things (IoT) technology and Global System for Mobile Communications (GSM), we have successfully created a robust and intelligent energy metering solution. The real-time monitoring capabilities offered by the IoT components enable users to access accurate and up-to-date information about their energy consumption. The GSM module facilitates seamless communication and alerts, ensuring that users are promptly notified of any anomalies or potential theft incidents. The project not only addresses the need for efficient energy management but also contributes to the broader goal of reducing energy theft, a pervasive issue in many regions. The system's ability to detect and alert authorities to unauthorized access or tampering is a crucial feature in safeguarding the integrity of the energy distribution network. Furthermore, the data collected through this system can be harnessed for comprehensive analysis, aiding in the development of strategies for optimizing energy consumption patterns. Overall, this project showcases the transformative potential of combining IoT and GSM technologies for enhancing energy infrastructure, fostering sustainability, and combating theft in the modern era. As we look ahead, there is immense potential for further refinement and expansion of this system, paving the way for a smarter and more secure energy landscape .

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