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Microcontroller Based System to Detect Power Theft by Using CT and PT

Dr. Trupti Wable[1], Gawandhe Chetan Ramdas[2], Bhabad Saurabh Mahadev[3], Gaikwad Siddhant Tulshiram[4], Tambe YashBhaupatil[5], Shirole Kunal Vitthal[6]
[1]*AssistantProfessor,* [2,3,4,5,6]*Students, Department of Electrical Engineering, Sir Visvesvaraya Institute of Technology, Nashik, Maharashtra, India*

Abstract: ***Energy management and conservation have become crucial in today's industrial landscape, as the cost of generating high-quality power continues to rise. Efficient energy usage not only ensures productivity but also keeps industries profitable and competitive. This paper addresses the critical issue of electricity theft that occurs along distribution lines. It introduces a method for detecting theft by comparing the total input power supplied to the distribution system with the cumulative power consumed by the individual customers. A discrepancy between these values indicates possible theft.***
The proposed system utilizes a microcontroller-based setup for theft detection, integrating current transformers and potential transformers to measure the power at both the input and consumer points. By calculating the difference between the two, the system can effectively identify whether power theft has occurred. Additionally, if any customer exceeds their sanctioned load, the system can trigger a warning message.
In India, utility companies face substantial losses due to electricity theft, with estimates suggesting a loss of over a billion US dollars annually. This work aims to present an algorithm for an electricity theft monitoring system that enables the detection of violators from a remote location. The study starts by analyzing the various losses in electrical power systems, with a particular focus on electricity theft, which is the primary cause of these losses. Other factors like poor maintenance or calculation errors may also contribute but are less significant in comparison.
The paper explores the different methods of electricity theft and discusses the design of a theft detection methodology using a backtracking algorithm. It also covers the communication of theft data from consumer premises to substations via existing power lines. The results and recommendations derived from the data collected are provided to offer a practical and effective approach to tackling electricity theft.
Keywords: Power Theft, microcontrollers, Sensors, GSM module, Energy Meter, Power consumption, GSM modem

I. INTRODUCTION

The demand for electrical energy is consistently on the rise, and currently, over 20% of power losses are attributed to transmission and distribution inefficiencies. Transmission losses range between 4-6%, while distribution losses—often caused by overloads or theft—account for 15-18%. This leaves an electrical power deficit of approximately 18%. Reducing these distribution losses could significantly mitigate the overall power deficit, with potential reductions of up to 6-8% in overload losses.

To address this issue, the adoption of newer technologies, including advanced Electrical Engineering solutions in the power distribution sector, is crucial. These technologies will enable better monitoring and control of power consumption. However, when the power consumption exceeds the sanctioned limits, it becomes challenging for the distribution system to identify whether the increase is due to legitimate consumption or theft. If theft occurs on the distribution line, it can cause significant disruptions, impacting both the distribution lines and the substations.Electric utilities around the world suffer substantial financial losses due to electricity theft. This illegal activity can be defined as the dishonest or unlawful use of electricity equipment or services with the intent to avoid paying the corresponding charges. Differentiating between honest and fraudulent consumers is a challenging task for utility companies. Although it may never be possible to completely eliminate fraud, steps can certainly be taken to detect, prevent, and reduce theft. The proposed system aims to automate theft detection, reducing manual intervention and improving overall control.

II. REVIEW OF LITERATURE

Electricity theft causes substantial financial losses, with estimates suggesting that between 30-35% of the earnings from electricity distribution are lost to theft.

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Previous attempts at monitoring power theft have been disorganized, mainly due to the illegal practices of some employees and consumers.

This research proposes a straightforward system that sends an alert whenever a power theft is detected at a particular location.

One innovative approach for detecting non-technical losses (NTLs) in electrical services uses artificial intelligence-based methods combined with pattern recognition to identify fraudulent customer consumption patterns. This system aims to detect power theft through analyzing discrepancies in power consumption without relying on historical data. In a proposed solution, data transmission and reception are carried out wirelessly, ensuring the protection of the distribution network from power theft, meter tampering, and other threats. The use of wireless communication technologies allows for continuous monitoring at the same cost and ensures that the network remains secure. [3]

In another method for power line theft detection, Sagar Patil, Gopal Pawaskar, and Kritikumar Patil recommend using digital meters, wireless data transmitters, and power line communication. The system integrates a digital meter connected to both the pole and the consumer's premises. Data from the consumer's premises is continuously transmitted to a microcontroller-equipped digital meter at the pole side via wireless communication. If the data discrepancy exceeds a preset tolerance, the system detects theft and notifies the substation via power line communication for further action. This enables real-time detection and effective line protection. [4]

Another proposed system incorporates an Arduino Uno controller, a smart energy meter, and GSM technology to detect power theft. This setup includes current transformers (CTs) connected to the distribution box, with data sent to the substation via GSM modules. The system compares data from the energy meters installed on both the consumer's side and the distribution side. If discrepancies exceed the tolerance, the system automatically identifies theft and pinpoints the location where theft is occurring, enabling prompt action. This system eliminates manual intervention and uses real-time data for detection. [5]

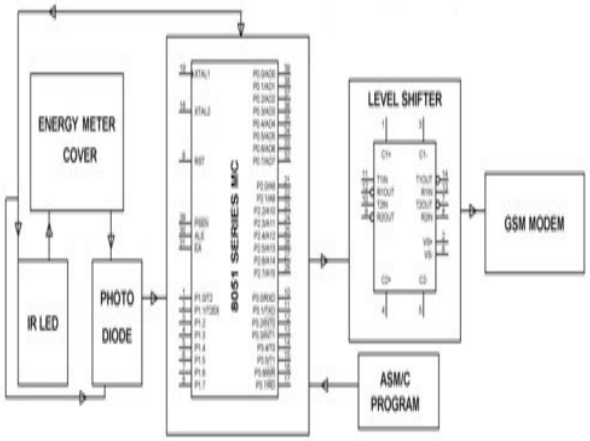
III. 8051 MICROCONTROLLER

The 8051 microcontroller is commonly used in simulations for detecting power theft. Despite its limited memory and slower processing speed compared to more advanced microcontrollers, such as the PIC microcontroller, it is a cost-effective solution for basic power theft detection. However, the 8051 requires additional components, such as an external ADC (Analog to Digital Converter), to function effectively for theft detection. For more complex implementations, microcontrollers like PIC, which have integrated ADCs, are preferred.

1) Zigbee Communication:

In existing systems, Zigbee wireless communication is used in conjunction with energy meters for theft detection. The system uses Zigbee for serial data transmission and cryptographic techniques to secure communication channels. Although Zigbee is efficient, one limitation is that it requires the collection of readings within a specific range, and power must be manually cut off if needed. Despite these challenges, this technology remains effective in smaller, localized applications. [6-7]

The rise in electricity theft is a growing problem worldwide, especially in regions like Pakistan. The increasing demand for energy is met with an equally concerning rise in stolen electric energy. To combat this, a new electric energy theft detection system using GSM modems has been proposed. The system utilizes a PIC microcontroller and integrates GSM technology to notify authorities of any suspicious activity in real-time, offering an efficient solution for energy theft management.



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IV.EXPECTED OUTCOMES OF THE POWER THEFT DETECTION SYSTEM

The primary objective of the proposed power theft detection system is to significantly reduce power losses in distribution networks, particularly those attributed to illegal electricity consumption. The anticipated outcomes of this system, once implemented, are multifaceted and will address several critical aspects of energy management, fraud detection, and operational efficiency within the electrical distribution sector.

1) Improved Detection of Power Theft

One of the key expected outcomes of this system is the efficient and accurate detection of power theft across the distribution network. Traditional methods of theft detection are often slow, manual, and reliant on periodic inspections, which can easily miss theft incidents that occur between inspections. The proposed system, utilizing advanced sensors, microcontroller-based devices, and wireless communication, will provide real-time monitoring of power usage across both the consumer side and the distribution side.

By continuously comparing the data from the energy meters installed on both ends, the system can detect discrepancies beyond a defined tolerance level. These discrepancies are often indicative of power theft, either from tampered meters or unauthorized connections to the grid. The system will thus allow utilities to identify and address theft in a timely manner, preventing further financial losses and ensuring that consumers who are legally consuming power are not unfairly burdened with the costs of theft.

2) Reduced Transmission and Distribution Losses

Power theft significantly contributes to transmission and distribution losses, which in turn affects the overall efficiency of the electrical grid. Transmission losses, though typically lower (4-6%), can be exacerbated by illegal connections that siphon off power without any record. Distribution losses (15-18%) are often much higher and are largely caused by overloading of the system or illegal connections.

With the implementation of this theft detection system, utilities will be able to detect and address power theft much more efficiently, reducing the overall losses in the distribution network. By minimizing illegal consumption, the system is expected to reduce both overload and theft-related losses, leading to a more efficient and reliable grid. This, in turn, can reduce the need for additional generation capacity, thus saving costs for utilities and, ultimately, consumers.

3) Financial Savings for Utility Companies

Electric utilities worldwide face significant financial losses due to power theft, especially in developing countries where the problem is more prevalent. In India, for instance, electricity theft costs utilities billions of dollars every year. By detecting power theft in real time, the proposed system will reduce the financial losses associated with these illegal activities.

Once theft is detected, the system can send immediate alerts to utility operators, enabling them to take corrective actions, such as disconnecting the illegal load or investigating further. Additionally, with the ability to pinpoint the exact location of theft, utilities can conduct targeted inspections, saving time and resources compared to traditional methods of detection, which may involve more widespread, less focused efforts.

4) Enhanced Operational Efficiency and Automation

The system's automation capabilities are another significant expected outcome. Traditionally, power theft detection requires manual intervention, periodic inspections, and customer complaints, which can be time-consuming and inefficient. The proposed system will eliminate much of this manual work by automating the monitoring and alerting processes. The use of microcontrollers, wireless communication, and GSM technology ensures that theft-related events are detected and reported in real-time, allowing for faster response times and minimizing the impact of theft on the grid.

Furthermore, the system's ability to track power consumption continuously and compare it against expected usage will allow utilities to better manage their distribution networks. It can also help in identifying other inefficiencies, such as overloading or underutilization of certain parts of the grid, enabling better load balancing and more informed decision-making.

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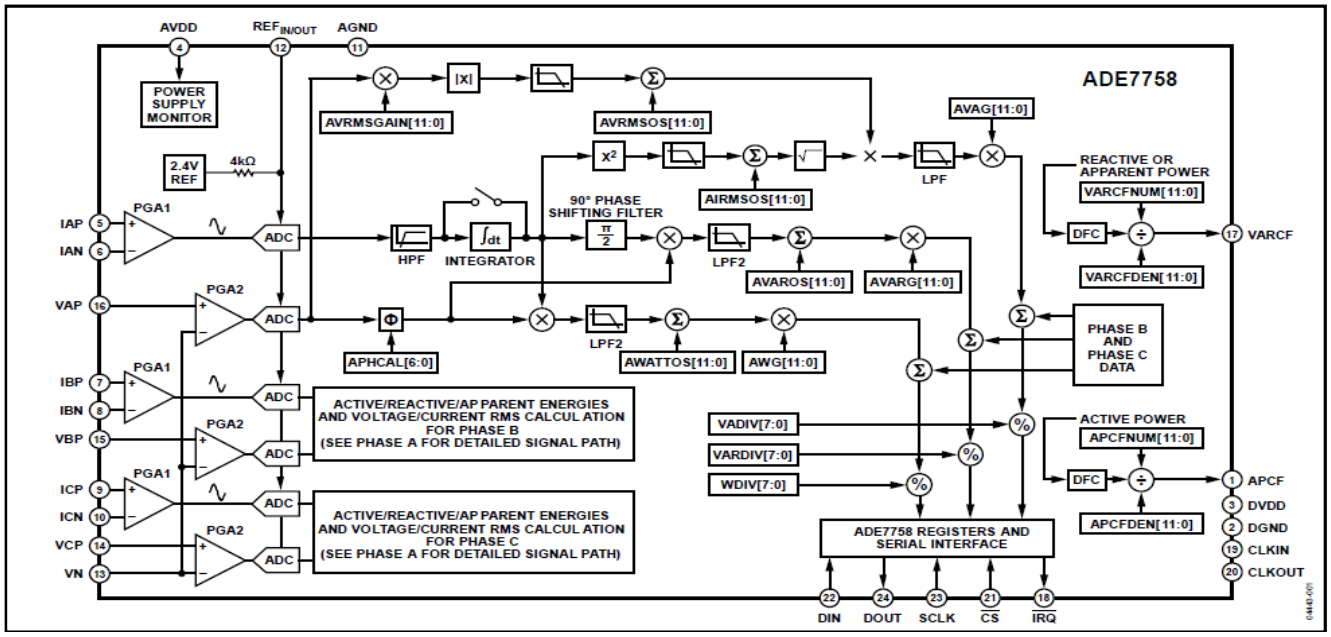


5) Consumer Awareness and Fair Billing

Finally, the system will contribute to more accurate billing practices, ensuring that consumers are billed according to their actual consumption rather than inflated figures resulting from theft-related losses. This will promote fairness and transparency in billing, enhancing consumer trust in the utility provider.

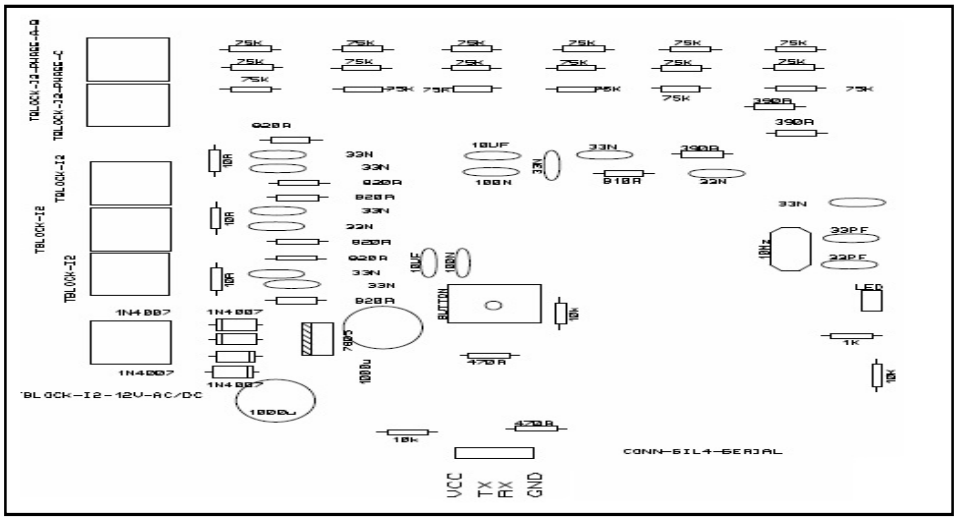
In the case of consumers exceeding their sanctioned load or engaging in illegal activities, the system will issue automated alerts, enabling utilities to take appropriate actions, such as issuing warnings or disconnecting power. These proactive measures will help in reducing unauthorized power consumption and maintaining a more equitable distribution system for all consumers.

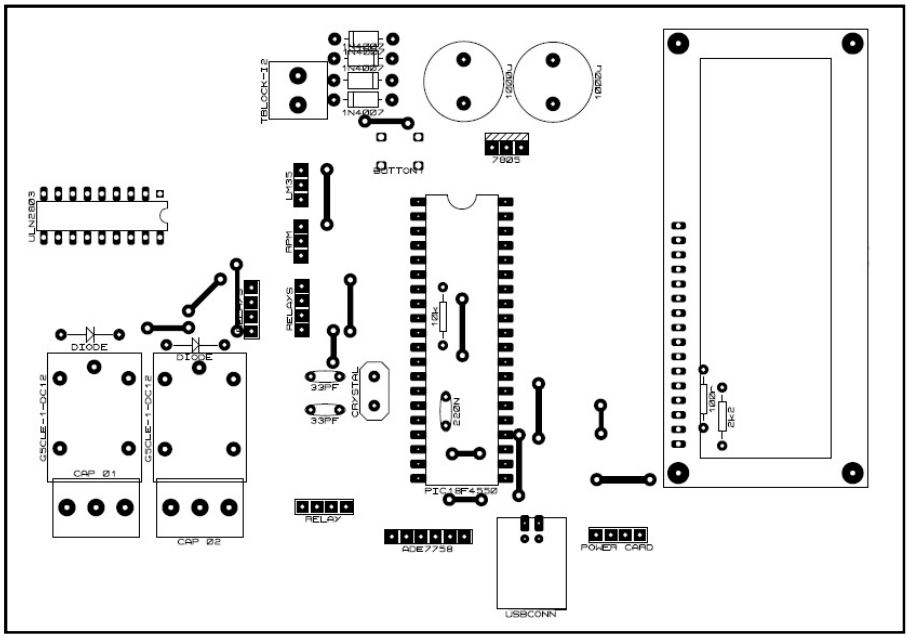
6) Scalability and Adaptability

The system is expected to be scalable, meaning it can be implemented in various regions with varying infrastructure capabilities. It can be adapted to work with different types of energy meters and communication technologies, making it flexible enough to be deployed in both urban and rural settings.

As power theft evolves in response to changing technologies, the system can also be updated and upgraded to address new forms of fraud, ensuring that utilities can continue to protect their infrastructure effectively.

V. RESULT





VI. CONCLUSIONS

Electricity Theft Detection and Monitoring was designed and developed with proper hardware and software integration. An intelligent power theft detectionsystemispresentedinthissystem.It detectsunmeteredload(illegalload)instantlyand alerts the utility company to take appropriate action. Thedesigned systemishighlyreliable,sensitive,and efficient. The study of various techniques is done in order to propose a new technique that is expected to havehigheraccuracyindetectingelectricitytheft. Thistechniquewouldassistpowerauthoritiesin furtherreducingnontechnicallossesinelectricity distribution.

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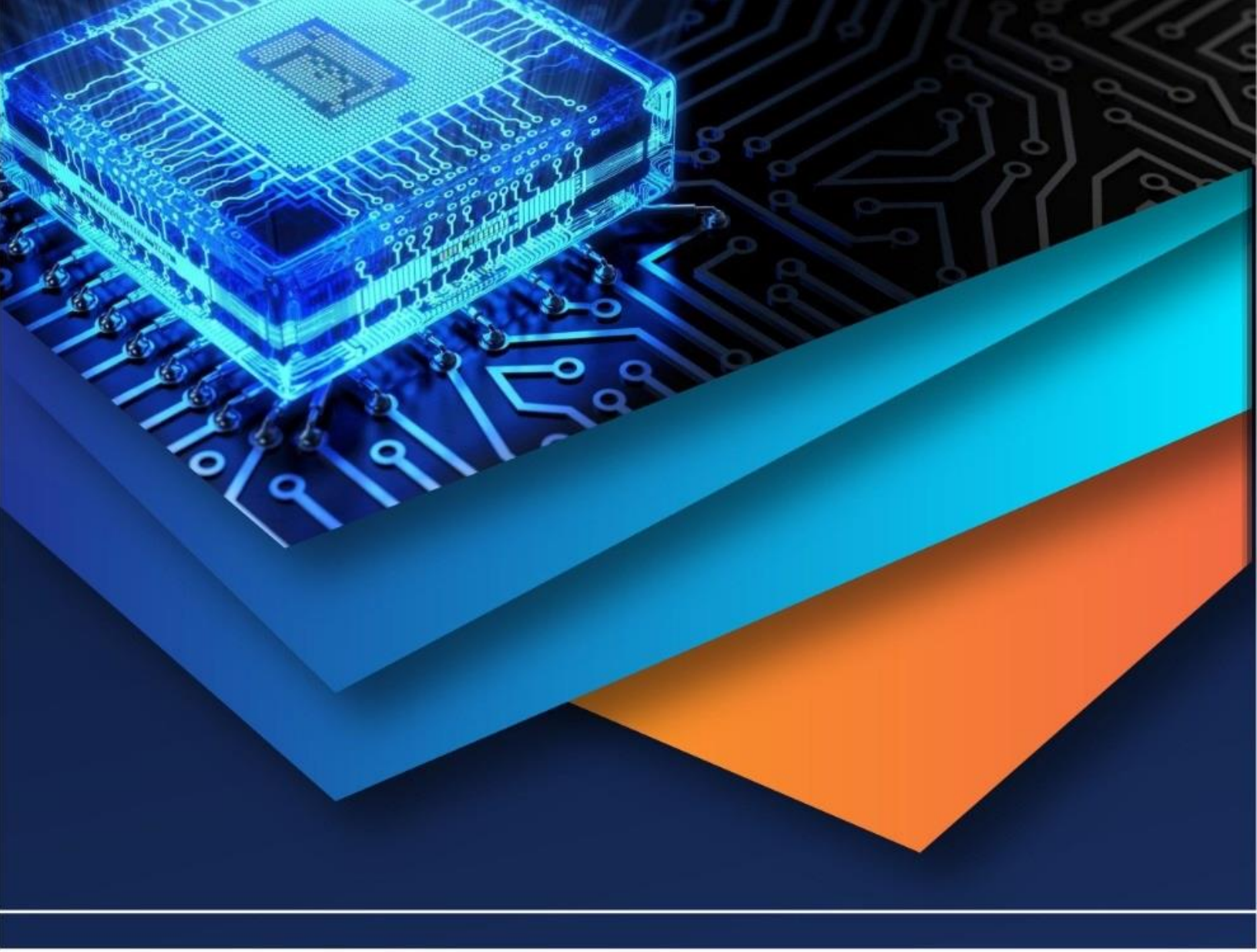

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