

IoT Based Efficient Electricity Theft Detection and Monitoring System

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Abstract: Internet of Things (IoT) have become common replacements for traditional analog meters. These systems enable wireless data transmission, minimizing the need for human intervention. However, the risk of electricity theft remains. According to lack of the specific methods in the existing solutions, such thefts often go undetected. This project aims to develop a system that monitors electricity consumption per load, detects theft, and prevents unauthorized usage in power lines and meters. Additionally, it will notify Electricity Board officials about detected thefts via IoT. A network of interconnected devices, including sensors, facilitates real-time data transmission over the Internet. The Atmega328p micro-controller plays a key role in identifying power theft and transmitting the information to the Wi-Fi module, which then alerts the electricity board.

Keywords: Smart Metering, IoT-Based Energy Monitoring, Wireless Power Tracking, Current and Voltage Sensors, Embedded Systems

I. INTRODUCTION

These technique is a groundbreaking innovation designed to identify power theft and meter tampering. This system employs Hall sensors to detect unauthorized meter interference or direct connections to the power supply before the meter. Upon detecting theft, the micro-controller logs the incident, including its nature and timing, and stores the data on an IoT platform while simultaneously publishing it on a designated web page. If theft attempts exceed a certain threshold, the system sends an alert to the website.

This solution is requires only a one-time download cost and it can be also used indefinitely. Aims to completely eliminate electricity theft, enhance revenue the government, and also conserve energy. These is also user-friendly, providing an efficient monitoring system. Electricity theft not only increases consumer costs but also poses serious safety risks. It leads to financial losses for suppliers, disrupting market operations. The cost of detecting fraud may exceed industry-wide expenses, and suppliers facing theft may bear additional costs related to power generation, network maintenance, and balancing electricity forecasts.

Traditional methods, such as physical inspections of meter seals and balance meters, it as been used to detect the electricity theft. However, these approaches have limitations tamper evident seals can be broken easily, and also balance meters can only identify discrepancies without pinpointing the culprits. Despite security concerns with smart meters, their high-resolution data collection presents a promising tool for enhancing traditional theft detection techniques. They offer potential improvements in metering accuracy, billing, fraud detection, and identification of metered connections.

Electricity theft takes various forms, including bypassing meter security controls and making unauthorized direct connections to power lines. A major challenge in theft prevention is inadequate monitoring and enforcement, worsened by outdated technology and insufficient supplier

incentives. Additionally, power availability for residential and commercial users remains a concern, along with increasing incidents of illegal line tapping.

To address these challenges, the proposed project, "Io T-Based Electricity Theft Detection and Monitoring," focuses on reducing illegal power consumption in domestic and commercial sectors. Its key objectives include:

1. Developing a portable electricity theft detection system.
2. Detecting theft using Hall sensors.
3. Monitoring theft via IoT and a dedicated website.
4. Controlling and preventing theft through a micro controller-based system.
5. This project aims to modernize electricity theft detection, ensuring a more secure and efficient power distribution network.

II. LITERATURE SURVEY

This section reviews past research and existing systems to identify gaps and areas for future development in electricity theft detection and smart energy management. Several studies have explored various approaches, ranging from IT-based monitoring to machine learning techniques for theft detection.

[1] Rajermani Thinakaran et al. proposed a Smart Energy Management System Using IoT for real-time monitoring and theft detection. Their system focused on improving energy tracking and identifying unauthorized usage.

[2] Islam Elgarhy et al. introduced Secured By Cluster-Based Electricity Theft Detector Againsts Black-box Evasions Attacks. This study compares two types of the SVM detectors, concluding that a binary class SVM as been trained on both benign and malicious data samples a one-class SVM trained only on the benign samples.

[3] Lakshman Prabhu B et al. presented an IoT-Based Electricity Theft Detection System Using AI Techniques. They highlighted how unauthorized connections, meter

tampering, and fraudulent methods increase operational costs and pose risks to power grid stability.

[4]Devendra Singh Mandloi et al. developed an Energy Meter and Electricity Theft Detection System Using IoT and ESP32. Their model sends data to the Things peak cloud platform via ESP8266. If cloud updates fail, a 4G GSM module sends alerts via SMS as a backup.

[5] Nisha Mishra et al. designed an Enhanced Low-Cost Smart Energy Meter with Theft Detection Using IoT. This system incorporates simple mechanisms to detect tampering and trigger alerts, making it an affordable solution for electricity distribution companies.

[6] Shanthi et al. worked on an IoT-Based Electricity Theft Detection System that communicates with Things peak via a Restful API. This platform allows users to keep data private or public, analyze it, and take necessary actions based on the findings.

[7] Tejas Chandhari et al. introduced an IoT-Based Smart Energy Meter with Theft Detection. Their system predicts current and voltage through a controller and connected detectors, aiming to eliminate theft and reduce energy wastage.

[8] Venkatakrishnan Perumalsamy et al. presented their research in the *Journal of Intelligent & Fuzzy Systems*, introducing an IoT-driven artificial intelligence system for monitoring indoor air quality. Their study outlines the methodology employed, along with details of the hardware and software components, a threshold-based algorithm, machine learning techniques, and the analysis of sensor-generated data. Additionally, an Android application is utilized to visualize the collected sensor data.

[9] Oscar Famous Darteh et al. designed an IoT-powered system for detecting electricity theft using Raspberry Pi. In Ghana, electricity providers such as the Electricity Company of Ghana (ECG) have introduced various energy meters to prevent unauthorized usage and theft.

[10]Konda Srinivas et al. introduced an IoT-based network intrusion detection system utilizing artificial intelligence techniques in *Studies in Indian Place Names*. This research presents a neural network-driven method for detecting intrusions in IoT networks, specifically aimed at identifying DDoS and DoS attacks

These studies collectively highlight the importance of IoT, AI, and cloud-based solutions in enhancing electricity theft detection. However, challenges such as real-time efficiency, security vulnerabilities, and cost-effectiveness still need further improvements.

III.PROPOSED SYSTEM

These proposed system leverages Internet of Things (IoT) for communication for electricity theft detection data to Electricity Board officials in real time. It predicts current and voltage by interacting with a micro-controller that connects to various sensors and detectors. This setup enables the system to identify and prevent electricity theft, ultimately reducing energy wastage and improving economic efficiency.

The system continuously monitors power, current, and voltage, calculating power consumption and notifying both the consumer and also EB via Internet. If an unusual load increase is detected, the system automatically reduces power

supply and sends a notification to the electricity board, displaying the message on an LCD screen. Any unauthorized load addition triggers a power cutoff, alerting both the electric board and the homeowner via Wi-Fi. Additionally, a buzzer alarm is activated to signal potential electricity theft, ensuring immediate attention.

To analyze energy consumption patterns, the system utilizes the Things peak application, which records average load usage, identifies excess load due to theft, and flags unauthorized usage. The Atmega328p based micro controller regularly assesses power parameters, ensuring continuous monitoring of electricity consumption and preventing fraudulent activities.

3.1. Modelling and Analysis

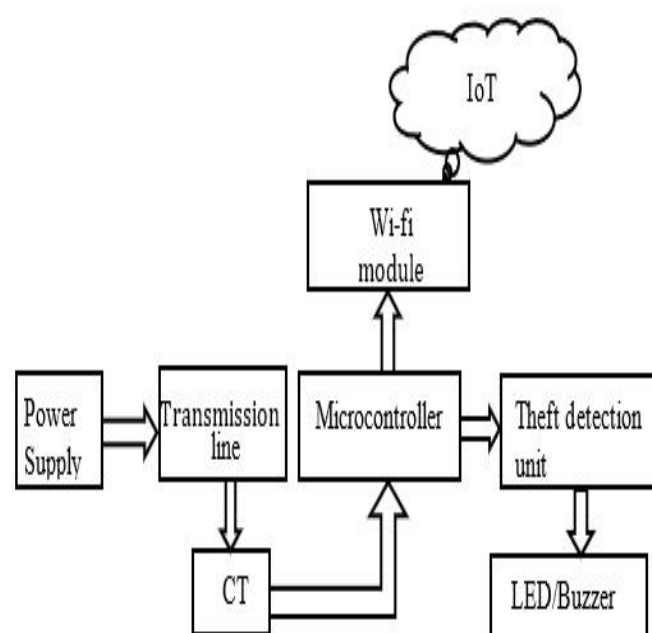


Fig. 1. Block Diagram of IoT based theft detection and monitoring.

Power Supply: An electrical device which delivers power to the load by converting incoming electric current into the appropriate frequency, voltage, and current for the system.

Transmission Line: A network of conductors designed to transport electrical signals from one location to another.

Current Transformer: The type of transformer reduces or amplifies the Alternating Current (AC) by generating a proportional current from the primary winding to the secondary winding.

Micro-controller: An embedded device that controls specific functions within a system. It processes data received from input/output peripherals using its central processor to execute commands.

Wi-Fi Module: Is known as a serial to Wi-Fi module, it plays a key role in the Internet of Things (IoT) transmission layer, enabling wireless data communication.

Theft Detection Unit: This module detects tampering with the meter, cuts off power supplys, and sends a theft alert to management system. It uses magnetic sensors to detect repeated tampering attempts.

LED (Light-Emitting Diode): A component that efficiently converts electrical energy into light without excessive heat generation, unlike traditional light sources that first convert electricity into heat before producing light..

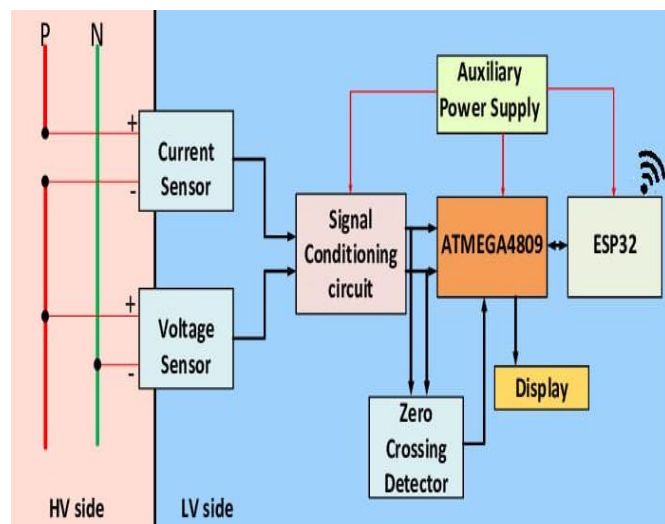


Fig. 2. Schematic circuit diagram

A. Things Speak

Thing Speak is an open source platform and API uses the HTTP protocols to the store and also retrieve data from the connected devices via Internet. It allows users to collect, analyze, and visualize data through a web browser. Thing Speak supports various applications, including sensor tracking, data logging, and IoT networking with real-time status updates.

Originally developed by IoT Bridge in year 2010 as service to support the IoT applications, these thing speak has since expanded to integrate with Math-Works' MATLAB. This integration allows users to do the process and visualize data by MATLAB without requiring separate license.

Thing Speak functionality fully integrated into the MATLAB documentation site. Users can log in to Thing Speak using their Math Works accounts, and the platform operates under Math Work steams of service and privacy policy.

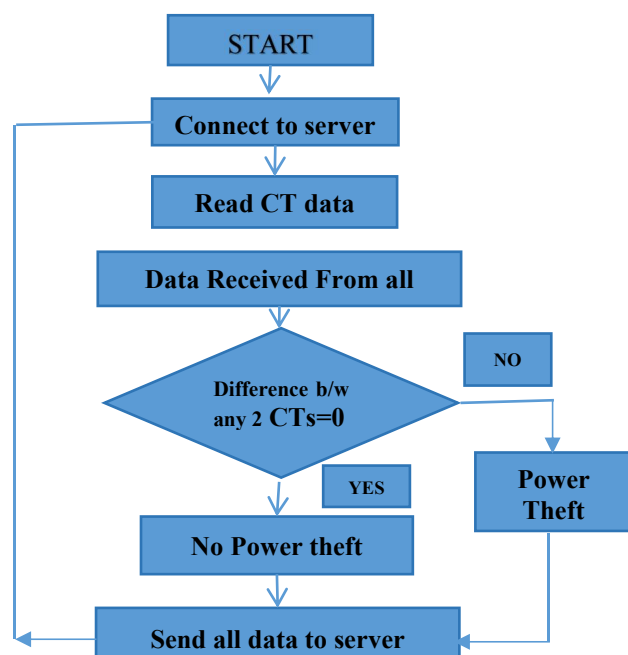


Fig. 3. Flowchart (Client side)

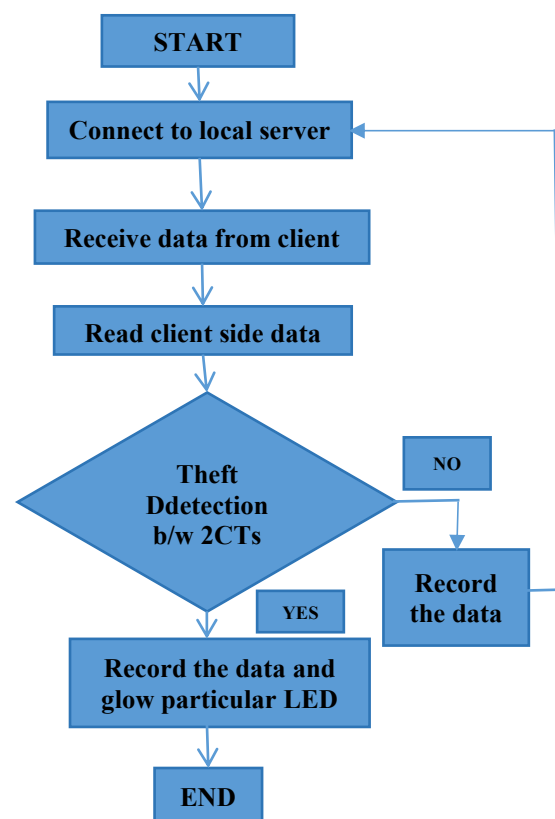


Fig. 4. Flowchart (Server side)

IV. RESULTS & DISCUSSION

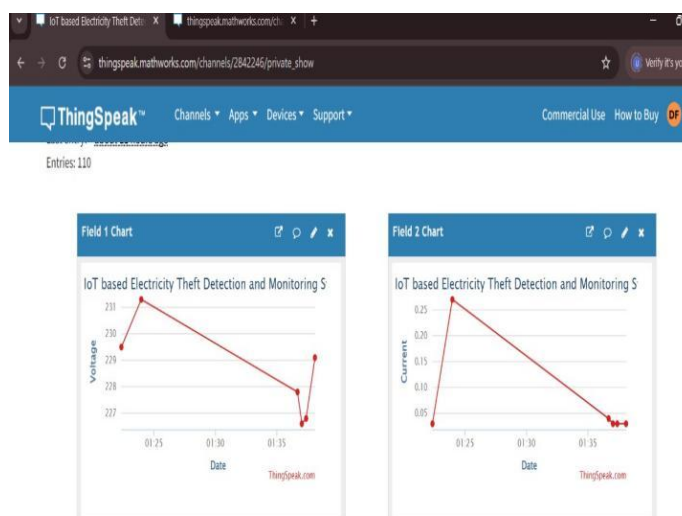


Fig. 5. Screenshot of the output (Current)

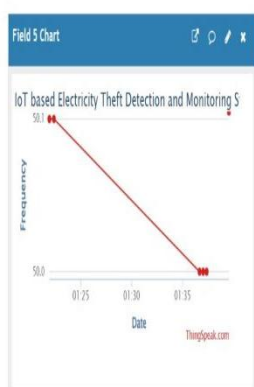


Fig:6.Screenshot of Frequency factor.

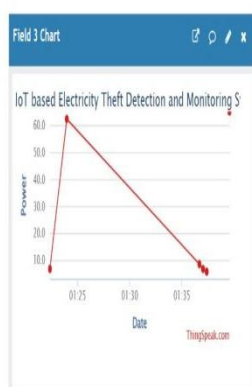


Fig:7. Screenshot of Power Factor.



Fig:8.Screenshot of Energy

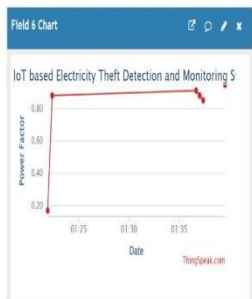


Fig:9.Screenshot of Power Factor

Fig. 5, shows that the current flowing through each pole which can be sensed by current sensor.

Fig. 6 shows that the theft detections between the two poles. We are provided logic here logic 1 shows thefts are detected and logic 0 shows there is no any theft between the any poles.

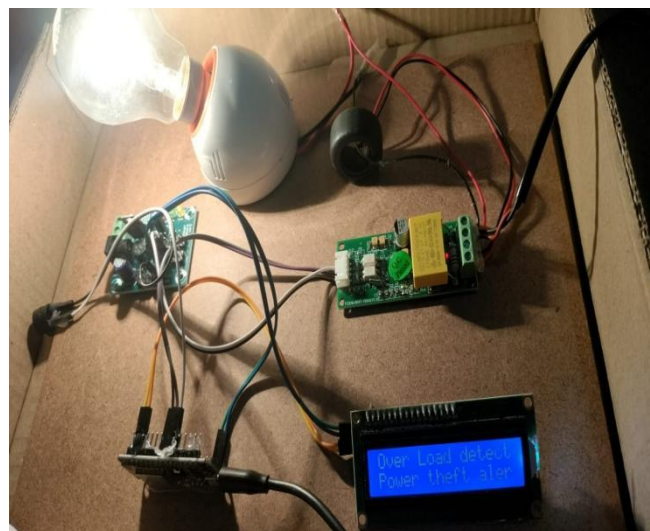


Fig. 10. The Hardware result of the theft detection.

V. CONCLUSION

The proposed system enables automated detection of electricity theft, eliminating the need for human intervention. It is capable of identifying faults on pole side of the distributions system and enhancing theft detection efficiency. Future implementations may include the integration of smart meters to further improve monitoring and control. By leveraging IoT technology, this system ensures real time data transmission and analysis. Additionally, the concept can be extended to domestic areas to prevent unauthorized electricity usage, promoting fair and efficient energy consumption.

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