IJARETY

International Journal of Advanced Research in Education and TechnologY (IJARETY)

Volume 12, Issue 2, March-April 2025

Impact Factor: 8.152

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE SJIF Scientific Journal Impact Factor

crossref

निस्केयर NISCAIR

International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 2, March-April 2025 ||

DOI:10.15680/IJARETY.2025.1202019

IOT based Electricity Power Theft Detection System

Prof. P.V. Shitole [1], Omkar Naik [2], Shravani Nikam [3], Jatin Pandhavale [4], Nupur Pote [5]

Department of Computer Engineering, AISSMS Polytechnic, Shivajinagar, Pune,

Maharashtra, India[1,2,3,4,5]

ABSTRACT: Electricity theft is a major problem that leads to significant financial losses for utility companies and can jeopardize the safety of electrical systems. In this paper, we introduce an innovative IoT-based electricity power theft detection system designed to tackle this issue effectively. Our system uses smart meters installed at customers' locations to monitor energy usage in real-time. These meters are connected to the internet, allowing them to send usage data to a central cloud-based server. Here, advanced data analysis techniques are applied to identify unusual consumption patterns that could indicate theft. For example, if a customer's usage suddenly spikes without a clear reason, the system flags it for further investigation. One of the key features of our system is its ability to learn from data. Using machine learning algorithms, it can improve its detection accuracy over time, adapting to normal usage trends and becoming better at spotting irregularities. When a potential theft is detected, the system generates immediate alerts, enabling utility companies to respond quickly and address the situation. In our trials, the IoT-based system showed a significant increase in identifying cases of electricity theft compared to traditional methods. This not only helps recover lost revenue for utilities but also promotes fair usage of electricity. Additionally, a user-friendly dashboard provides operators with valuable insights and visualizations, making it easier to monitor and manage energy consumption. Overall, this IoT solution represents a proactive step towards ensuring the integrity of electrical distribution networks, reducing losses, and fostering a more sustainable energy future. By harnessing the power of IoT technology, we can create a safer and more efficient energy landscape for everyone.

I. INTRODUCTION

Power theft, a significant issue in the energy sector, refers to the illegal consumption of electricity through unauthorized means, such as bypassing meters or tampering with electrical infrastructure. It is a major concern for utility companies, as it results in significant revenue loss, increased operational costs, and safety hazards. To combat power theft effectively, innovative technologies and detection systems have been developed. These systems rely on a combination of data analytics, sensor technologies, and machine learning algorithms to detect anomalies in energy consumption patterns. By identifying irregularities in real-time, power theft detection systems help utilities pinpoint fraudulent activities, reduce losses, and improve the overall efficiency of power distribution networks.

This approach not only helps in curbing theft but also ensures a fair distribution of electricity, minimizes environmental impact, and enhances customer satisfaction. In this context, the need for advanced, scalable, and robust power theft detection solutions has never been more critical. In recent years, technological advancements have revolutionized how power theft is detected and prevented. Traditional methods of identifying and addressing power theft were often reactive, based on routine inspections and physical checks. These methods were time-consuming, costly, and, in many cases, ineffective due to the sheer scale of the problem. The need for more efficient, proactive, and accurate systems has led to the development of modern power theft detection techniques. The integration of smart meters, remote sensing technologies, data analytics, and machine learning algorithms offers utilities the ability to identify fraudulent activities with greater precision and speed. This evolution of power theft detection technology is essential not only for reducing financial losses but also for improving the sustainability and integrity of power systems.

As the world transitions toward more advanced grids, such as smart grids and renewable energy-powered networks, the ability to detect power theft will become even more critical in maintaining a stable and reliable energy supply. Additionally, the push for energy conservation and carbon footprint reduction makes it vital to eliminate wasteful practices, such as power theft, that exacerbate the environmental impact of electricity production. For example, countries in South Asia, Africa, and Latin America have seen some of the highest rates of power theft. The scale of the problem can lead to an increased cost of electricity for legitimate consumers, as utilities are forced to recover their losses through higher tariffs. Additionally, power theft can create unfair disparities, as those who engage in theft benefit from free or reduced-cost electricity at the expense of paying customers

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 2, March-April 2025 ||

DOI:10.15680/IJARETY.2025.1202019

II. LITERATURE SURVEY

Paper	Review/Survey
Nitin K Mucheli, Umakanta It represents work has to be Nanda, D Nayak, P K Rout, done both for the hardware “Smart Power Thef Detection System”, 2019.	It represents work has to be done both for the hardware and software. The hardware includes the customized electric meter and the distributor box and the software includes the development of both website and mobile application.
Kuldeep Sharma, Malik, Isha, "An Arun Efficient IoT Based Electricity Detecting Framework Electricity Theft for Consumption", 2021.	It the proposed system discusses the features that can be added to the existing smart electric meter and observer contributors to non-technical losses are meter tampering and illegal connections.
Celimpilo Lindani Zulu, Oliver Dzobol, "Real-time power theft monitoring and detection system with double connected data capture system", 2023.	The principal gain of this device over the alternative systems proposed in advance is that the structures proposed formerly useful discover power theft but do no longer stop it

III. PROPOSED METHODOLOGY

The proposed methodology for an IoT-based electricity power theft detection system leverages advanced IoT technologies, data analytics, and machine learning algorithms to detect and prevent power theft in real-time. The system is designed to continuously monitor energy consumption through smart meters equipped with sensors to measure parameters like voltage, current, power factor, and power usage. These meters are connected to an IoT gateway, which aggregates the data and transmits it securely to a centralized cloud platform or local server for processing and analysis. The core of the system lies in the data analytics module, where historical consumption patterns are established using machine learning algorithms, creating baseline profiles for each consumer. The system continuously compares real-time data against these baseline patterns to detect anomalies such as sudden drops or spikes in power usage, which could indicate potential theft or meter tampering. For instance, a sudden drop in consumption may suggest bypassing the meter, while irregular spikes might signal unauthorized usage. Once an anomaly is detected, the system generates real-time alerts, notifying utility providers with detailed information about the location and nature of the irregularity. These alerts are accessible via a mobile or web-based monitoring interface, enabling utility staff to respond quickly and investigate potential theft. The methodology also includes continuous data collection, preprocessing, and periodic updates to the machine learning models to adapt to changing consumption patterns. By combining real-time monitoring, intelligent anomaly detection, and automated alerts, the IoT-based system significantly reduces the risk of power theft, improves operational efficiency, and ensures accurate billing, all while enhancing safety by preventing tampering-related hazards.

IV. SYSTEM ARCHITECTURE

The sensors for measuring current, voltage, and power consumption. Consider factors like accuracy, cost, and environmental conditions. Communication network: Design a reliable communication network (e.g., WiFi, cellular) to transmit sensor data to a central monitoring system. • Data processing and Analysis: Develop algorithms and models to analyze sensor data and detect anomalies indicative of power theft. Alert System: Implement a mechanism to trigger alerts or notifications when suspicious activity is detected

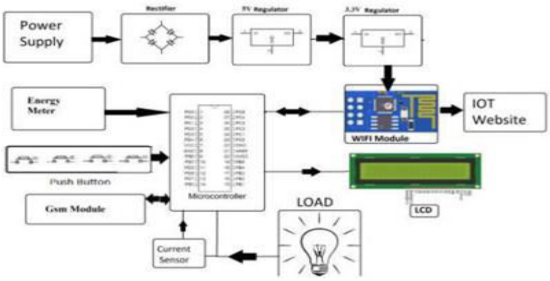


Fig 4.1 Circuit diagram

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 2, March-April 2025 ||

DOI:10.15680/IJARETY.2025.1202019

1. Microcontroller
   NodeMCU ESP32**:** A microcontroller board based on the ESP32 chip, which integrates Wi-Fi and Bluetooth connectivity. It's used for programming and controlling the entire system.

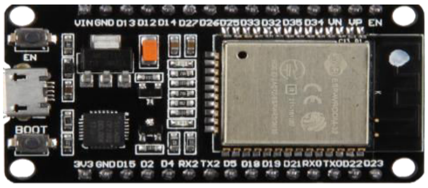


Fig 4.2 NodeMCU ESP32

2. Display
   LCD 16x2 I2C: A liquid crystal display that shows text and numbers. The I2C interface allows for easy communication with the microcontroller It consists of 16 columns and 2 rows, meaning it can display up to 32 characters at a time. The "I2C" part refers to the communication protocol used to control the display, which makes it more convenient compared to traditional LCDs that require multiple control pins. With I2C (Inter-Integrated Circuit), the LCD only needs two wires (SDA for data and SCL for clock) to communicate with a microcontroller (like an Arduino or Raspberry Pi), significantly reducing the number of pins needed for connection. This is ideal for projects with limited I/O pins or when a compact setup is desired.

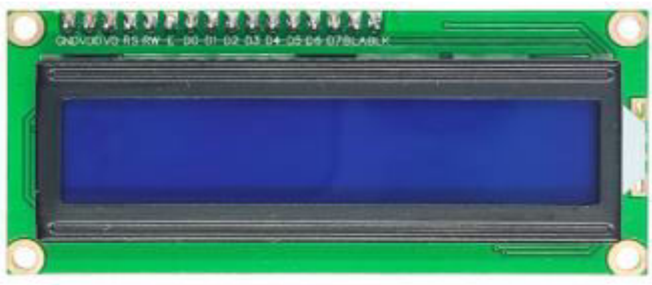


Fig.4.3 LCD 16x2 I2C

3. Communication
   GSM800L: A GSM module that allows for cellular communication, enabling the system to send SMS alerts or connect to the internet. This module allows microcontrollers (like Arduino or Raspberry Pi) to send and receive data via SMS (Short Message Service), make voice calls, and connect to the internet using GPRS (General Packet Radio Service). The GSM800L module operates on the 850/900/1800/1900 MHz frequency bands, making it suitable for use in many regions around the world. It communicates with the microcontroller through a serial interface (UART), sending and receiving data over a simple connection. This module requires a SIM card (like those used in mobile phones) for cellular network access. Common applications of the GSM800L module include remote monitoring systems, home automation, GPS tracking, and emergency alert systems.

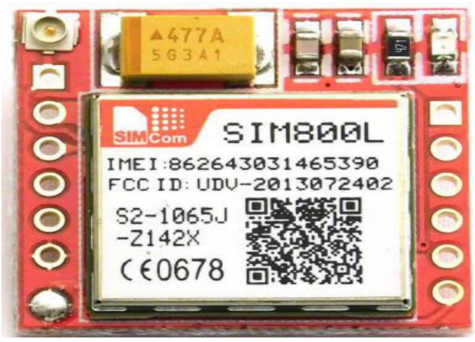


Fig 4.4 GSM800L

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 2, March-April 2025 ||

DOI:10.15680/IJARETY.2025.1202019

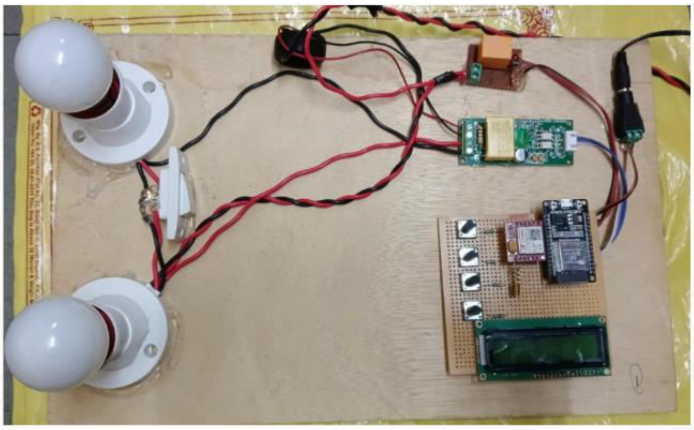
4. Sensor
   PZEM-004T Sensor: A three-phase energy metering sensor that measures voltage, current, power, and energy consumption. It communicates with the microcontroller via serial communication. The PZEM-004T communicates with microcontrollers (such as Arduino or ESP8266/ESP32) via the UART (serial) interface, making it easy to integrate into various projects. It is capable of measuring voltage in the range of 80V to 260V, current up to 10A, and power up to 2.2 kW. Additionally, it provides data on energy consumption in kilowatt-hours (kWh), helping users track the energy usage over time.

V. SOFTWARE IMPLEMENTATION

1.BLYNK APPLICATION:
Blynk is a popular Internet of Things (IoT) platform that allows users to easily build mobile applications to control and monitor their hardware projects remotely. It provides a simple way to create custom apps for controlling devices like lights, motors, sensors, and more using your smartphone or tablet.Blynk works by connecting your hardware (like an Arduino, Raspberry Pi, or ESP8266/ESP32) to the Blynk app via the internet, typically using Wi-Fi, Bluetooth, or cellular networks. The platform offers a drag-and-drop interface, so users can add buttons, sliders, graphs, and other widgets to their Blynk mobile app to control or display data from their hardware. This makes it beginner-friendly while also being powerful enough for more advanced users.

Fig 5.1 BLYNK

VI. PROJECT OUTCOME



| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 2, March-April 2025 ||

DOI:10.15680/IJARETY.2025.1202019

VII. RESOURCES

1. Nodemcu esp32
2. Pzem 004t sensor
3. Lcd 16x2 i2c
4. Push button
5. Pcb board 4x4
6. Gsm800l
7. Bulb holder
8. Bulb
9. 5v 1amp dc adaptor

VIII. CONCLUSION

The proposed IoT-based smart energy meter with theft detection capabilities offers a promising solution to combat electricity theft while providing users with real-time monitoring of their energy consumption. By integrating advanced technologies, this project aims to enhance operational efficiency for utility providers and promote fair billing practices.

REFERENCES

[1] Nitin K Mucheli, Umakanta Nanda, D Nayak, P K Rout, "Smart Power Theft Detection System", 2019.
[2] Rekha. R. Patil, Shwetha, Thrupthi, Vaishnavi. S. Shetty, "Power Theft Detection using GSM", 2019.
[3] Kuldeep Sharma, Arun Malik, Isha, "An Efficient IoT Based Electricity Theft Detecting Framework For Electricity Consumption", 2021.
[4] Celimpilo Lindani Zulu, Oliver Dzobo1, "Real-time power theft monitoring and detection system with double connected data capture system", 2023.
[5] Ankit Gola, P.Swamit Simha, Prakash Sharma, Prashant Dutta, "A study of Power Theft Detecting and Metering in Power Distribution", 2024.
[6] R. M. Mutupe, S. O. Osuri, M. J. Lencwe and S. P. Daniel Chowdhury, "Electricity theft detection system with RF communication between distribution and customer usage," IEEE PES Power Africa, Accra, 2017, pp. 566-572.
[7] R. E. Ogu and G. A. Chukwudebe, "Development of a cost-effective electricity theft detection and prevention system based on IoT technology," IEEE International Conference on Electro-Technology for National Development (NIGERCON), Owerri, 2017, pp. 756-760.
[8] A. S. Metering, S. Visalatchi and K. K. Sandeep, "Smart energy metering and power theft control using Arduino & GSM," 2nd International Conference for Convergence in Technology (I2CT), Mumbai, 2017, pp. 858-96.
[9] M. U. Hashmi and J. G. Priolkar, "Anti-theft energy metering for smart electrical distribution system", in 2015 International Conference on Industrial Instrumentation and Control (ICIC), Pune, 2015, pp.1424-25.
[10] Y. Tawaragi, "Power theft inspection apparatus and method, and recording medium," U.S. Patent 14/593,160, 2015.
[11] M. Singh and E. V. Sanduja, "Minimizing Electricity Theft by Internet of-Things," International Journal of Advanced Research in Computer and Communication Engineering, Vol. 4(8), pp.326-329, 2015.

IJARETY

INNO SPACE
SJIF Scientific Journal Impact Factor

International Journal of Advanced Research in Education and Technology

ISSN: 2394-2975 Impact Factor: 8.152

www.ijarety.in editor.ijarety@gmail.com