International Journal of Sciences and Innovation Engineering

(Peer-Reviewed, Open Access, Fully Refereed International Journal)

website: ***www.ijsci.com***
Vol.02 No.04. P. 75-80

E-ISSN : 3049-0251
DOI: https://doi.org/10.70849/ijsci

Power Theft Detection and Protection Using IOT

Rachana Patil[*1], Shrutika Rahane[*2], Pranjali Dhanokar[*3], Pratiksha Sapate[*4], Rutuja Hage[*5]

[*1]*Assistant Professor, Electronics and Telecommunication Department, Mauli Group Institutions' College of Engineering and Technology Shegaon, Maharashtra*

[*2,3,4,5] *Electronics and Telecommunication Department, Mauli Group Institutions' College of Engineering and Technology Shegaon, Maharashtra*

Article Info

Article History:
(Research Article)

Published:30 APR 2025

Publication Issue:
Volume 2, Issue 4
April-2025

Page Number:
75-80

Corresponding Author:
Pranjali Dhanokar

Abstract:

Power theft is a significant threat to the power industry, causing heavy financial losses and threats to infrastructure and public safety. This project proposes an IoT-based Power Theft Detection and Protection System that constantly tracks electricity consumption, identifies unauthorized entry or manipulation, and sends alerts in real time.

Wherever there is theft or short circuit detection, the system shows a distinct "Theft Detected" notification, triggers a siren or buzzer based on the type of fault, and provides real-time alerts to the control room through IoT communication. All these features provide for instant awareness and quicker response. Through the integration of automation, real-time monitoring, and remote reporting, the system increases security, lessens manual intervention, and enhances the transparency and credibility of power distribution. The intelligent solution is a move towards curbing energy theft and grid infrastructure modernization.

Keywords: power theft, iot (internet of things), real-time monitoring, smart grid, unauthorized usage, short circuit detection, automated alerts, centralized control, data logging, alarm system, remote notification, energy security, embedded system

1. Introduction

Power is an essential commodity in contemporary society, but electricity theft is a serious problem, especially in third-world countries. It leads to significant economic loss, system instability, voltage drop, and even blackouts in extreme situations. Conventional theft detection techniques like manual checks and audits are slow, time-consuming, and incapable of real-time monitoring, with the result that theft can persist for a long time without detection. Besides, existing systems frequently do not provide local notifications, sound alarms, and short-circuit detection capability, compromising both security and safety. They are also hardly ever connected to central monitoring systems, restricting coordinated reactions.

In an effort to mitigate these drawbacks, the IoT-based Power Theft Detection and Protection System proposed herein introduces a number of significant advancements. It allows for real-time monitoring of electrical consumption, automatically recognizing anomalies pointing towards theft or faults. On detection, it shows a "Theft Detected" message on site and sets off either a siren or a buzzer differentiating between theft and short circuits. The system even sends automatic signals to the control room or the electricity board for prompt response by authorities. As it has internal automation, it can act on its own by immediately disconnecting power to save further loss. In addition, the system records all events for historical analysis to enable utility providers to detect trends in theft, streamline grid management, and plan long-term infrastructure more effectively. This intelligent, proactive strategy dramatically enhances the efficiency, safety, and reliability of power distribution networks

Problem Statement

Power theft is a common problem that causes great economic losses, power imbalances, and safety risks in electricity distribution systems, particularly in developing nations. The conventional methods of detection, based on manual checkups and lagged reporting, are inefficient, time-consuming, and frequently cannot identify unauthorized consumption in real-time. Moreover, these systems do not have features like automated alerts, local notifications, and short circuit detection, leading to delayed responses and higher risk to infrastructure and public safety. There is an urgent need for a smart, automated, and real-time solution that can efficiently detect power theft and electrical faults while ensuring rapid communication with utility authorities. This project seeks to overcome these issues by creating an IoT-based system that improves the accuracy, speed, and reliability of power theft detection and protection.

Objective

- To identify power theft in real-time via IoT-integrated sensors and monitoring systems.
- To send instant alerts via visual indicators and audio signals on detection of unauthorized use of electricity.
- To make a discrimination between power theft and short circuits by employing different alarm systems (siren for theft, buzzer for faults).
- To automatically inform authorities or control rooms for prompt response and action.
- To facilitate centralized monitoring of power distribution and theft incidents through IoT communication.
- To minimize manual inspection work by automating detection and reporting functions.
- To record and analyze past data for detecting theft patterns and enhancing future prevention measures.
- To increase the safety, efficiency, and transparency of the electrical power distribution system.

2. Literature Review

1) Arduino-Based Power Theft Protection and Detection (2023)

Arduino-based solutions utilize IoT technology, such as microcontrollers (e.g., Arduino Uno), current sensors (ACS712), and Wi-Fi modules (ESP8266/NodeMCU) to identify power theft through detection of anomalies in energy usage. The system provides remote disconnection notification to suppliers and enables consumers to track their consumption in real time. The methodology enhances energy efficiency and revenue protection but relies on sensor quality and communication infrastructure.

2) Real-Time Detection of Power Theft Using Edge Computing (2023)

Edge computing facilitates real-time processing of data from smart meters, enhancing detection speed and accuracy and minimizing cloud data transmission. This technique assists utilities in detecting power theft in real-time, minimizing energy losses, and improving grid reliability. Machine learning integration can further enhance detection and evolve to accommodate new theft patterns.

3) Deep Learning and Smart Meter Data for Power Theft Detection (2022)

By employing deep learning algorithms on smart meter data, this system detects usage patterns and theft with high precision. Deep learning models, with large datasets, can identify anomalies and learn to adapt to changing theft patterns. This approach provides improved detection and increased security.

4) Power Theft Protection with Smart Grids and AI (2021)

Smart grids embedded with AI scrutinize power usage patterns to identify theft. Machine learning detects anomalies in usage, allowing rapid responses to irregularities. This enhances security, eliminates energy loss, and encourages grid stability, though issues around data quality and scalability persist.

3. Methodology

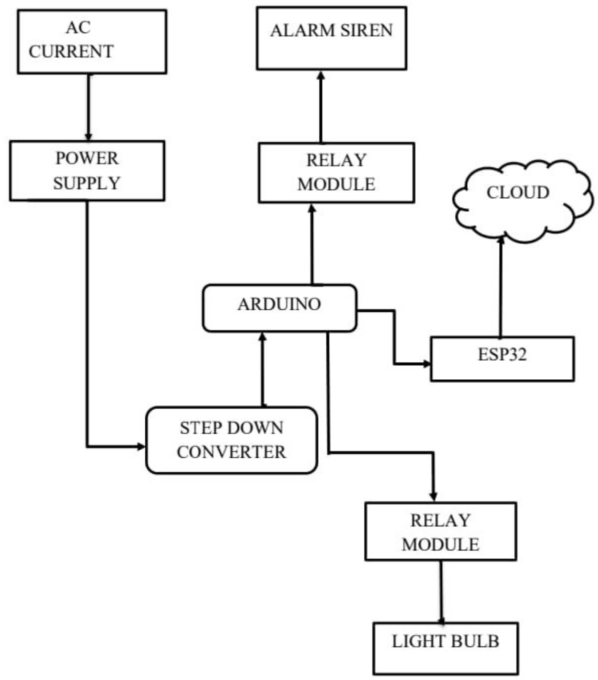

Fig.3.1: Block Diagram.

This system employs an Arduino and ESP32 to track and manage energy consumption. AC power is reduced to power the components. The Arduino gathers voltage/current information and manages a relay for a light bulb and alarm siren, triggering alarms in the event of faults (e.g., surges). The ESP32 is connected to the cloud, allowing real-time monitoring, data logging, and remote control. It also manages a second relay for load management. Together, Arduino manages local processing, and ESP32 provides remote access, so the system is well-suited for smart homes or industrial automation.

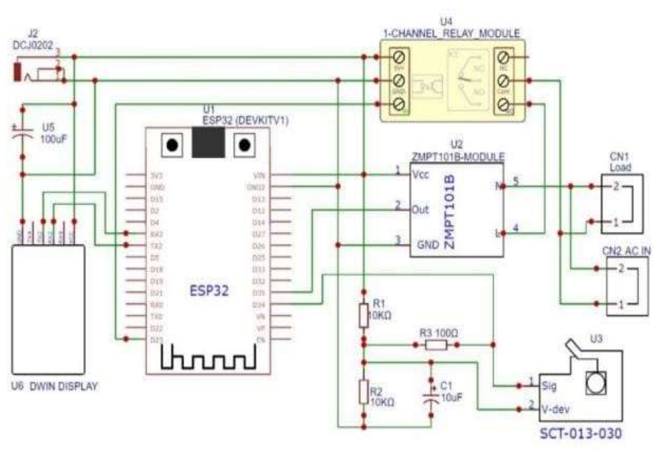

Fig.3.2: Circuit Diagram

This diagram shows a smart energy monitoring and control system based on the ESP32 microcontroller. The central element of the system is the ESP32 (U1), acting as the processor. It accepts Analog input from voltage and current sensors, performs processing, and controls an AC load through a relay. The voltage sensing is achieved via the ZMPT101B voltage sensor module (U2), which is directly connected to the AC input lines. This module provides an Analog voltage signal that is proportional to the AC mains voltage, which is read by the ESP32 through one of its ADC (Analog-to-Digital Converter) pins. Current sensing is achieved via a non-invasive current sensor, the SCT-013-030 (U3), which wraps around a single AC line. The sensor produces a small Analog voltage signal that is proportional to the current, which is fed through a burden resistor (R3) and filtered by a capacitor (C1) to give a stable input to the ESP32. Two other resistors (R1 and R2) are employed as a voltage divider to reduce the input signal to the range acceptable by the ADC of the ESP32.

A single-channel relay module (U4) is employed to switch an AC load (connected at CN1). The relay is driven by a digital output pin of the ESP32, enabling the microcontroller to switch the load on or off depending on electrical parameters being measured or user input. The relay also offers electrical isolation between the low-voltage control circuit and the high-voltage AC circuit for safety. The system also contains a DWIN display module (U6), which is connected with the ESP32 through serial communication lines (TX2/RX2). The display will be used as a user interface to display real-time voltage, current, and power values, and possibly to enable interaction with the system, e.g., setting threshold limits or the relay on/off. Power to the system is provided by means of a DC jack (J2), and there is also a 100μF capacitor (U5) provided for stabilization of input voltage and removal of noise. Generally, the given setup makes real-time observation of energy consumption and smart control of electrical loads possible, so it is useful in smart home or industrial control applications.

4. Result Analysis

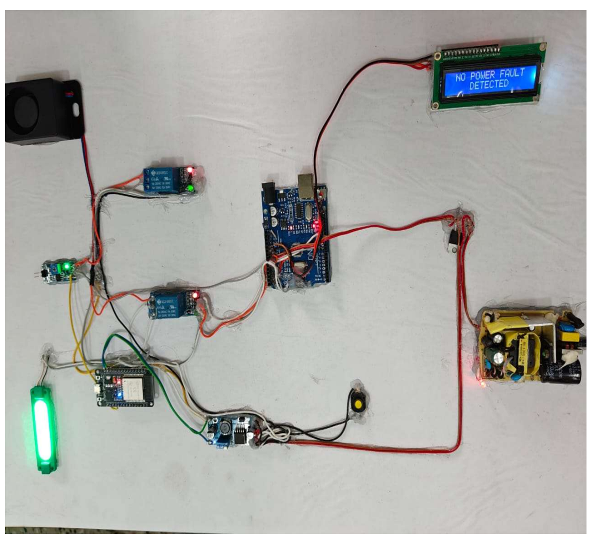

Fig 3.3 Power theft detection and protection

This system employs Arduino UNO and ESP32 to sense AC power and detect faults. Arduino is responsible for local monitoring through sensors, showing status on a 16x2 LCD, and controlling a relay to activate an alarm siren during faults. ESP32 provides cloud connectivity, controls a relay for load control, and powers a green indicator to indicate normal operation. A step-down converter supplies low-voltage components, and a power supply unit powers the entire system. The configuration provides real-time notifications through LCD, LEDs, and alarm, making it suitable for industrial fault detection and smart homes.

5. Conclusion

Power theft detection and protection is an important part of ensuring the reliability and efficiency of energy distribution systems. The use of advanced technologies like smart grids, artificial intelligence, and machine learning has transformed how utilities respond to energy theft detection and prevention. These systems provide better accuracy, real-time detection, and greater security, allowing utilities to proactively respond to energy theft and safeguard revenue. As the energy scenario keeps changing, the creation of more advanced power theft detection and protection systems will be critical in fostering a safe and efficient energy environment. With these technologies, utilities can mitigate energy losses, enhance grid stability, and ensure a greener future for power distribution.

Future Scope

The future of power theft detection is fuelled by technologies such as AI, ML, IoT, and blockchain. These technologies will improve detection precision, facilitate real-time monitoring, and provide secure energy transactions. Predictive maintenance and analytics will prevent faults from happening in the first place. With increasing adoption, these systems will minimize energy losses, safeguard revenue, and enhance grid stability. Global standards will further enhance efficient implementation and security in the energy industry.

References

1. Pawar, B., Baste, V., Khot, A., & Jadhav, V. (2024). Design and implementation of an IoT-based power theft detection system using sensor networks. Journal of Semiconductor Devices and Circuits. https://journals.stmjournals.com/josdc/article=2024/view=167741
2. Gawas, M. A., Wale, P. P., Gavade, R. P., Mujawar, S. J., & Mali, P. S. (2020). IoT things based power theft analyzer & detection. International Journal of Engineering Research & Technology (IJERT). https://www.ijert.org/iot-things-based-power-theft-analyzer-detection
3. Karajagi, S. P., Vedpathak, M. M., Waghmare, O. D., Birajdar, B. H., & Swamy, S. S. (2024). IoT-based smart energy meter monitoring with theft detection. JournalNX, 10(5). https://repo.journalnx.com/index.php/nx/article/view/5355
4. Gill, T. S., Shehwar, D. E., Memon, H., & Zaidi, S. S. H. (2021). IoT based smart power quality monitoring and electricity theft detection system. 2021 IEEE International Conference on Emerging Technologies (ICET). https://www.researchgate.net/publication/358326718
5. K., R., V., P., & M., K. (2021). Power theft detection and alert system using IoT. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12(10), 4302–4308. https://turcomat.org/index.php/turkbilmat/article/view/4302
6. Patil, D., Sutar, V., Waychal, P., More, R., & Sachane, M. N. (2021). Electricity theft detection & notification using IoT. International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 10(5), 178–183. https://ijarcce.com/papers/electricity-theft-detection-notification-using-iot/
7. Swapna, N., & Reddy, V. S. (2024). IoT enabled power theft detection system. CVR Journal of Science and Technology, 25(1). https://cvr.ac.in/ojs/index.php/cvracin/article/view/885
8. Malik, P., Banerjee, I., Yadav, A., Shaw, N., & Patidar, A. (2023). Spatio-temporal graph neural networks for real-time energy theft detection in smart grids. International Journal of Modern Developments in Engineering and Science. https://journal.ijmdes.com/ijmdes/article/view/231
9. Mohammadi Rouzbahani, H., Karimipour, H., & Lei, L. (2021). An ensemble deep convolutional neural network model for electricity theft detection in smart grids. arXiv preprint arXiv:2102.06039. https://arxiv.org/abs/2102.06039
10. Finardi, P., Campiotti, I., Plensack, G., Derradi de Souza, R., Nogueira, R., Pinheiro, G., & Lotufo, R. (2020). Electricity theft detection with self-attention. arXiv preprint arXiv:2002.06219. https://arxiv.org/abs/2002.06219

11. Hu, W., Yang, Y., Wang, J., Huang, X., & Cheng, Z. (2020). Understanding electricity-theft behavior via multi-source data. arXiv preprint arXiv:2001.07311. https://arxiv.org/abs/2001.07311
12. Alameady, M. H., Albermany, S., & George, L. E. (2022). Energy theft detection and preventive measures for IoT using machine learning. Mathematical Statistician and Engineering Applications, 71(3s3), 155–168. https://doi.org/10.17762/msea.v71i3s3.357
13. Patil, D., Sutar, V., Waychal, P., More, R., & Sachane, M. N. (2021). Electricity theft detection & notification using IoT. International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 10(5), 178–183. https://ijarcce.com/papers/electricity-theft-detection-notification-using-iot/
14. Ullal, B. S., Kumar, P., Rakshith, G. N., Sachith, B., & Varun, K. N. (2023). Power monitoring and theft detection system. International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 12(4), 498–502. https://ijarcce.com/papers/power-monitoring-and-theft-detection-system/
15. Patil, D., Sutar, V., Waychal, P., More, R., & Sachane, M. N. (2021). Electricity theft detection & notification using IoT. International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 10(5), 178–183. https://ijarcce.com/papers/electricity-theft-detection-notification-using-iot/