

IoT Based Electric Power Theft Detection and Prevention System Using NodeMCU

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Abstract: Electricity theft remains a major issue in the power sector, causing huge financial losses and affecting the efficiency of energy distribution. To address this problem, this project proposes a Smart Energy Theft Detection and Reporting System using NodeMCU (ESP8266) and the Internet of Things (IoT). The system employs an ACS712 current sensor to measure current consumption and compare it with the expected load. When any abnormal or unauthorized usage is detected, the microcontroller identifies it as a theft condition and automatically operates a relay to disconnect the power supply. Simultaneously, the status is updated on a web server through Wi-Fi, enabling remote and real-time monitoring by authorities. This automated approach reduces human intervention, improves transparency, and ensures reliable energy management. The proposed system thus provides an efficient, low-cost, and scalable solution for controlling power theft in modern smart grids.

Keywords: Power Theft Prevention, Intelligent Energy Tracking, IoT-Based Monitoring System, NodeMCU Module.

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I. INTRODUCTION

Electricity theft is a serious issue that results in major financial losses and reduced power quality in distribution systems. To overcome this problem, the project introduces an IoT-based Smart Energy Theft Detection and Reporting System using the NodeMCU. The system continuously monitors and compares incoming and outgoing power values to detect abnormal variations. When theft is identified, it immediately sends a real-time alert through Wi-Fi and disconnects the power supply using a relay, ensuring efficient, reliable, and automated energy management.

II. LITERATURE SERVEY

Numerous studies have focused on minimizing electricity theft through automated detection systems and wireless communication methods.

In 2013, Sagar Patil, Gopal Pawaskar, and Kirtikumar Patil developed a project titled “*Electrical Power Theft Detection and Wireless Meter Reading*.” Their design followed the Input–Output comparison technique by placing two meters—one at the distribution pole and another at the consumer end. A microcontroller continuously analyzed both readings, and if the difference exceeded allowable line losses, theft was identified. The system also supported Wireless Meter Reading (WMR), which reduced manual meter

checking and enhanced efficiency.

Later, in 2022, Goutam Barma, K. Naresh, Muddasani Chanukya Reddy, and G. Upendar introduced “*Wireless Power Theft Monitoring System in Power Lines*.” Their model used IoT technology with an Arduino Uno and current transformers (CTs) to monitor current at two different points. Any variation between the CT readings signaled unauthorized consumption. The IoT-based setup enabled continuous monitoring and rapid detection of theft activities.

III. METHODOLOGY

The system employs the NodeMCU with an ACS712 sensor to continuously measure line current. The controller evaluates the sensed data against a preset limit to identify irregular conditions. When unauthorized usage is detected, it disconnects the load through a relay and sends real-time notifications via Wi-Fi.

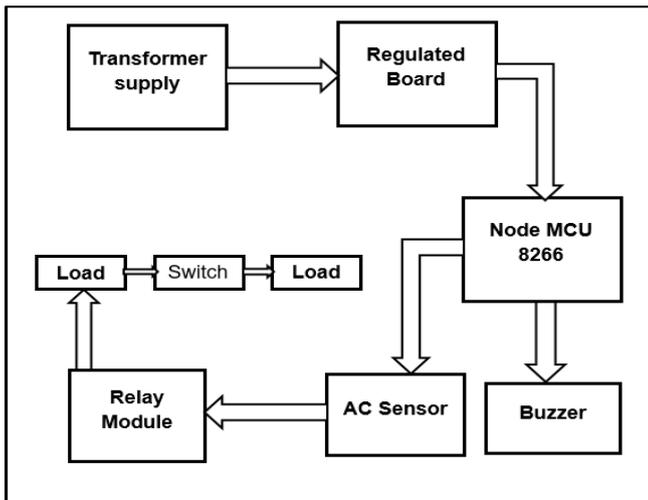


Fig 1 Methodolog

IV. HARDWARE DESCRIPTION

➤ Step-Down Transformer

The transformer converts 230V AC mains supply to 12V AC. It provides electrical isolation and ensures safe voltage levels for the electronic circuit.

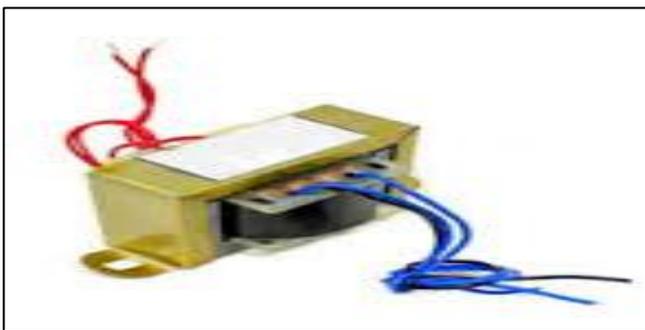


Fig 2 Stepdown Transformer

➤ Regulated Board

The regulated power supply board converts AC to stable DC voltage. It includes rectifier diodes, filter capacitors, and voltage regulators to remove ripples and provide constant DC output required for electronic components.

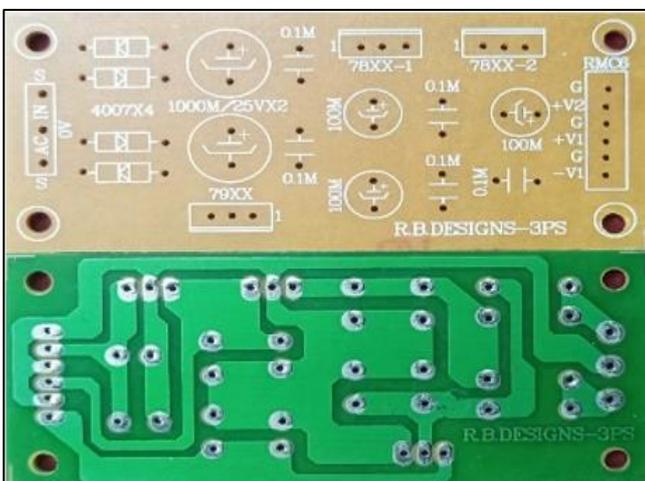


Fig 3 Regulated Board

➤ Node MCU

The NodeMCU is a Wi-Fi-enabled microcontroller used to process sensor data, compare current values, control the relay and buzzer, and send real-time updates to a web server.

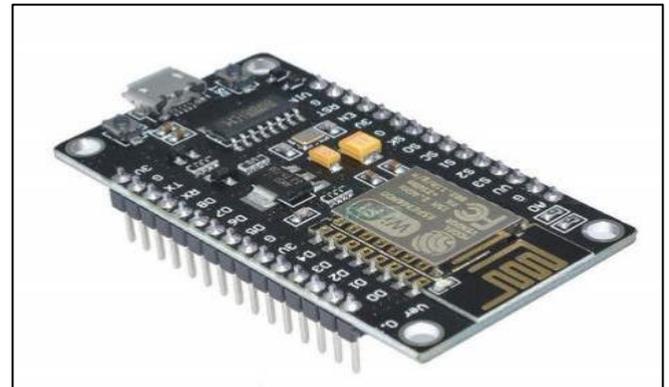


Fig 4 NodeMCU

➤ AC Sensor

The ACS712 current sensor measures AC current using the Hall Effect principle. It provides an analog output voltage proportional to the current flowing through the conductor, enabling safe and isolated monitoring.



Fig 5 AC Sensor

➤ Buzzer

A buzzer is an electronic sound device that produces an audible alert when theft or overload is detected, providing immediate local indication.



Fig 6 Buzzer

➤ Relay Module

A relay module acts as an electrically operated switch. It allows the low-power NodeMCU to control and disconnect the high-voltage load during theft conditions.

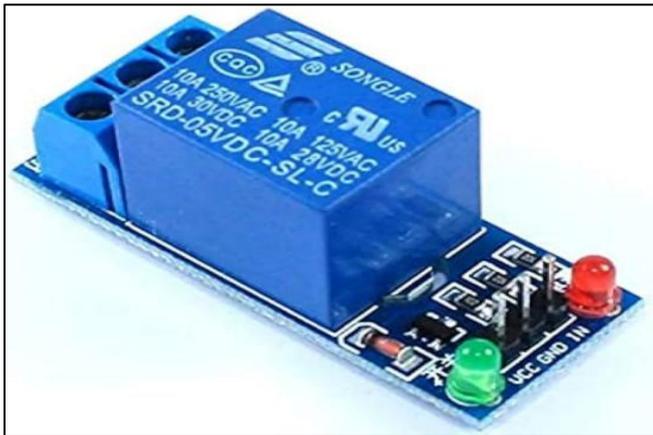


Fig 7 Relay Module

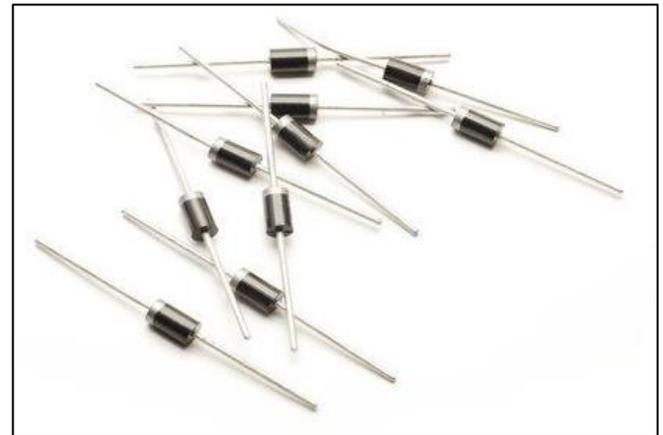


Fig 10 Diode

➤ *Load As Bulb*

The bulb acts as a resistive load in the prototype model. It demonstrates normal and theft conditions by drawing measurable current.

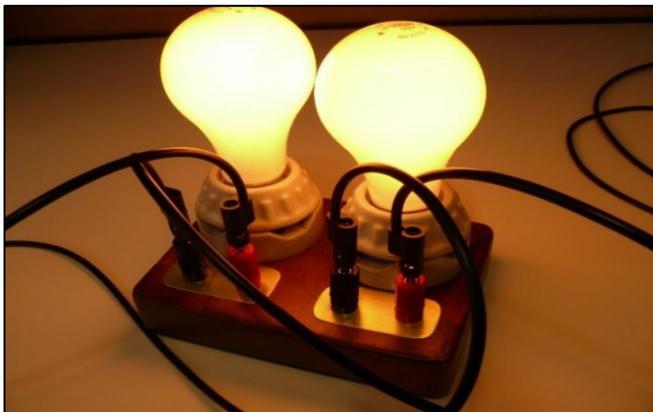


Fig 8 Bulb

➤ *Capacitor*

A capacitor stores electrical energy and filters unwanted ripple in DC supply. It smooths voltage fluctuations in power supply circuits.

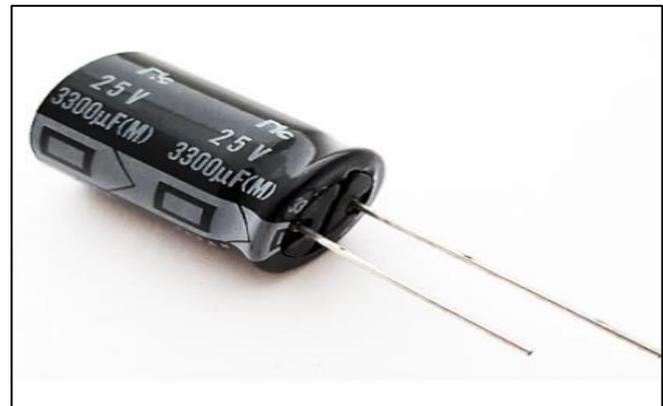


Fig 11 Capacitor

➤ *Switch*

A switch is a mechanical device used to manually turn the circuit ON or OFF by opening or closing the electrical path.



Fig 9 Switch

➤ *Diode*

A diode allows current to flow in only one direction. It is mainly used for rectification, converting AC into DC and protecting circuits from reverse polarity.

V. SOFTWARE IMPLIMENTATION

The proposed system software is designed using the Arduino IDE and embedded into the NodeMCU through C/C++ programming. Initially, the controller configures ADC channels, GPIO pins, Wi-Fi connectivity, and threshold parameters. The ACS712 sensor continuously provides analog signals representing line current, which are processed and converted into measurable values. A decision-making algorithm evaluates these readings to detect irregular conditions. If theft is identified, the relay disconnects the load, the buzzer activates, and real-time data is updated on a web interface via Wi-Fi.

➤ *Experimental Setup*

The experimental arrangement includes a NodeMCU connected to an ACS712 current sensor, relay module, step-down transformer, and bulb loads mounted on a base board. The setup is wired to simulate normal and theft conditions. It enables real-time current monitoring, automatic load disconnection, and wireless status updates through Wi-Fi for performance evaluation.

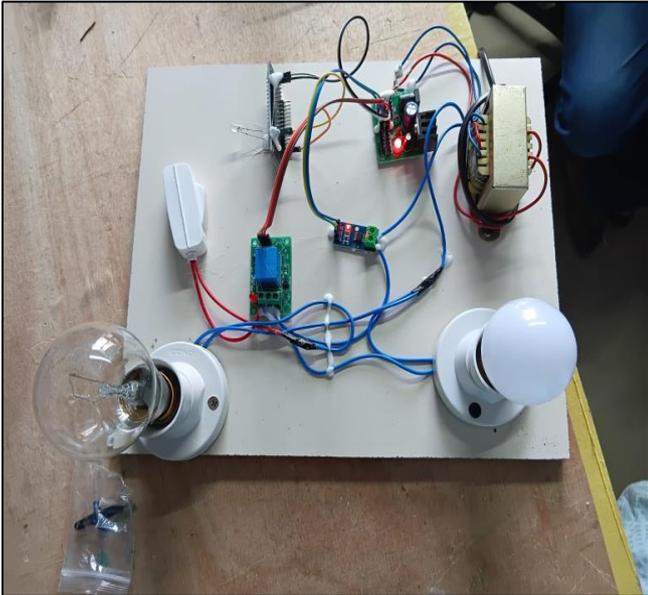


Fig 12 Prototype Model

Journal of Innovations in Engineering and Technology, 2022.

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VI. FUTURE SCOPE

The system can be extended to a three-phase network for industrial use. Integration with cloud storage and centralized servers will enable large-scale monitoring and data analysis. Long-range communication using LoRaWAN and GSM modules like SIM800 can support remote alerts, relay control, and reliable wide-area deployment.

VII. CONCLUSION

The proposed system demonstrates that a cost-effective IoT solution using the NodeMCU can efficiently replace traditional manual inspection methods for electricity theft detection. Experimental results confirm accurate real-time monitoring and reliable identification of unauthorized usage. When abnormal current variations occur, the system immediately sends a wireless alert and disconnects the load through a relay. This rapid response reduces energy losses, prevents continuous theft, and enhances revenue protection and operational efficiency.

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