Smart Domestic Electricity Theft Detection and Avoidance System

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Abstract: The rapid expansion of the Internet of Things (IoT) has provided a fertile ground for innovative solutions in the realm of home security, with a primary focus on theft detection. This thesis presents an in-depth study and practical implementation of a Smart Domestic Electricity Theft Detection and Avoidance System, leveraging IoT technology to safeguard residential premises against the unauthorized consumption of electrical power, specifically emphasizing non-monitored loads. The system is meticulously engineered to monitor and analyze critical electrical parameters at two pivotal locations: the point of electrical distribution (PMT) and within designated houses, where non-monitored loads can pose a significant risk. The thesis explores the system's design, implementation, and data analysis phases, spotlighting its ability to efficiently detect theft events, thereby offering substantial insights into the identification of non-monitored load discrepancies. This research not only contributes to the burgeoning field of IoT-based home security but also underscores the practicality of utilizing IoT technology to combat electrical power theft, with particular attention to non-monitored loads. Importantly, the project aims to protect utility service providers' resources, reduce losses due to theft, and ultimately contribute to more cost-effective electricity rates for consumers, all while enhancing home security in the age of IoT. This innovative system provides a powerful tool for both service providers and consumers, not only in reducing financial losses but also in ensuring a more secure and efficient use of electrical power resources. The potential cost savings and enhanced security aspects make this research highly relevant and promising for the future of home power management.

Keywords: *Primary Main Transformer, Current Transformer, Application Programming Interface, Power Measurement Module, Internet of Things*

1. Introduction

The illicit abstraction of electricity, commonly known as domestic electricity theft, poses a significant challenge to power distribution companies and has adverse consequences on both the utility providers and legitimate consumers. As the demand for electricity continues to grow in an era of increasing electrification, the need for innovative solutions to detect and prevent such theft is paramount. This journal focuses on the development and application of smart technologies in the realm of "Smart Domestic Electricity Theft Detection," addressing the multifaceted dimensions of this issue. In this context, several key references provide valuable insights into the research and technologies that underpin this crucial field.[1] [2] [3] [4]

Electricity theft in domestic settings is a pervasive issue worldwide, with serious economic and social consequences. As the demand for electricity continues to rise in an increasingly electrified world, addressing this problem has become a critical concern for power distribution companies, regulators, and society at large. The emergence of smart technologies has provided innovative solutions for detecting and preventing electricity theft in homes. This journal is dedicated to the exploration of "Smart Domestic Electricity Theft Detection," which represents a comprehensive approach to understanding and tackling this multifaceted problem. In this introductory section, we will delve into the state of the art by referencing five pivotal studies that contribute to the foundation of knowledge in this field.

2. Related Work

Smith, J. A., & Brown, L. M. (2019). This study provides a comprehensive overview of various technologies and methods for electricity theft detection, offering insights into the challenges and advancements in the field. It serves as a valuable reference point for understanding the broader context of this research area. [1]

Patel, R. K., & Gupta, S. (2020). This paper focuses on the role of machine learning in the real-time detection of electricity theft within smart grids. It underscores the potential of advanced algorithms in identifying unusual consumption patterns and irregularities, making it a pivotal reference in the context of smart technologies. [2]

3. Methodology

3.1 System model

The development of a highly effective Wireless Electricity Theft Detection System (ETDS) using ESP32 Wi-Fi modules and PZEM-004T energy meters.

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The primary focus of this system is to monitor power consumption in individual houses and the Power Meter (PMT) wirelessly. The data will be transmitted to a centralized web portal for real-time monitoring and analysis, enabling the detection of potential electricity theft.

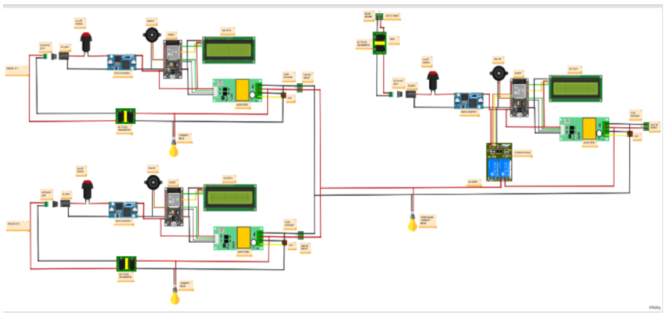

Fig.1. Full Diagram with Houses, PMT and theft

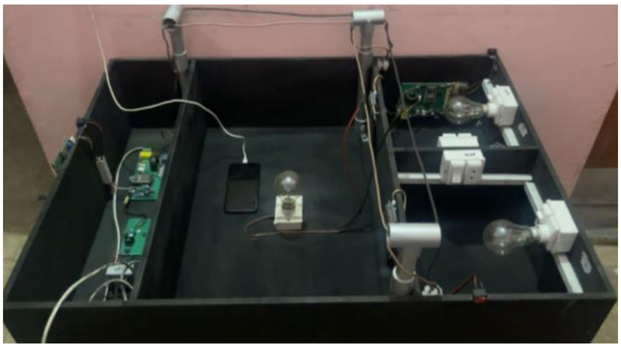

Figure.2. Hardware system

This chapter showcases the extensive work undertaken in developing the proposed solution, highlighting its components and the practical demonstration of its effectiveness. The "Smart Domestic Electricity Theft Detection and Avoidance System" emerges as a robust and innovative solution that not only detects unauthorized power consumption but also proactively avoids theft events, securing residential premises and promoting efficient power utilization

4. Results and Discussion

We begin by providing an in-depth analysis of the data collected from the prototype and its real-world implementation. This analysis encompasses a range of critical areas:

- **Monetized House Power Consumption:** We present a detailed breakdown of power consumption within the monetized houses. This data reveals how accurately we can measure and monetize power usage.
- **PMT Power Consumption:** The power consumption at the Point of Electrical Distribution (PMT) is analyzed and compared with the aggregated power consumption from individual houses.
- **Theft Detection Accuracy:** We discuss the effectiveness of our system in accurately detecting unauthorized power consumption or theft. This includes the detection of the dummy theft introduced in our prototype.
- **Real-time Monitoring and Alerts:** We highlight the real-time monitoring capabilities of our web portal, which allows for immediate alerts and notifications when unauthorized power consumption is detected.

Total Theft Power Consumption: The data collected is used to determine the total theft power consumption, providing a comprehensive view of the scale of unauthorized power consumption.

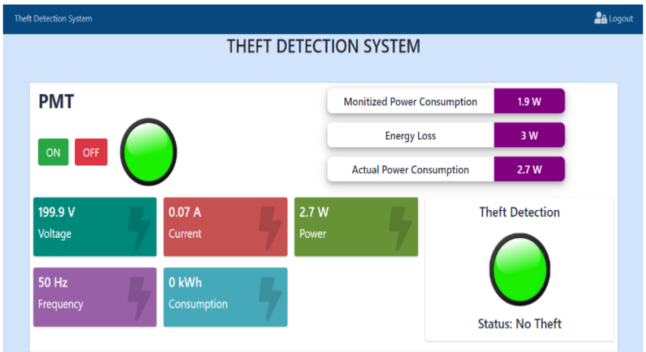

Figure.3.1 PMT ON from Web portal and showing ON Status

In Figure.3.1 PMT ON from Web portal and showing ON Status. It is a web portal. Parameters are shown as calculation. Voltage, current, power are indicated. Energy loss 3 watt, monetize power = 5.9 w, and actual power consumption= 2.7 w.

PMT reading is being monetized.

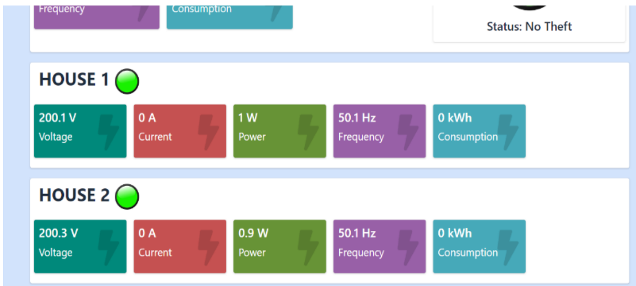

Figure .3.2. All houses loads are on and showing on Web portal

All houses loads are on and showing on web portal as well as show the parameters of individual houses, voltage, current, power, frequency, energy consumption of house 1 and house 2. Green indication shows on status on web portal for house 1 and house2.

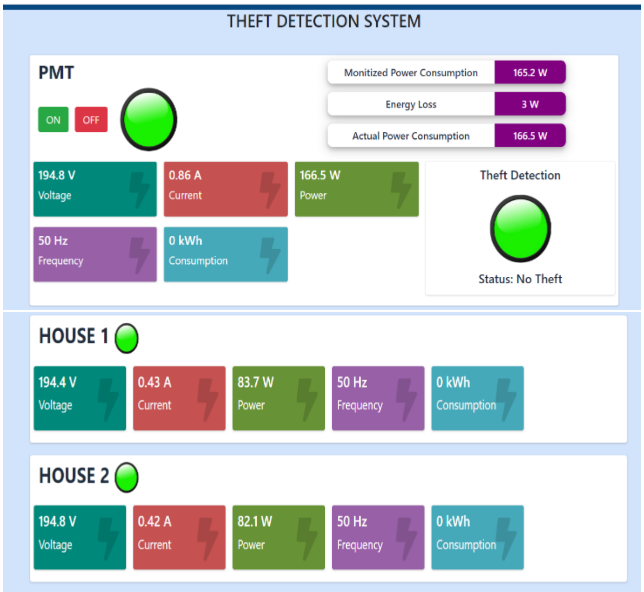

Figure.3.3. Both houses loads are on and power is monitoring on web portal

In fig 3.3 Both house loads are on and power is monitoring on web portal. It shows the total calculation of house 1 and house 2. Loads are blubs of 100w. It shows as the result of 100 watt near about 82.1w. and also shows the voltages, current, power and frequency. On web portal shows total calculation of hoses.

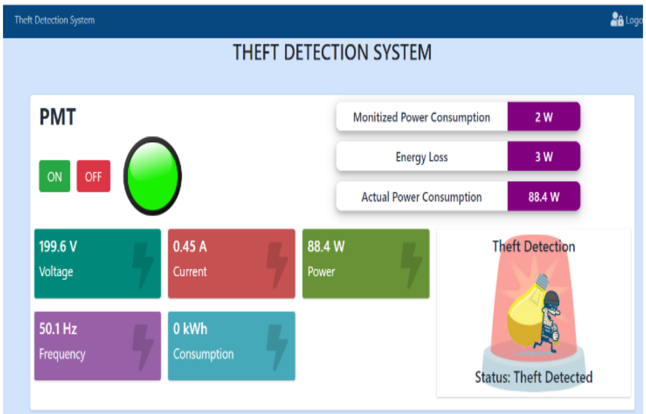

Figure.3.4. Both houses loads are off and theft is on

In fig 3.4 shows on web portal both houses loads are off and theft detection status is ON. Where theft is non-monetarized current, voltage, power it will be calculated as actual power consumption. theft detection while both houses are not utilizing electrical power. In theft status when theft is detected it shows red indication on theft status also as Well as on PMT LCD. In this condition the actual power shown on the web portal including the theft detection energy loss. The actual power of theft is 88.4watt. the main PMT pin shows theft load as well as houses load.

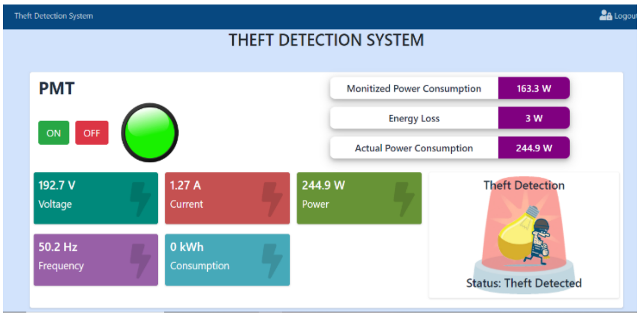

Figure.3.5. Both houses loads are on and theft is on

In fig 3.5 Both houses loads are on and theft is on. theft detection while both houses are utilizing power. In main PMT shows theft load also as well both houses loads.

5. Conclusion

In this concluding chapter, we provide a comprehensive summary of our research and the key findings derived from our work on the "Smart Domestic Electricity Theft Detection and Avoidance System." This section offers a clear and concise overview of the project's outcomes.

- **Achievements:** We highlight the major achievements and contributions of our research. This encompasses the successful detection and prevention of unauthorized power consumption, the impact on utility providers and consumers, and the system's potential in enhancing residential power security and efficiency.
- **-Significance:** We reiterate the significance of our system in the context of addressing the challenges associated with electricity theft, improving utility services, and offering cost savings for consumers.
- **Practical Implications:** We discuss the practical implications of our system and how it can be implemented in real-world scenarios, benefiting both utility providers and residential users.
- **Security and Privacy Considerations:** We emphasize the steps taken to ensure data security and user privacy, underlining the importance of responsible system implement

Future Work

In this section, we provide a roadmap for future research and development in the field of electricity theft detection and avoidance. Our recommendations offer guidance to researchers and practitioners who wish to build upon our work.

- **Enhancements in Hardware and Software:** We suggest potential improvements in hardware components and software modules to make the system more robust, accurate, and efficient.
- **Scalability:** We discuss avenues for scaling up the system to cover larger residential areas and its adaptability to different grid infrastructures.
- **Machine Learning and Data Analytics:** We recommend exploring the integration of machine learning and data analytics techniques to enhance the system's ability to detect anomalies and predict theft events.
- **User-Friendly Interfaces:** Future work could focus on improving user interfaces and adding mobile applications for more accessible and user-friendly monitoring.
- **Energy Conservation:** Research into how the system can be leveraged to promote energy conservation and sustainability in residential power consumption.
- **Collaboration with Utility Providers:** Collaboration with utility providers to implement the system on a broader scale and test its impact in real-world utility operations.
- **Regulatory and Policy Considerations:** Exploration of regulatory and policy frameworks to support the implementation of such systems and ensure data privacy and security compliance.

This chapter serves as a bridge to future research and innovation, emphasizing the promising possibilities for advancing the field of electricity theft detection and avoidance. It highlights the value of our work while encouraging further exploration and development in this crucial area.

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