IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"IOT Based Energy Consumption Optimizer With ML And AI Based Bill Prediction System"

*Mr. Sharad Jadhav 1 , Srushti Tatte 2 , Pragati Raut 3 , Tanvi Shinde 4 , Satyam Kumar5

1 Assistant Professor, 2,3,4,5 BE Student

Department of Computer Engineering,Dr. D.Y. Patil College of Engineering & Innovation Varale, Talegaon, Pune, Maharashtra, India.

ABSTRACT: In many developing nations, gathering readings from utility meters and identifying unauthorized electricity use is and time-consuming process that demands considerable human resources. Implementing an energy meter reading and monitoring system through the Internet of Things offers an efficient and cost-effective method to wirelessly transmit information about the energy consumed by users. Moreover, it helps in detecting electricity theft. This study focuses on measuring household electricity use and automatically generating bills using IOT and telemetry communication methods. Additionally, it seeks to identify and address energy theft. An Arduino microcontroller is utilized to manage operations with the digital energy meter and to link the system to a WIFI network, subsequently connecting to the Internet and a server. A passive infrared sensor is integrated to detect any unauthorized alterations in the metering system. If such activities are detected, the system will send an alert to the server and can automatically disconnect and reconnect the electricity supply. The proposed system is capable of continuously monitoring energy consumption and notifying both providers and consumers about the amount of power used. Energy consumption is computed automatically, and bills are updated online using an IOT network. This automation can lessen the demand for manual labor significantly.

.

Keywords: Internet of Things (IOT), Microcontroller, Electricity theft, AMR

1. INTRODUCTION

Electricity is a crucial necessity for human life. As a non-renable energy source, it is imperative that we utilize it wisely to ensure sustainability (Tan, Lee, & Mok, 2007). In Sri Lanka, many consumers express dissatisfaction with their electricity providers due to outdated meter reading practices that require significant manpower and long hours to gather data for billing. Manual billing can often be delayed for various reasons. Moreover, traditional human-operated metering can lead to inaccuracies (Mohamed Mufassirin & Hanees, 2018; Mufassirin & Hanees, 2014).

Electricity theft poses a significant challenge for the Sri Lankan electricity board. It has been reported that approximately 30% of the total electricity supply is lost to theft (Mohamed Mufassirin, Hanees, & Shafana, 2016). In 2011, electricity board officials apprehended 2,935 individuals who stole electricity, collecting around 199 million LKR in fines (News, 2014). Consequently, the Electricity Board plans to enforce stricter regulations, including the disconnection of services to households or businesses involved in theft. The economic repercussions of such theft not only diminish revenue from electricity sales but also create a need for increased consumer charges. Simply expanding power generation is insufficient to fulfill contemporary electricity demands. It is essential to monitor and manage both electricity consumption and losses to use generated power efficiently (Mohamed Mufassirin & Hanees, 2018).

The Internet of Things (IoT) allows for remote control and sensing of objects through existing communication networks, facilitating greater integration between the physical world and computer systems. This leads to enhanced efficiency, accuracy, and economic advantages (Pooja & Kulkarni, 2016; Muhammed & Hanees, IOT Based Waste Collection Monitoring System, 2017). This study proposes an IoT-based smart energy meter reading and monitoring system that tracks electricity usage for individual households and automatically generates bills using IoT and telemetric communication techniques, like microcontrollers. Additionally, it incorporates an effective method for detecting and managing electricity theft at the household level through infrared sensors and IoT.

2. OBJECTIVES

The primary goal of this study is to create and establish a comprehensive "Iot Driven Energy Consumption Optimizer with ML and AI enabled Bill Prediction System**"** equipped with cutting- edge features such as remote metering, theft detection, and the ability to manage the electricity supply to users. This research focuses on managing all consumer data related to energy usage with the help of a software application. The aim is to design and implement an intelligent system that monitors electrical energy consumption through IoT technology.The system will offer instant measurements of power, current, voltage, energy, and associated costs.

3. EXISTING WORKS

In this study, the authors examined the traditional meter reading system utilized by energy providers in Sri Lanka and identified several limitations and challenges. They explored various technologies and methods aimed at alleviating the issues associated with meter reading. After reviewing numerous research papers and studies, the authors devised a practical and effective solution. A summary and evaluation of some key papers are provided in this section.

Tan, Lee, & Mok (2007) proposed a GSM-based automated power meter reading (GAPMR) system to address the issues with traditional meter reading. This system features GSM digital power meters installed in each consumer's unit, along with an electronic billing system on the utility provider's side. However, the study did not account for areas lacking reliable third-party GSM network coverage.

Darshan & Radhakrishna (2015) introduced an IoT-based system comprising a Power Line Communication (PLC) modem, a theft detection unit, and a Wi-Fi module. The system is built using two separate subsystems: one is installed at the consumer's energy meter, while the other resides at the utility supplier's location. In total, three microcontrollers are suggested for the project; two would be placed in the consumer-end system for IoT and theft detection, while the third would be used at the utility office (Darshan & Radhakrishna, 2015). Nonetheless, this proposed solution may not be cost-effective, as it necessitates the operation of two distinct systems.

Jain & Bagree (2011) indicated that more precise prepaid digital energy meters are replacing traditional electromechanical energy meters. They noted that a significant portion of electricity revenue was lost due to inadequate meter readings and monitoring. Implementing prepaid energy meters and cards could help minimize substantial revenue losses. The prepaid card system connects to the power service provider via mobile communication. Although the authors deemed the proposed prepaid meter a viable solution for collecting revenue from consumers, it complicates the billing process, creating challenges for users. Moreover, while they suggested communication between prepaid energy meters and power utilities via mobile infrastructure, the specifics of this communication module and framework were not clearly outlined in their work.

4. METHODOLOGY

4.1 IoT- Based Energy Management Technology

The increasing need for effective energy usage and awareness in monitoring has driven various researchers to develop innovative solutions for controlling and overseeing energy sectors. In a similar vein, many companies offer Enterprise Energy Management (EEM) software applications designed to analyze the data gathered. By generalizing these practices, a unified system architecture for energy monitoring using IoT can be established, as illustrated in Figure 1.

At the foundational layer of this architecture, smart meters and sensors are present, which can connect via either wired or wireless networks. The smart energy meters on the market can capture various parameters, such as power consumption and maximum/minimum peak voltage and power factor, offering great flexibility in monitoring and analyzing energy use.

In the middle layer, the collected data is transmitted to a gateway, and then sent to a local computer or to the internet using standard communication protocols like ZigBee wireless technology. When utilizing wireless networks, sensors can be positioned more flexibly throughout the shop floor.

Ultimately, this data is input into EEM software for analysis or integrated into other enterprise systems, such as Building Management Systems (BMS), Advanced Production and Scheduling systems (APS), Manufacturing Execution Systems (MES), Manufacturing Resource Planning (MRPII), or simply into the Enterprise Resource Planning (ERP). Additionally, data from smart metering systems can be connected with a supervisory control and data acquisition system (SCADA).

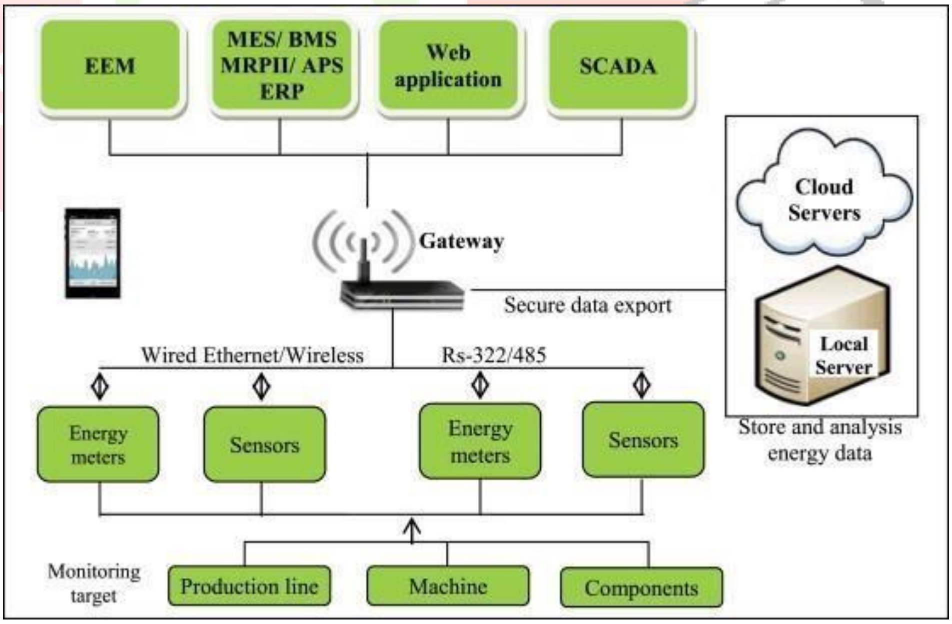

Figure 1. General System Architecture for Energy Monitoring Using IoT

4.2 Design of Method

The concept of Internet of Things (IoT) plays an important role in changing the current Internet into well featured internet (Muhammed & Hanees, 2018).

The proposed IoT based smart energy meter contains mainly five modules.

1. Microcontroller module
2. Bill Prediction module
3. Energy Meter module
4. Automated Meter Reading (AMR) module
5. Wi-Fi module

In the design of the smart energy meter, the microcontroller connects with the AMR module, theft detection module, and Wi-Fi module. The microcontroller serves as a vital element of the smart energy meter system, located at the consumer's end to measure the meter reading, detect theft, and store the data. This information is transmitted between the consumer's side and the energy supplier using the IoT ESP3866 Wi-Fi. The AMR module constantly tracks the meter, gathers readings, and sends them to the microcontroller. Currently, there is a pressing need for a reliable method to identify the smart meter device remotely. To enable remote identification, each connection is assigned a unique IP address. This paper focuses on theft detection, efficient power usage, and providing energy consumption data to the user.

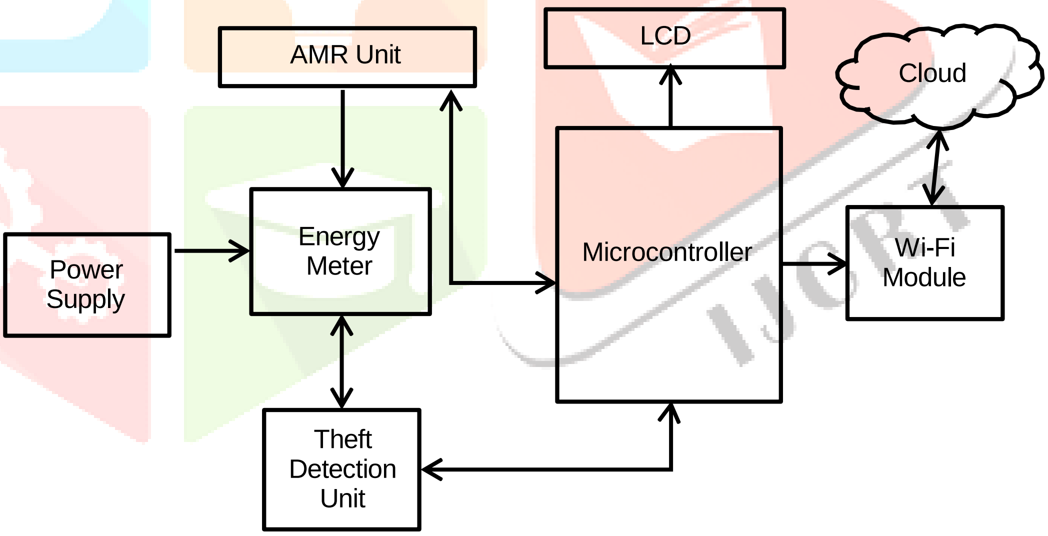

Figure 2. Block Diagram of IoT Based Smart Energy Meter Reading and Monitoring System

A. Consumer End Process

On the consumer side, the power supply module delivers all the energy required for the system's operation. This module also charges the DC Backup, enabling it to power the system when there's a disruption in service from the utility provider. A microcontroller gathers and records data from the electricity meter, managing the control processes and transmitting essential information—like the number of units used—via a Wi-Fi module to the energy supplier. The LCD module displays crucial information, such as consumption figures, alert notifications, and connection status. The DC backup unit ensures that the system remains operational even without utility supply, utilizing a compact 8.4V, 5600mAh rechargeable battery.

B. Supplier End Process

At the energy provider's end, a server computer is responsible for receiving meter readings and generating bills. If any tampering is detected, the system triggers an alert and disconnects the energy supply. Should a consumer fail to settle their electricity bill by the due date, the system can issue commands to disconnect and later reconnect the service through the controller.

5. IoT ANALYTICS AND RESULTS

Data analytics involves examining large datasets to generate insights about their contents. In this study, a data analytic platform was implemented to track the data transmitted by the energy meter to calculate bills and identify theft. The Thingspeak.com IoT Data Analytic platform was employed to visualize meter status online. An infrared sensor detects any tampering, alerting the controller and network interface units. The network module links the meter to the Internet by connecting to a compatible Wi-Fi network and subsequently uploads the meter's status online. An energy provider may manage numerous meters simultaneously, making comprehensive monitoring challenging. However, employing data analytics allows for effective supervision of multiple meters at once. Figure 3 illustrates sample interfaces displaying the units consumed and the corresponding bill on the server.

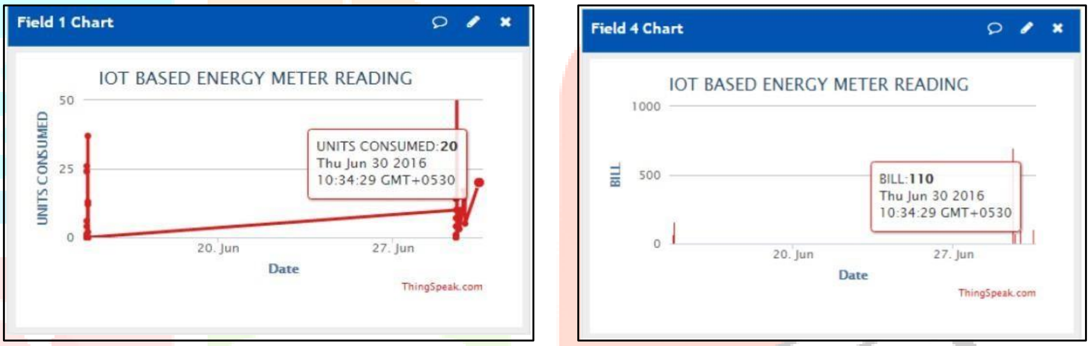

Figure 3. Sample Interface of the Consumed Unit of Energy and Bill in the Server

6. CONCLUSION

This paper proposes a smart energy meter reading and monitoring system based on the Internet of Things (IoT). The system offers several important benefits, including wireless data transmission, reduced workload, remote monitoring and control, an anti-theft feature, and lower costs. It simplifies the process of collecting meter readings and detecting electrical power theft without requiring human intervention. The incorporation of an embedded microcontroller and Wi-Fi module enhances the reliability of wireless data transmission. With this system, customers can conveniently check their electricity usage and bills online, eliminating the need for paper billing, which helps save on paper and printing expenses. Payments can also be processed through an online customer support platform. In the future, this project could be expanded to contribute to the development of smart cities using IoT-based sensors, as seen in various global initiatives. Compared to existing GSM- based and other traditional energy metering and monitoring systems, the proposed solution is more efficient and cost-effective. It empowers consumers to check their energy consumption and billing information at any time they log into the system, while other systems typically only issue bills monthly or upon request.