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IOT based Smart Energy Meter with Android App

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***Abstract*— The Smart Energy Meter System seamlessly integrates Arduino Uno and Node-MCU technologies with a mobile app, offering a sophisticated solution for energy consumption management. By employing energy sensors, the system ensures precise data collection, eliminating billing errors and promoting responsible energy use. Users can remotely control their power supply, allowing real-time adjustments for enhanced convenience and potential cost savings. Apart from the individual advantages, the system also works well for utility companies, as it provides accurate consumption data for proper billing and efficient load control. The automated billing processes streamline transactions and reduces administrative burdens. Moreover, the system contributes to sustainability by curbing energy wastage, fostering eco-friendly practices, and empowering consumers to make informed decisions for increased energy efficiency. KSEB operators can remotely deactivate power supply for outstanding bills, encouraging timely payments. In essence, the Smart Energy Meter System represents a significant stride towards a digitally advanced and sustainable energy ecosystem, aligning with modern energy conservation goals and benefiting both consumers and utility companies.**

***Index Terms*— IoT, Smart energy meter, android app**

I. INTRODUCTION

The rapid growth of urbanization and industrialization has led to an increasing demand for electricity in the world. However, the conventional electricity metering and billing system has many drawbacks, such as manual errors, high operational costs, lack of transparency, and vulnerability to tampering and theft. Moreover, the consumers have limited access to their energy consumption data and feedback, which hinders their ability to manage and optimize their energy usage and save money. Therefore, there is a need for a smart and efficient solution that can overcome these challenges and provide benefits to both the electricity suppliers and the consumers.

Internet of Things (IoT) is a paradigm that enables the interconnection and communication of various devices and sensors over the internet. IoT can be applied to various domains, such as smart homes, smart cities, smart grids, etc. One of the applications of IoT is to develop a smart energy meter that can measure and monitor the electricity consumption of a household or a building using the internet. A smart energy meter can also send the data to an android app, where the user can view the current and historical usage, control the appliances remotely, and receive alerts or notifications. A smart energy meter can offer many advantages, such as:

- It can improve the reliability and safety of the power supply by detecting and reporting any faults or anomalies.
- It can enable dynamic pricing and demand response by adjusting the consumption according to the grid conditions and market signals.
- It can support the integration of renewable energy sources and smart grid technologies by facilitating

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bidirectional communication and data exchange.

In this paper, we propose an IoT based smart energy meter using ESP32 and Blynk app. ESP32 is a low-cost and low-power microcontroller that has built-in WiFi and Bluetooth capabilities. Blynk app is a no-code application builder that allows the user to create mobile and web apps to remotely control and monitor the IoT devices. We use a ZMPT101B AC voltage sensor and a SCT-013 current sensor to measure the electrical parameters, such as voltage, current, power, and energy. We use a 16x2 LCD display to show the readings locally, and the Blynk app to display and control the data remotely. We also use a relay module to switch the appliances on and off from the app. We implement the proposed system on a prototype circuit and test its functionality and performance. We also compare the proposed system with some existing systems and discuss the advantages and limitations of our system. IoT-based Smart Energy Meters incorporate advanced technologies such as sensors and connectivity to gather real-time data on electricity consumption. These meters communicate this information through the Internet of Things, allowing users and utility providers to access insights remotely. The data collected enables better decision-making, efficient resource allocation, and the identification of patterns for improved energy management.

These meters often employ wireless communication protocols like Wi-Fi or cellular networks, ensuring seamless connectivity and accessibility. Through continuous monitoring, users gain a detailed understanding of their energy usage patterns, enabling them to make informed decisions about consumption habits. Utility providers benefit from real-time insights, allowing for proactive grid management, quick issue identification, and better load balancing. The integration of IoT technology in energy meters not only enhances operational efficiency but also contributes to building a more responsive and sustainable energy infrastructure.

In addition to real-time monitoring, IoT-based Smart Energy Meters can offer features such as predictive maintenance. By analyzing the collected data, these meters can predict potential issues or equipment failures, allowing for timely maintenance and reducing downtime. Furthermore, the integration of smart grids can enable bidirectional communication, facilitating the implementation of demand-response strategies, where utilities can adjust energy consumption based on real-time demand fluctuations. The holistic approach of these meters towards data-driven decision-making makes them a cornerstone in creating smarter, more resilient energy ecosystems. IoT-based Smart Energy Meters also contribute to the concept of smart homes and buildings. By providing users with detailed insights into their energy consumption, individuals can optimize their usage, automate energy-intensive processes, and even integrate renewable energy sources seamlessly. These meters serve as a foundation for creating energy-efficient environments that align with sustainability goals. Additionally, the scalability of IoT technology allows for future enhancements and the integration of emerging technologies, fostering continuous innovation in the realm of smart energy management.

Shubham Hadap *et al.* [1] presented that Owing to the human population's explosive growth and dependence on electricity, there is a shortage of electrical energy at peak hours due to the rising demand for electricity. Modernizing the electrical infrastructure is essential to addressing the energy concerns. Technology known as the Internet of Things (IoT) can be used in many methods to control energy distribution and consumption. This study primarily focuses on power optimization, theft detection, power card installation, automatic billing, and providing relevant energy consumption data to stoners. Two main components of an IOT-based smart energy cadence system are a theft discovery device, WiFi, and a voltage regulator. The theft sensor detector recognizes the problem and takes appropriate action if there is a theft or malfunction. Qie Sun, Hailong Li *et al.* [2] presented that the field of energy operation systems plays a pivotal part in icing effective application of coffers and effective monitoring of energy consumption. still, several abecedarian limitations live within these systems, including challenges related to accurate metering, energy monitoring, and furnishing visual information for consumer cargo biographies. To address these limitations, this paper proposes the design and perpetration of a Smart Energy Meter (SEM) with online billing capabilities specifically acclimatized for domestic consumers. The SEM described in this paper leverages microcontroller technology to enable the collection and storehouse of harmonious energy readings. The heart of the system is the Arduino UNO microcontroller, which serves as the central processing unit for data accession and transmission. By uniting with colorful detectors and communication modules, the Arduino UNO facilitates real- time monitoring and analysis of energy consumption patterns. One of the crucial features of the SEM is its integration with the Thing speak operation, an Android- grounded platform designed for energy monitoring and control. Through this integration, energy data collected by the SEM is transmitted to a remote garçon hosted on the Thing speak platform. This enables consumers to pierce their energy consumption data from anywhere with an internet connection, furnishing them with lesser visibility and control over their operation.In addition to energy monitoring, the SEM also incorporates features for online billing and theft discovery. By enforcing a PIR stir detector, the system is suitable to descry any unauthorized access or tampering with the energy cadence, furnishing an added subcaste of security for consumers.

Rutuja Kajrolkar *et al.* [3] presented that energy security and the environment are facing enormous challenges due to the marked rise in energy consumption and the quick development of renewable energy sources like wind and solar power. In the meantime, these developments are pushing the evolution of energy networks in an increasingly intelligent direction. The most fundamental components of intelligent energy networks are clever measures. Smart energy measurements can alter data on energy use and the state of energy networks between consumers and mileage firms in addition to assessing energy overflows. Similarly, home appliances and other bias can be covered and controlled by smart energy measures according on the specific needs of each consumer. This essay provides a thorough analysis of the creation and use of smart energy policies. Sreedevi *et al.* [4] presented that for the past several decades, the idea of a smart grid has come to pass with the development of metering from mechanical to electronic cadence and from Automated Meter Reading (AMR) to Advanced Metering structure (AMI). Networks that transport and distribute power based on certain smart technology are known as smart grids. Through AMI, the objectification of smart measures inside the grid, smart grids overcome the limits of conventional grids. An energy cadence with several integrated smart features, such as demand side operation, demand response, cargo management, cargo curtailment, etc., that measures energy usage is called a smart cadence. A smart grid's foundation is made up of smart measures that connect all of its smart technologies to the grid.

The conventional energy meter functions through a system of mechanical components, notably a rotating metallic disc, which measures the flow of electrical energy. Despite its historical reliability, this setup has notable drawbacks. Firstly, it cannot provide real-time insights into energy consumption, limiting customers' ability to monitor and manage their usage promptly. Moreover, the mechanical parts are subject to wear and tear over time, necessitating periodic maintenance or replacement. Recognizing these limitations, the adoption of smart meter technology has surged. Smart meters offer real-time monitoring capabilities, empowering consumers with immediate access to their energy consumption data and associated costs. Additionally, these advanced devices boast superior accuracy compared to their conventional counterparts, signaling a gradual transition towards their widespread implementation and the eventual phasing out of traditional energy meters.

II. METHODOLOGY

A. PROPOSED SYSTEM

The project consists of two main parts: the hardware setup and the software implementation. The hardware setup involves interfacing the Arduino Uno with energy sensors to measure load values, while the NodeMCU is responsible for connecting to the internet and transmitting the data to a remote database.

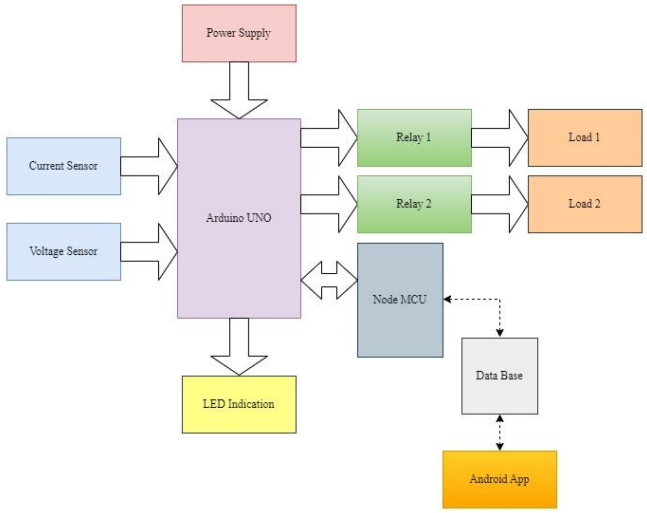

Fig: Block diagram of proposed system.

The software implementation encompasses database management, user interface development, and communication protocols. This project leverages Arduino Uno and NodeMCU for data collection and database interaction, while also integrating a mobile app for real-time usage visualization and bill generation. The system enables users to gain insights into their energy consumption patterns, make informed decisions, and streamline the billing process, fostering energy efficiency and cost savings. The system also operates as follows: when a consumer

fails to make a timely payment for their electricity consumption, KSEB operators can remotely deactivate the main switch, effectively interrupting the power supply to the consumer's premises. This action prompts the consumer to settle their outstanding bills to restore their electricity connection. The mobile app incorporates a user registration and login system to ensure secure access to personalized energy data. User credentials are used to authenticate and authorize users for viewing their consumption and billing information. Using the collected consumption data, the mobile app calculates and generates accurate energy bills. Users can view their current bill, previous bills, and a breakdown of charges directly within the app. This automated billing process eliminates estimation errors and ensures transparent billing practices.

III. Result

The system empowers users to monitor energy consumption with live meter readings, facilitating informed energy management decisions. Online bill payment streamlines the payment process, enhancing convenience and efficiency. Compatibility with various handheld devices, including cell phones, ensures accessibility and flexibility, enabling users to conveniently install the Android application on any new device. Overall, the system offers a seamless experience, combining real-time monitoring, convenient payment options, and device versatility to meet users' energy management needs effectively.

IV. Conclusion

The IoT-based smart energy meter with an Android app offers a revolutionary solution for efficient energy management. Through real-time monitoring and control capabilities, users can track their energy consumption patterns, identify inefficiencies, and make informed decisions to optimize usage. The integration of IoT technology enables seamless communication between the energy meter and the Android app, providing users with convenient access to their energy data anytime, anywhere. With the ability to set alerts and notifications, users can receive timely updates on their energy usage, helping them to stay within budget and reduce wastage. Additionally, the app may offer features such as historical data analysis, predictive insights, and energy-saving tips to further empower users in their energy conservation efforts. Overall, the IoT-based smart energy meter coupled with an Android app brings transparency, convenience, and efficiency to energy management. By harnessing the power of IoT and mobile technology, it contributes to a more sustainable future by promoting responsible energy consumption practices.

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