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SMART ELECTRONICS ENERGY MEASUREMENT, MONITORING, BILLING AND PAYMENT SYSTEM USING MOBILE APPLICATION

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Abstract
The project introduces the rapid growth of energy consumption in homes and industries requires smart and effective methods for monitoring, management and bills. With the advancement of IoT and mobile technology, the energy monitoring system can now offer real -time data access and control through smartphones. A smart electronics meets these modern needs using energy measurement, monitoring, invoicing and payment system using a mobile application. In the current system, manual meter reading and delayed invoicing processes are lacking inaccuracy, human errors and real -time monitoring, disabled energy management. These deficiencies can be overcome by integrating sensors, microcontrollers and wireless communication to automatically activate data collection, enable surveillance of real -time and ensure accurate invoicing. The proposed system uses an ESP32 microcontroller attached to the voltage and power sensors to measure energy consumption, shows data on an LCD and sends it to a mobile application developed using the MIT App Inventor. Finally, this system provides a reliable, user -friendly and effective solution for smart energy management, reduces manual efforts and enables better control of power use.

Keywords-Smart Energy Meter, IoT-based Monitoring, ESP32 Microcontroller, Mobile Application, Embedded Systems, Automated Billing, Remote Load Control, Digital Payment, Energy Efficiency, Energy Consumption Analytics, Home Automation.

I. INTRODUCTION:

Internet of Things (IoT) quickly changes different industries by enabling interconnected units to communicate and operate through direct time exchange. In energy management, IoT shows the ability to monitor, analyze and handle power consumption with high accuracy, efficiency and responsibility. Despite these advances, the traditional energy system still dominates many parts of the world and faces many boundaries. Manual meter reading is still a common practice, which causes a delayed and often a risk of incorrect invoicing, an increase in operating costs and human errors. Users usually lack real -time access to their consumer data, prohibiting their ability to make appropriate decisions on use and cost savings. In addition, many energy infrastructure does not support remote monitoring or automatic control, which makes it difficult to detect errors, surcharge or energy value in time. These chronic systems also struggle to be compatible with increasing requirements for energy efficiency, stability and integration with digital technologies. With the increasing requirement for intelligent energy solutions in both urban and rural surroundings, there is a need for pressure for the systems that can provide transparent insights, real -time notification, automated invoicing and spontaneous digital interactions. It is important to meet these challenges to ensure reliable power supply, improve energy efficiency and support the development of smart networks and durable societies.

II.LITERATURE REVIEW:

This research detected the design and implementation of a smart energy meter system, which utilized the Internet of Things (IoT) technology for monitoring real -time and distance management. The system used an energy meter that consistently records power consumption and transmits the data on the cloud server via GSM communication. An online interface allowed users to access real -time data, track energy use and get awake. In addition, the system automated the invoicing process on the basis of consumption, which made users their bills paid externally. Research emphasized the IoT ability to reduce energy waste, promote efficient energy use and provide distance monitoring capacity for both users and tool suppliers. [1]

This article examines the development of a smart energy meter that uses IoT technology for monitoring and controlling power consumption. The system combines a microcontroller with voltage and power sensors to collect real-time data, which is then transferred to users through Wi-Fi connections. Through an online dashboard, users can easily monitor energy use, identify specific areas of high consumption, and when their use exceeds the predetermined area can receive information. An important innovation in this work is the integration of an IoT platform, which strengthens users with greater control and visibility of energy use. Research shows how to increase real -time and digital access facilities and contribute significantly to energy savings. [2]

This research introduced the development of a prepaid energy measurement system, where users needed to load credit to their account before using power. The system is based on an Arduino microcontroller, which uses GSM technology to send and obtain data, enables users to check the remaining credit and energy consumption. When prepaid balance is consumed, the system automatically cuts the power supply, prevents overweight and effectively promotes energy consumption. The main function of this system was the prepaid model, which helped users control their energy costs by reducing the risk of bill shock. The integration of GSM allowed surveillance distance, which made it a more user -friend and flexible approach to energy management. [3]

This article described an IoT-based system designed for real-time monitoring and management. The system used power and voltage sensors to measure energy consumption and broadcast data on a cloud platform for storage and analysis. The mobile app provided a detailed consumption pattern to the users and helped them identify energy -oriented devices. Users can also specify a high consumption notice to adjust the use. The system was designed to be scalable, which allows integration with smart home platforms. The project emphasized the increasing role of IoT to reduce energy waste and improve the user's awareness of their energy consumption behavior. [4]

The paper focused on an IoT-based smart energy meter system that included in real-time monitoring, automatic load control and overload detection. Using an ESP8266 microcontroller recorded the system data on voltage, power and energy consumption and brought this data to the cloud via Wi-Fi. A mobile application showed data on energy consumption and allowed users to control the connected load. If an overload state was detected,

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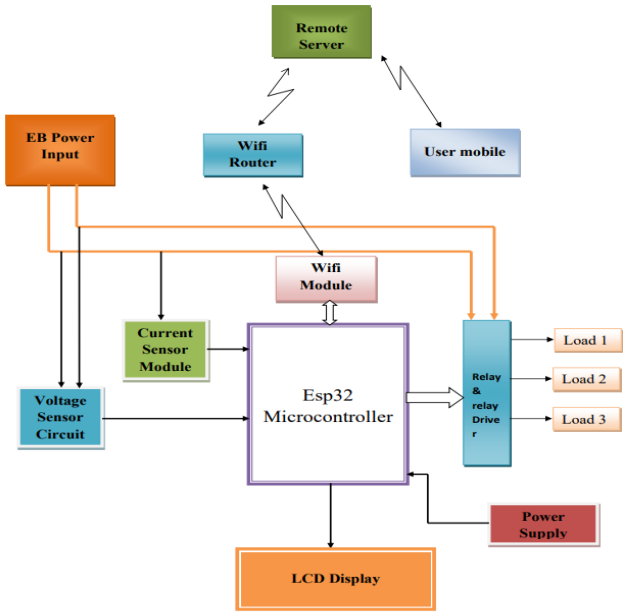
the system can automatically disconnect the load, ensure safety. This research showed how IoT technology can be used to increase energy management through automation, improve awareness of energy consumption and to prevent power outages caused by overload. [5]

III.PROPOSED SYSTEM

The proposed system is an advanced IoT-based smart energy monitoring and invoice solution designed to provide better control, safety and convenience for residential and small commercial users. It benefits from an ESP32 microcontroller, which jointly monitors real -time energy consumption with voltage and power sensors. The data collected, including voltage, electricity, power and total energy use, are transferred to the cloud-based Firebase Real-Time database, which allows spontaneous synchronization between hardware and user interface.A mobile application developed using the MIT app Inventor acts as the user's primary interface. This detailed energy consumption in real time shows calculations, billing information and notice. One of the main features of the system is the ability to automate the invoicing process. It calculates the energy bill based on real consumption and updates it in real time so that users can track costs accurately. In addition, users can directly pay online through the mobile app, increase the convenience and ensure that bill settlement in time.The system provides intelligent load control functionality. Users can specify a predetermined energy consumption area, and when it crosses the limit, the system automatically connects the load to prevent excessive use. It also includes safety systems such as automatic voltage protection: If the input voltage is more than 240V, the system cuts power to protect the connected devices and restore it after 10 seconds. When the voltage goes back to a safe area.Sky integration ensures that all data are stored and updated in real time, giving users a quick access to consumption trends and alerts from any location. Mobile app also shows status indicators for overconsuration, voltage spikes and system couplings, and ensures that users remain informed.Overall, this smart energy solution contributes to reducing energy waste, controlling power costs, improving power safety and simplifying energy management, making it a practical and effective tool for modern energy users.



a) Power Sensing Module: This module includes voltage and current sensor (AC voltage sensor and ACS 712 power sensor) that continuously measure electrical parameters. These sensors provide analog signals that are treated by ESP 32, which is to calculate real -time power consumption using the formula: Power = voltage × current.

b) Microcontroller module (ESP32) ESP32 acts as the brain in the system. It receives entrance from the sensor, processes data to calculate the use of electricity, is examined for threshold violations (eg supplementation or high voltage), and check the load accordingly. It also handles communication with the Wi-Fi Firebase database.

c). Cloud Communication Module (Firebase) This module manages data synchronization between ESP32 and mobile applications. It stores real -time sensor reading, energy consumption data, billing calculation and load position. This ensures that the app shows the latest data.

d) Mobile application module: The MIT app developed using real -time energy use, units consumption, billing information and four base to display the load position with the mobile app Firebase using the inventor. Users can also see notification, energy pulp and payment details through the app.

e) Load control and security module: This module consists of a relay controlled by ESP32. It disconnects the load when consumption exceeds the predetermined energy area or when the voltage exceeds 240V. If the voltage returns to a secure level, the relay re -reconnects the load after 10 seconds. This module ensures safety and prevents electrical damage.

f) Billing and Payment module: This module calculates invoicing based on the consumption and duration of the device. Billing data is displayed in the app, where users can pay payment manually or through integration with Payment Gateway (if used). It automatic automatic billing cycle for a better user convenience.

IV. IMPLEMENTATION

Implementation of smart electronics energy, monitoring, billing and payment system using mobile applications and IoT is carried out through a structured approach that adds both hardware and software elements to enable real-time energy monitoring and control.

System Design and Plan: This process begins with the define of the general system architecture, outlines the roles of components such as voltage and power sensors, ESP32 microcontroller, Firebase RealTime Database and MIT apps using the MIT App Inventor. This phase includes mapping data flow, control logic and user interaction mechanisms.

Hardware Integration:ESP32 microcontroller is connected to an alternative power sensor and an ACS712 -power sensor to measure energy parameters. A relay module is included to control the electrical load based on the user -down threshold. An LCD is also added to show the actual time's energy data at the local level.

Built -in software development: Programming is done in built -in C using Arduino idea. This includes the code to read the sensor values, calculate the strength (p = V × I) and transfer data to the fire base via Wi-Fi. The software also includes logic to automatically disconnect the load when energy is exceeded using use or voltage kit.

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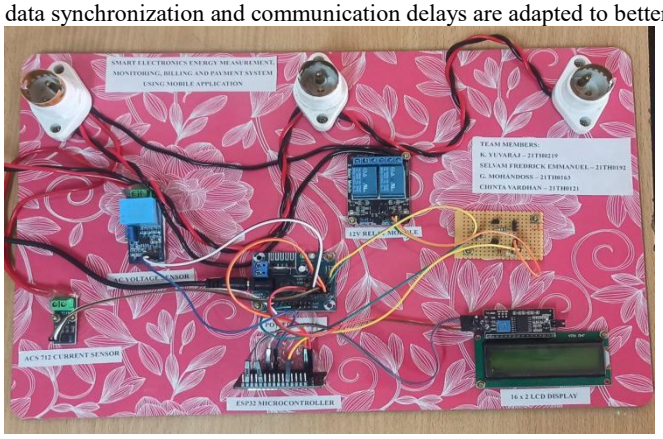
Cloud integration: The Firebase RealTime database is configured to store energy consumption data and system status. Two -way communication between ESP32 and Firebase ensures real -time data updates and external command.
Mobile application development:A mobile app is developed using the MIT app Inventor. It shows truth voltage, electricity, electricity, energy consumption, billing details and alerts. The facilities include setting limits on energy consumption and remote controlling the load.
Testing and customization: The system is tested under different load conditions to verify the sensor's accuracy and system reaction. Calibration, data synchronization and communication delays are adapted to better performance.



V. RESULT AND DISCUSSION

Finally, Smart Electronics Energy, monitoring, invoicing and payment system using mobile applications presents a complete and innovative solution for modern energy management challenges. By combining IoT technologies with real -time monitoring functions, the system makes users tracking power consumption, monitoring voltage and power levels and getting automated billing details through a dedicated mobile application. The integration of ESP32 microcontrollers, voltage and power sensors and four -base cloud storage allows spontaneous data communication between the hardware and the app, which provides immediate updates and provides complete transparency. The system effectively addresses the boundaries of traditional energy meters, such as manual reading errors, billing delays, remote control shortages and the absence of preventive safety systems. Main functionality such as consumption limits, automatic load cutting and live status updates when it comes to high use or high voltage not only improves user systems, but also improves energy security and efficiency. In addition, the project promotes the concept of smart life by reducing power, supporting energy savings and enabling smart energy consumption decisions. In the future, this smart energy monitoring and invoicing system can be improved by integrating with a smart network to enable dynamic pricing and effective load distribution, as well as a secure mobile payment gateway for direct billing payment through UPI or digital wallet. Advanced data analysis and AI can be used to predict energy use trends and to offer individual energy -saving tips. Smart Home System like Alexa or Google Assistants will be able to compatibility with hand -free control and real time.

VI. REFERENCE

[1] A. Sharma, S. Gupta, and R. Sharma, "IoT-Based Smart Energy Meter for Automatic Meter Reading and Billing System," *International Journal of Engineering Research & Technology*, vol. 8, no. 9, pp. 223–227, Sep. 2019.

[2] M. S. Islam and M. H. Ali, "Smart Energy Meter Using Internet of Things (IoT)," *International Journal of Engineering and Advanced Technology*, vol. 9, no. 3, pp. 2411–2416, Feb. 2020.

[3] P. S. Mane and R. M. Patrikar, "IoT Based Smart Energy Meter Using ESP32 and Firebase," *International Research Journal of Engineering and Technology*, vol. 7, no. 4, pp. 1205–1210, Apr. 2020.
[4] N. K. Suryawanshi and V. R. Ghorpade, "Smart Electric Meter with Power Theft Detection and Load Control using IoT," *IEEE International Conference on Smart Technologies for Smart Nation*, pp. 219–223, 2020.
[5] R. Kumar and P. Singh, "Smart Energy Meter with Load Control and Billing System Using IoT," *International Journal of Engineering Sciences and Research Technology*, vol. 8, no. 6, pp. 50–55, 2019.
[6] A. Shinde and V. U. Suryawanshi, "Real-Time Energy Monitoring Using ESP32 and Firebase," *International Journal of Scientific Research in Science, Engineering and Technology*, vol. 7, no. 3, pp. 315–319, Mar. 2021.
[7] S. Thakur and N. Jain, "Design of IoT Based Smart Electricity Billing System Using Mobile App," *International Journal of Innovative Technology and Exploring Engineering*, vol. 9, no. 4, pp. 1942–1946, 2020.
[8] B. H. Suvarna and K. N. Naveen, "Smart Energy Meter and Billing System Using GSM and IoT," *International Journal of Engineering Research and Technology*, vol. 9, no. 10, pp. 303–306, Oct. 2020.
[9] R. M. Raut and P. N. Raut, "IoT Based Smart Energy Meter for Automatic Meter Reading and Theft Detection," *International Journal of Research in Advent Technology*, vol. 7, no. 6, pp. 30–33, Jun. 2019.

[10] A. Deshmukh, S. Mali, and V. Patil, "IoT Based Automatic Energy Meter Reading and LoadControl Using Firebase and ESP32," *International Journal of Engineering Applied Sciences and Technology*, vol. 5, no. 2, pp. 29–34, Apr. 2020.