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Energy Monitoring System Using Iot

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ABSTRACT: The popularity of IoT-based applications is increasing rapidly, offering effective solutions for various real-time problems. This project proposes a real-time monitoring and prepaid system for energy consumption, aiming to provide a cheap, easy-to-implement, and manageable solution for monitoring our daily electricity usage.The goal of this project is to address issues such as human errors, manual labor, and excessive costs in energy consumption. The primary focus is on implementing an IoT-based prepaid energy monitoring system. The proposed design involves the use of a low-cost wireless sensor network and protocol for smart energy management, along with a web application that can automatically read and display the energy meter readings for users.By implementing this system, users will have visibility into their electricity usage, allowing them to identify wastage and reduce consumption costs. Additionally, the web application enables the setting of monthly unit limits to prevent excessive energy usage. The key components of the system include a digital energy meter, Arduino Nano, ESP32 Wi-Fi module, and web applications for energy management.When supply is connected to the energy meter, the energy consumption data is displayed on an LCD screen. The energy meter is connected to the system, and current sensors are used to collect data, which is then updated in the Firebase software. The ESP32 Wi-Fi module is integrated into the system to facilitate communication between the system and the web application, utilizing the TCP/IP protocol.Overall, this project proposes an IoT-based prepaid energy monitoring system that offers affordable and efficient energy management, allowing users to monitor and control their electricity usage effectively.

Key Words: ESP32,Arduino nano,Current sensor,IoT,ZMCT103C,LCD.

I. INTRODUCTION

The ever-increasing demand for electricity and the importance of efficient energy management have given rise to advanced technologies in the realm of energy monitoring. Among these technologies, the Internet of Things (IoT)-based energy monitoring system stands out. This innovative system utilizes IoT devices and connectivity to offer real-time monitoring and analysis of energy consumption in various settings, including households, commercial buildings, and industrial facilities.Traditional methods of energy monitoring heavily rely on manual meter reading and periodic billing, but they come with inherent limitations. These limitations include the potential for inaccurate readings, delays in detecting abnormalities or faults, and restricted access to real-time energy usage data. To overcome these challenges, IoT-based energy monitoring systems have emerged as a transformative solution by enabling automated and continuous monitoring of energy consumption.The IoT-based energy monitoring system comprises smart meters, sensors, data communication networks, and cloud-based platforms for data storage and analysis. Smart meters are installed at individual electricity consumption points, such as homes or businesses, and possess the capability to measure and record energy usage in real-time. By connecting these smart meters to the internet, seamless data transmission to the cloud platform is made possible.The cloud platform serves as a centralized hub for collecting, storing, and analyzing energy consumption data. Users can conveniently access this information through web-based or mobile applications, granting them an intuitive interface to monitor their energy usage effectively.The advantages of implementing an IoT-based energy monitoring system are numerous. Firstly, it empowers users to gain a deeper understanding of their energy consumption patterns, enabling them to identify areas of waste and make informed decisions to reduce energy usage. Additionally, real-time monitoring capabilities facilitate the early detection of faults or abnormalities, allowing for timely maintenance and preventing potential energy losses. Moreover, utility companies can leverage the system's data to optimize energy distribution, manage peak loads, and enhance overall grid efficiency.

In conclusion, IoT-based energy monitoring systems provide a powerful solution to overcome the limitations of traditional energy monitoring methods. By offering real-time data, advanced analytics, and user-friendly interfaces, these systems enable individuals and organizations to monitor and manage their energy consumption effectively. The integration of IoT technologies into energy monitoring represents a significant stride towards achieving a more sustainable and efficient energy ecosystem

II. LITERATURE REVIEW

Veerakumar.P[1] has introduced an IoT-based Interactive Industrial Home remote system that is specifically designed for large-scale applications, such as industrial areas. The system utilizes various communication methods, including GPRS, SMS, and email, to enable remote control and monitoring.

A cost-effective remote energy monitoring system was developed by Harvard Swart, A.J[2] utilizing the ESP8266 NodeMCU. The system was specifically designed for implementation in Cape Town, South Africa, to measure the energy output of a pico-solar system and monitor ambient temperature. However, it is important to note that this system may not be suitable for household use. Furthermore, while the ESP8266 WiFi module was utilized in their implementation, it is worth considering that more advanced and improved results could potentially be achieved by using the ESP32 module, which was not incorporated in their study. Additionally, the inclusion of a Raspberry Pi in their setup might increase the overall cost of the system, deviating from their initial goal of developing a cost-effective solution.

Dahlan, N. Y., Aris, A. A. M., Saidin, M. A., Nadzeri, M. J. M., Nawi, M. N. M., Abbas, W.F., and Arshad, P[3] developed a device that effectively records and displays real-time power and energy consumption, energy cost, energy index, and CO2 emissions. The device proves to be useful for monitoring and recording CO2 emissions. However, it lacks the capability to directly read and update the units from the energy meter, preventing users from viewing their current energy meter readings within the software.

Rao, B. N., and Sudheer, R.[4] developed a low-cost energy monitoring system aimed at identifying devices that consume excessive power and facilitating energy savings. However, it is important to note that they utilized the MIT App Inventor platform app, which has certain limitations. These limitations include restricted access to the device, limited web capabilities, and limitations in user interface design. These constraints could pose disadvantages to the overall functionality and user experience of the system.

Abubakar Salisu, Aminu Bugaje, and AZ Loko[5] presented a paper that revolves around the design and implementation of an IoT-based system for household electricity energy monitoring and remote control of electric bulbs. The primary objective is to reduce electrical wastage by utilizing an ESP 32-bit microcontroller. They incorporated the use of Matlab app, which offers convenient debugging capabilities and facilitates the development of computational codes. However, it is important to consider that Matlab can have performance limitations, as it can be slow, especially if poor programming practices are employed, which may result in unacceptably slow execution.

III. PROPOSED SYSTEM

3.1.OBJECTIVE

The objective of energy monitoring using IoT is to accurately measure, track, and analyze energy consumption in real-time with the help of interconnected devices and sensors. IoT-enabled energy monitoring systems aim to collect energy consumption data in real-time or at frequent intervals. This data is gathered from sensors, smart meters, and other connected devices placed at various points within the energy system, such as households, commercial buildings, or industrial facilities.IoT-based energy monitoring systems are designed to continuously monitor energy consumption, providing a continuous stream of data on usage patterns and trends. This allows for immediate detection of abnormal or inefficient energy consumption, enabling timely actions to address any issues.

A key objective is to promote energy efficiency and conservation. By monitoring energy consumption patterns, IoT systems can identify areas of wastage, inefficiency, or excessive energy usage.

3.2.SYSTEM MODEL:

IoT devices and sensors are deployed at various points of energy consumption, such as appliances, or renewable energy sources. These devices collect real-time data on energy usage, including voltage, current, power, and other relevant parameters.The collected energy data is transmitted from the IoT devices to a central data collection point.The data is securely transmitted to ensure its integrity and privacy.At the central data collection point, the received energy data is processed and stored. This involves performing

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necessary calculations or conversions, and organizing it for further analysis.The energy monitoring system is continuously monitored and maintained to ensure its accuracy and reliability.Here the user will we able to control the appliances remotely and furthe will also be able to detect problems such as current theft,over consumption,etc.

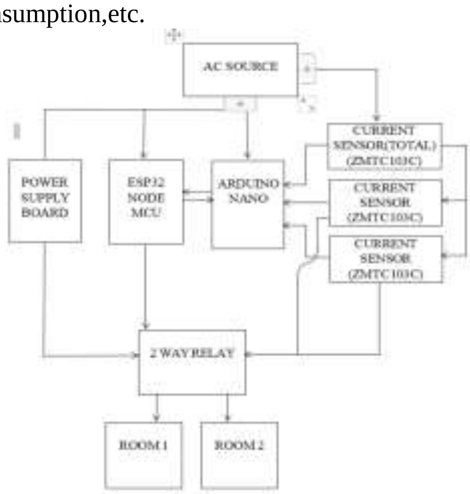

Fig 1: Block Diagram

3.2.1.ESP32 Microcontroller:

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth.The ESP32 can host a web server or develop a mobile application interface to provide users with a convenient interface for monitoring their energy usage. The ESP32 plays a crucial role in energy monitoring systems by enabling data acquisition, wireless connectivity, real-time monitoring, cloud integration, remote control, and user interfaces. Its versatility and compatibility with IoT frameworks make it a popular choice for developing energy monitoring solutions.

3.2.2.ARDUINO NANO:

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor.The Arduino Uno can interface with different sensors, such as current sensors, voltage sensors, temperature sensors, or light sensors, to measure and acquire energy-related data. It can collect data from these sensors and convert analog signals into digital values for further processing.Arduino Uno's open-source nature allows for customization and prototyping of energy monitoring systems.

3.2.3.Current Sensor(ZMCT103C):

The ZMCT103C is a type of current sensor commonly used for measuring alternating current (AC) in electrical systems.The ZMCT103C enables accurate and real-time measurement of AC current flowing through a conductorBy integrating the ZMCT103C current sensor with IoT devices and connectivity, energy consumption data can be collected and transmitted wirelessly to a central server or cloud platform.The data collected by the ZMCT103C sensor can be integrated into IoT platforms for further analysis, visualization, and reporting. This enables users to access energy consumption data remotely through web-based or mobile applications, providing them with valuable insights and control over their energy usage.

3.2.4. 2 Way Relay:

The two-way relay can be used to remotely control the power supply to specific loads or devices in an energy monitoring system. It allows for the switching on or off of electrical appliances or equipment based on user commands or automated rules.By incorporating a two-way relay into an IoT-based energy monitoring system, users can gain enhanced control, automation, and flexibility in managing energy consumption. It offers the ability to remotely control appliances, optimize energy usage, and improve overall energy efficiency in a connected and intelligent manner.

IV. WORKING & RESULT:

The ESP32 will process this data from the current sensors and send it to the arduino nano for further computation which is then sent to the LCD Display and the mobile app for the user to see the energy consumption and even control the individual rooms remotely via the app.

Fig 2: Working Model

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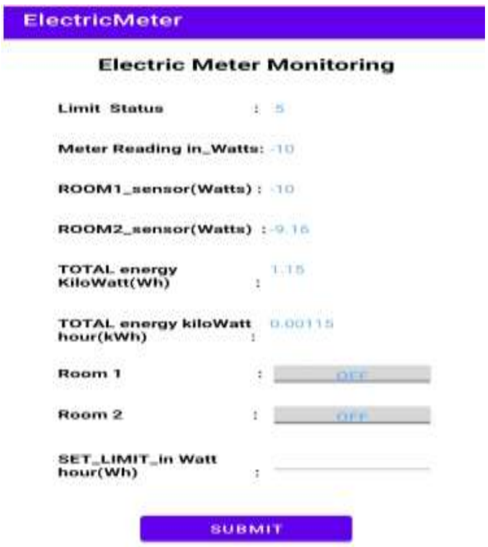

Fig 3:Mobile Application

WATTS	POWER CONSUMPTION(Kwh)	
	THEORETICAL VALUE(Kwh)	PRACTICAL VALUE(Kwh)
100W	0.0167	0.019
60W	0.01	0.0115
40W	0.0066	0.0067

Fig 4: Power Consumtion Table

From the table mentioned above we are able to see the consumption differences between the theoretical calculations and practical values, this shows the small amounts of energy losses in the appliances which change the output of the energy measured.We can also use this project to measure individual room consumptions in an household which will further be helpful to recognize faulty appliances.

V. CONCLUSION & FUTURE SCOPE:

Conclusion: In conclusion, energy monitoring using IoT has revolutionized the way we manage and optimize energy consumption. By leveraging IoT devices, sensors, and data analytics, this technology enables real-time monitoring, analysis, and control of energy usage, leading to significant benefits in terms of efficiency, cost savings, and sustainability.It provides users with real-time visibility into their energy consumption, empowering them to make informed decisions and take proactive steps towards energy conservation. By identifying energy wastage, optimizing equipment performance, and implementing energy-saving measures, businesses and individuals can reduce their environmental footprint and achieve substantial cost savings on energy bills.

Energy monitoring using IoT is a transformative technology that offers immense benefits for energy management, cost savings, and environmental sustainability. With ongoing research, innovation, and collaboration, we can harness the full potential of IoT in energy monitoring and pave the way for a more efficient and sustainable energy future.

Future Scope: The system can be adopted into larger industrial sectors and communitiesAI and ML integration will include developing algorithms that can learn from historical data, predict energy consumption patterns, optimize energy usage, and automate energy-saving actions without human intervention..Further integrating energy monitoring systems with smart grid technologies can enable seamless communication and coordination between energy producers, consumers, and distributors. This integration can optimize energy distribution, facilitate demand response programs, and improve overall grid efficiency.

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