Home Electricity Monitoring System Using IoT

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Abstract- ***Home automation involves using smart technology to control and automate various household tasks and functions, such as managing lighting, heating, ventilation, air conditioning, security systems, and other devices. These systems aim to make our lives more convenient, comfortable, and energy-efficient. The combination of home automation and energy efficiency not only helps the environment but also saves homeowners money. This overview highlights how home automation can change the way we manage energy in our homes, promoting a more sustainable and smarter approach to residential living.***

Keywords: Home Automation, Smart Homes, Smart Sensors, Actuators, Gateway Devices, User Interfaces, Energy Management

I. INTRODUCTION

The desire to better understand home electricity consumption has led to an increase in the number of home electricity monitoring systems. These systems typically use sensors in electrical circuits and real-time usage monitors, such as phone apps. Homeowners can see their electricity demand at any time, identify areas where they can reduce energy consumption, and save money.

Home electricity tracking systems help homeowners monitor their energy usage patterns and find ways to improve energy efficiency. Some of these systems offer personalized power-saving suggestions, appliance cost analysis, and remote control or scheduling of appliances. This means homeowners can access their power consumption data and control their appliances even when they are not at home using smart home technology and Internet of Things (IoT) connectivity. Relay and Arduino interfaces are commonly used in these systems to enable remote control of domestic appliances.

With these systems, homeowners can turn appliances on and off remotely and monitor their electricity usage from anywhere. Home electricity monitoring systems provide a convenient and efficient way to manage and save energy. Additionally, the integration of intelligent power scheduling algorithms can further optimize energy consumption. By analyzing data collected from the monitoring system, homeowners can make informed decisions on how to use electricity more efficiently and reduce their energy consumption.

Overall, home electricity monitoring systems offer a practical solution for homeowners to keep track of their energy usage and effectively manage their electricity consumption.

II. LITERATURE SURVEY

Kabalci et. al discussed about the design and implementation of a device to track renewable energy sources. The device aims to optimize the use of renewable energy by monitoring and managing the energy flow from various sources such as solar and wind. The focus is on improving the efficiency and reliability of renewable energy systems by providing real-time data and control functionalities.[1]

Stankovic, John A. provided a comprehensive set of guidelines for the development and deployment of Internet of Things (IoT) systems. It covers various aspects such as security, privacy, scalability, and interoperability. The guidelines aim to address the challenges and complexities associated with IoT, ensuring robust and efficient system design.[2]

Luigi Atzori, Antonio Iera, and Giacomo Morabito. provided an extensive overview of the IoT landscape, covering its main concepts, enabling technologies, and applications. It examines the architectural elements, communication protocols,

and potential challenges of IoT. The paper is foundational for understanding the scope and impact of IoT on various industries and everyday life.[3]

Madakam et al. review the existing literature on IoT, highlighting its evolution, key components, and applications. The paper discusses the technological advancements that have enabled IoT and explores various use cases across different sectors. It also addresses the challenges and future directions for IoT research.[4]

Kang Bing, Liu Fu, Yun Zhuo, and Liang Yanlei. presented the design of a smart home system based on IoT technologies. The system integrates various home appliances and devices, allowing for automated control and monitoring through a centralized platform. The aim is to enhance home automation, energy efficiency, and user convenience.[5]

Wang et al. propose an IoT-based system for controlling household appliances. The system enables remote control and automation of home devices, contributing to energy savings and improved home management. The paper emphasizes the integration of IoT technologies to create smarter and more efficient living environments.[6]

Riyaj Kazi et al. discussed an interactive energy management system for industrial and home use. The system uses IoT technologies to monitor and control energy usage, providing real-time data and alerts via GPRS, SMS, and email. The goal is to enhance energy efficiency and provide users with actionable insights into their energy consumption.

Madakam and Ramaswamy explore the concept of smart homes, discussing the potential benefits and challenges of implementing IoT technologies in residential settings. The paper outlines the key features of smart homes, such as automation, security, and energy management, and provides a conceptual framework for their development.[8]

M. Moreno et al. introduced a comprehensive IoT-based platform for managing smart environments. The platform integrates various IoT devices and systems to provide centralized control and monitoring. The focus is on creating a cohesive and efficient management solution for smart cities, homes, and industrial environments.[9]

Gubbi et al. present a vision for the future of IoT, detailing its architectural elements and potential directions for development. The paper discusses the enabling technologies, applications, and challenges of IoT, providing a roadmap for future research and implementation.[10]

Liang's book is an introductory guide to programming with Python. It covers fundamental programming concepts, syntax, and techniques, making it accessible to beginners. The book is widely used in academic settings to teach programming skills and problem-solving using Python.[11]

Fang Shifeng et al. describes an integrated IoT-based system for environmental monitoring and management. The system collects and analyzes data from various environmental sensors, providing real-time information for managing and mitigating environmental issues. The focus is on enhancing the efficiency and effectiveness of environmental monitoring using IoT technologies.[12]

Sharma, Gautam, Singh, and Chaurasia (2023) provides a comprehensive review of IoT-based home automation systems, highlighting advancements, applications, challenges, and future directions. The authors detail the integration of smart sensors, actuators, gateways, and user interfaces that enhance home efficiency, security, and user convenience. They explore various applications such as energy management, security, health monitoring, and entertainment, showcasing the transformative impact of IoT on modern living spaces. The paper acknowledges key challenges, including privacy and security concerns, device interoperability, and network infrastructure needs. Future research directions emphasize enhancing security, improving device interoperability, and developing user-friendly interfaces. The review concludes by emphasizing the potential of IoT-based home automation to revolutionize daily living while calling for continued innovation and collaboration to address existing barriers. This work is a valuable resource for understanding the current state and future potential of smart home technologies.[13]

III. METHODOLOGY

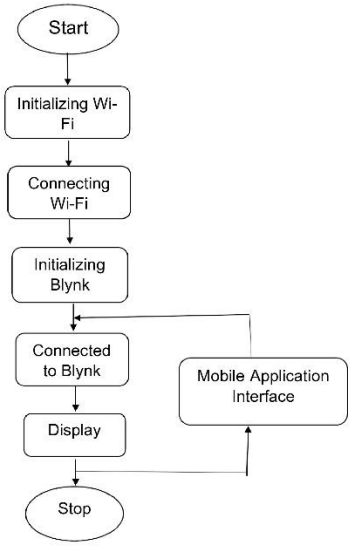

Figure 1: Working of the device

Figure 1 is showing the overall working of proposed system. The primary goal of this task is to layout home electricity monitoring device and share the information through android application (Blynk). The main objective of this device is to monitor the electricity consumption and can easily control the device by switching on and off from anywhere.

The working of the device is to collect voltage and current data using the ESP32, which will be the microcontroller for this project. The ESP32 will process the data from the sensors and send it to an OLED display so the user can see the energy consumption. Additionally, we'll use a HI-Link 5V SMPS module to convert 220V AC into 5V DC to power all the components.

A. Hardware Used-

- ESP32 WROOM 32D Module
- HI LINK 5V 3W SMPS
- ZMPT101B Voltage Sensor
- LED 1 5. ACS712 Current Sensor
- 1 Channel relay module
- 220V AC 3 Pin Socket MALE 1
- 220V AC 3 Pin Socket FEMALE

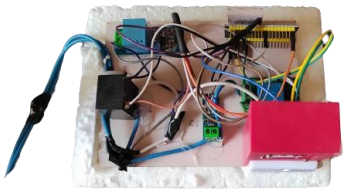

Figure 2: Hardware Setup

An IoT-based home electricity monitoring system allows you to monitor your energy usage and discover areas for improvement expand more The system normally consists of non-intrusive current sensors clamped around the main power wire entering your home expand more These sensors measure the current passing through the cable and, together with voltage measurements from the meter, determine real-time power consumption.

The collected data is then wirelessly transferred to a central hub, which is often a microcontroller board such as Arduino.expand_more This hub processes data and sends it to a cloud platform via WiFi or ethernet connection. The cloud platform securely keeps the data and makes it available to you via a user-friendly mobile app or online interface.

This interface allows you to visualize your energy consumption in a variety of ways, including time of day, appliance usage, and cost projections. You can configure warnings for exceeding predefined use limitations or for odd surges that could signal a faulty appliance.

In advanced systems, the data can be used to implement smart controls. Integrating with smart plugs allows you to remotely control certain appliances or schedule their operation during off-peak hours. This can help you save money on your energy bills and live a more environmentally conscious lifestyle.

B. Software Used-

- Adafruit Library
- Blynk App

IV. IMPACT & APPLICATION OF HOME ELECTRICITY MONITORING SYTEM

Installing a home electricity monitoring system has a big impact on how people use and save energy, as

well as on the environment. It helps homeowners understand their energy use better by showing real-time data, making them more aware of their habits. By spotting which appliances use the most energy and when usage is highest, homeowners can lower their electricity bills by turning off devices when not needed or switching to energy-efficient ones. The system's detailed information helps optimize energy use and improve efficiency. With IoT connectivity, homeowners can monitor and control their energy use remotely, adding convenience and preventing waste even when they are not home. Reducing energy consumption also lowers the household's carbon footprint, benefiting the environment. Homes with these systems are often more appealing to buyers and can increase in value. Overall, home electricity monitoring systems help homeowners manage their energy use better, save money, improve energy efficiency, and support environmental sustainability.

Home electricity monitoring systems offer numerous benefits to homeowners. They allow users to track their energy consumption in real time, providing valuable insights into usage patterns and areas for potential savings. By identifying high-energy appliances, homeowners can manage energy costs more effectively, either by using these appliances more efficiently or replacing them with energy-efficient models. These systems also help in shifting energy-intensive activities to off-peak hours, reducing strain on the power grid and lowering electricity bills. With IoT connectivity, homeowners can monitor and control their energy usage remotely, ensuring devices are turned off when not in use. Integration with smart home devices enables automated energy-saving actions, like turning off lights in unoccupied rooms. The data collected helps homeowners make informed decisions about energy efficiency improvements, such as adding insulation or installing solar panels, thereby reducing the household's carbon footprint. Additionally, monitoring systems can detect unusual consumption patterns, indicating faulty appliances or electrical issues, allowing for timely maintenance. These systems enhance home automation by enabling schedules and automation of devices, contributing to overall energy savings and convenience. Furthermore, homes equipped with these systems often see increased property value due to their modern, energy-efficient features.

V. RESULT

Implementing a home electricity monitoring system has greatly helped homeowners manage and understand their energy use. This system gives real-time data on current, voltage, power, and energy usage, displayed on an OLED screen. The ESP32 microcontroller, along with sensors like the ZMPT101B and ACS712, collects and processes this data accurately. It not only shows the information locally but also uses IoT technology to send data for remote monitoring.

By analyzing this data, homeowners can see which appliances use the most energy and when usage is highest. This helps them make better decisions to reduce energy waste, improving energy efficiency and saving money. The ability to check this data remotely adds convenience, letting users monitor and control their electricity use from anywhere with a connected device. Overall, the home electricity monitoring system gives users the tools and information they need to optimize their energy use, making their household more sustainable and cost-effective.

CONCLUSION

In conclusion, implementing a home electricity monitoring system is viable based on the findings of the feasibility study. The system offers benefits such as increased energy efficiency, potential cost savings, and a positive environmental impact. User feedback indicates strong acceptance, and the technology proves to be both compatible and scalable. Financial considerations suggest a positive return on investment. It is recommended to proceed with implementation, consider pilot programs, and explore collaboration opportunities. Continuous improvement and adaptation based on user feedback are emphasized to ensure ongoing success.

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