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IoT Based Smart Electricity Energy Meter with ESP32 and Blynk 2.0

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ABSTRACT: Traditionally, monitoring electricity consumption involves manual meter readings, which can be time-consuming and inconvenient. The Internet of Things provides a solution by automating remote data collection, thereby saving time and money. The concept of a Smart Energy Meter has gained significant popularity worldwide in recent years, making this an excellent opportunity to build our own IoT based electricity energy meter. We will create an IoT-based Smart Electricity Energy Meter using search ESP32 and the updated Blynk 2.0 application. By using the best current sensor (SCT-013) and voltage sensor (ZMPT101B), we can measure voltage, current, power, and total energy consumed in kWh. The readings will be sent to the Blynk 2.0 application and displayed on a dashboard accessible from any location. In case of power outages, the energy meter data will be stored in search ESP32's EEPROM, ensuring continuous readings. Let's start our project to automate electricity consumption monitoring.

KEYWORDS: ESP32, Energy, Internet of Things, Blynk 2.0, Power, Voltage sensor, Current sensor

I.INTRODUCTION

Electric energy use has surged in recent years. As a result, a large increase in energy supply was required. due to population growth and other factors in the coming decades development of the economy as a result, there is a demand-supply imbalance. According to the current scenario, the power generated, which is mostly derived from fossil fuels, will be depleted within the next 20 years. Electronic energy monitoring solutions are currently available on the market that are extremely accurate. In the case of residential applications, the majority of these monitor the power utilized in a domestic household. Consumers are frequently disappointed with their power bills since they do not display the power used at the device level. The Internet of Things (IoT) is a new sector, and IoT-based devices have ushered in a revolution in electronics and information technology. Energy usage, particularly electricity consumption, is one of the most critical issues we face today. An effective technique to monitor this energy consumption is required. The Internet of Things (IoT) offers a solution to these issues. Hardware, software, and the cloud are all interconnected. As a result, we offer an energy consumption model. Household appliance monitoring system that can be used to calculate energy consumption of the family and to keep the user up to date on his or her electricity usage and be able to make informed decisions. With the advent of Internet of Things (IoT) technology, an existing energy meter with an industrial communication protocol can be adapted to improve connection and observability of power and energy consumption. This can be accomplished by utilizing IoT technology. As a result, this study presents an approach that incorporates IoT technology so that current digital energy meters in buildings can be modified to enable for online monitoring.

II.RELATED WORK

The IoT-based smart energy meters using ESP32 and Blynk 2.0 have gained significant attention in recent years due to their potential in optimizing energy consumption and promoting sustainability. Here's an overview of some related work in this field:

"Design and Implementation of an IoT-Based Smart Energy Meter Using ESP32 and Blynk" by M. F. Amin et al. (2021)
This paper presents a smart energy meter system that utilizes ESP32 and Blynk for real-time energy monitoring and remote control. The system can measure voltage, current, power, and energy consumption, with data transmitted to the Blynk cloud for visualization and analysis.

"IoT-Based Smart Energy Meter Using ESP32 and Blynk" by M. S. Islam et al. (2020)
The authors developed a smart energy meter system capable of monitoring and controlling electrical appliances remotely. The system uses an ESP32 microcontroller to acquire energy consumption data and transmit it to the Blynk app for user access.

"IoT-Based Smart Energy Meter with Blynk App Integration" by S. Chowdhury et al. (2021)
This work proposes an IoT-based smart energy meter system that integrates with the Blynk app for remote monitoring and control. The system utilizes ESP32 and current sensors to measure energy consumption, with data displayed on the Blynk app in real-time.

"Development of an IoT-Based Smart Energy Meter Using ESP32 and Blynk Cloud" by M. S. Rahman et al. (2022)
The authors developed a smart energy meter system that leverages ESP32 and Blynk cloud for real-time monitoring and analysis of energy consumption. The system includes features such as voltage, current, power, and energy measurement, as well as remote control capabilities.

"IoT-Based Smart Energy Monitoring System Using ESP32 and Blynk" by A. K. Das et al. (2021)
This work presents a smart energy monitoring system that employs ESP32 and Blynk for real-time data acquisition and visualization. The system enables users to monitor and analyse energy consumption patterns remotely through the Blynk app. These studies highlight the potential of combining ESP32 and Blynk 2.0 for developing IoT-based smart energy meter systems. The systems typically involve measuring various electrical parameters, transmitting data to the Blynk cloud, and providing user interfaces for real-time monitoring and control through the Blynk app.

III. METHODOLOGY

Energy Meter Integration: The ESP32 is connected to an energy meter or sensor capable of measuring energy consumption. This could be accomplished through various methods, such as using a current transformer (CT) sensor or interfacing with an existing energy meter's pulse output.

Data Acquisition: The ESP32 periodically reads the energy consumption data from the connected meter or sensor and processes it to calculate relevant metrics, such as instantaneous power consumption, cumulative energy usage, and cost estimates.

Wireless Communication: The ESP32 establishes a secure Wi-Fi connection and transmits the processed energy consumption data to the Blynk 2.0 cloud platform using the Blynk library for ESP32.

Blynk App and Dashboard: Users can install the Blynk app on their smartphones or access the Blynk web dashboard to monitor and interact with their smart energy meter system. The Blynk app provides a visually appealing and customizable interface, displaying real-time energy consumption data, historical trends, and other relevant information.

Remote Monitoring and Control: With the Blynk app, users can remotely monitor their energy consumption from anywhere, as long as they have an internet connection. Additionally, the app can be configured to send push notifications or alerts when energy consumption exceeds predefined thresholds, helping users identify and address inefficiencies or potential issues.

Data Analytics and Reporting: The Blynk platform offers advanced data analytics and reporting capabilities, allowing users to generate detailed reports, analyse historical data, and identify energy consumption patterns. This information can be invaluable for optimizing energy usage and implementing energy-saving strategies.

The IoT-based Smart Energy Meter using ESP32 and Blynk 2.0 project offers numerous benefits, including cost savings through increased energy awareness, remote monitoring capabilities, and the potential for integrating with smart home automation systems. It empowers users to take control of their energy consumption and make informed decisions to reduce their carbon footprint and lower their utility bills.

IV.IMPLEMENTATION

The implemented prototype outlines the Vrms to 246.82 V and Irms to 0.0067A displayed on the 16x2 LCD display. The energy profile of the light bulb was effectively captured in the energy monitoring system, as shown in Figure 7. It devoured, according to the widgets. As a result, this type of power and energy consumption exists. Tracking can be a highly valuable technique for determining the power and energy of a system in companies and households, consumption patterns of appliances or electrical machinery are studied and analysed for decision making.

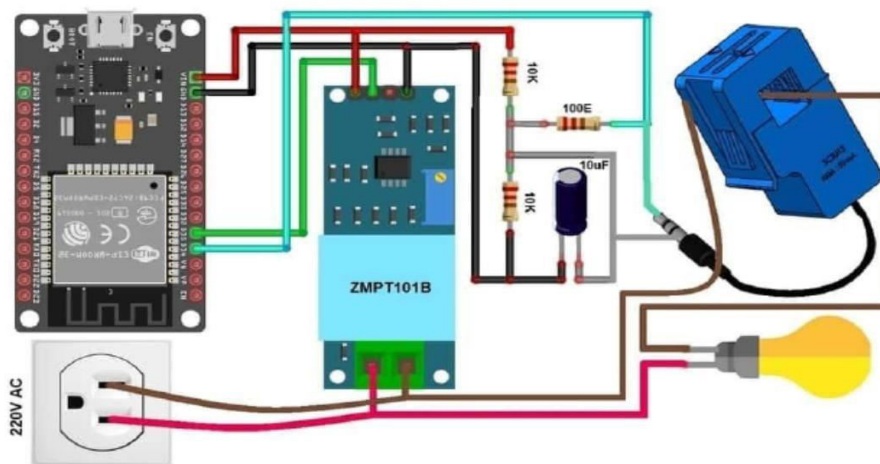


Fig.(a) Connection diagram of IoT based smart energymeter using esp32 and blynk 2.0

Working:

The IoT-based smart energy meter utilizing ESP32 and Blynk 2.0 operates by first interfacing with current and voltage sensors to measure electrical parameters like current flow and voltage across the circuit. These readings are processed by the ESP32 microcontroller, which calculates energy-related metrics such as power consumption. Through a Wi-Fi connection, the ESP32 communicates with the Blynk 2.0 server, enabling real-time transmission of data to the user's smartphone. The Blynk 2.0 app serves as the interface, displaying energy consumption data in user-friendly formats and allowing remote monitoring and control of connected appliances. Users can access historical data, set alerts, and make informed decisions to optimize energy usage. Additionally, security measures ensure the confidentiality and integrity of the data exchanged between the ESP32 and the Blynk 2.0 server, providing a reliable and efficient solution for energy management.

V.EXPERIMENTAL RESULTS

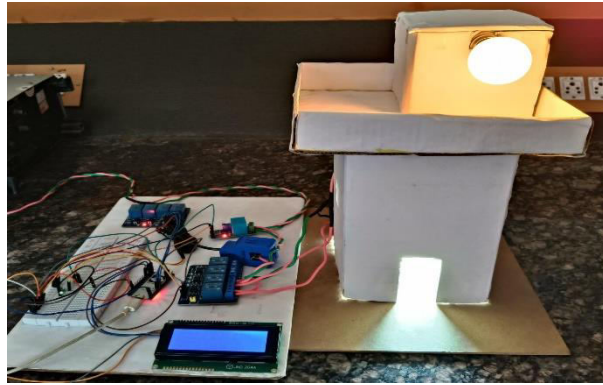
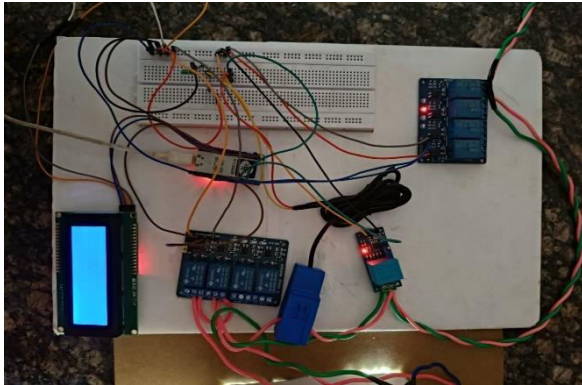


Fig.(b) Overall Hardware Setup

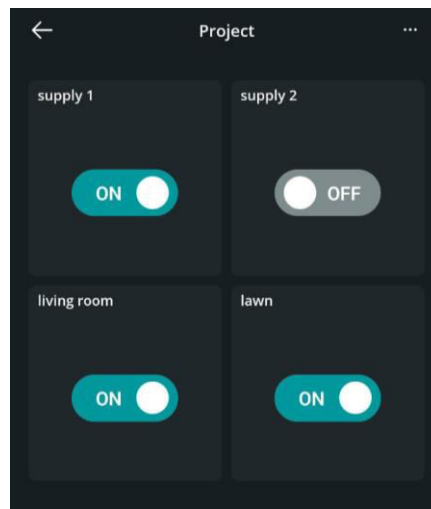
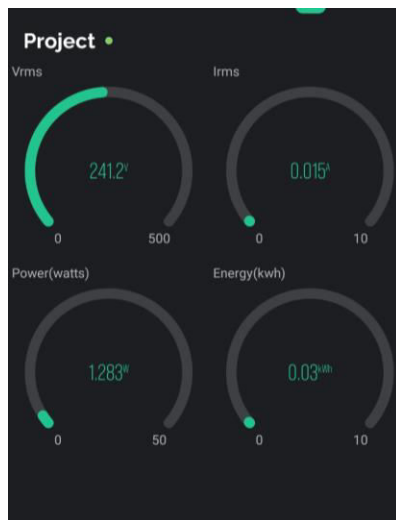


Fig.(c) Output in blynk 2.0& Arduino IoT remote



Fig.(d) Output in LCD Display

VI.CONCLUSION

The IoT-based Smart Energy Meter project utilizing ESP32 and Blynk 2.0 represents a significant advancement in energy monitoring and management systems. By integrating ESP32 microcontrollers with Blynk's user-friendly platform, the project achieves real-time data acquisition and remote control capabilities, empowering users to monitor and regulate energy consumption conveniently from their smartphones. One of the project's key strengths lies in its seamless connectivity, allowing users to access energy data remotely via the Blynk app. This feature enhances convenience and accessibility, enabling users to make informed decisions about energy usage regardless of their location. Moreover, the utilization of ESP32 ensures robust performance and reliability, facilitating accurate data collection and transmission. The project's scalability is another notable aspect, as it can accommodate various sensor types and support expansion to monitor multiple energy parameters simultaneously. Additionally, the integration of Blynk 2.0 introduces enhanced features and customization options, enriching the user experience and enabling tailored energy management solutions. Overall, the IoT-based Smart Energy Meter project offers a comprehensive solution for monitoring and managing energy consumption efficiently. Its combination of hardware reliability, seamless connectivity, and user-friendly interface makes it a valuable tool for both residential and commercial applications, contributing to energy conservation efforts and cost savings.

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