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IOT based Modification of Existing Energy Meter

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ABSTRACT: The proposed meter computes the overall energy usage by measuring the consumer's voltage and current consumption. The user may then track their energy usage in real time by downloading the Blynk app, which receives the data via the I2C module. A relay module on the meter can be used to turn off the power supply in the event that the bill is not paid on time. In order to identify if someone opens the meter to tamper with it, a limit switch is also employed. The proposed meter has several advantages over traditional electricity meters. First, it provides real-time monitoring of energy consumption, which allows consumers to identify and eliminate energy wastage. Second, it has a relay module that can be used to cut off the power supply if the bill is not paid on time, which reduces the risk of electricity theft. Third, it has a limit switch that detects tampering with the meter, which improves security. The proposed meter is implemented using the ESP32 microcontroller, which is a low-cost and powerful microcontroller with built-in Wi-Fi and Bluetooth. The ESP32 microcontroller is used to measure the current and voltage consumption, calculate the total energy consumption, and transmit the data to the Blynk app. The LCD display is used to display the energy consumption to the consumer.

KEYWORDS: ESP32 microcontroller, LCD display, Blynk app.

I. INTRODUCTION

An IoT-based smart electricity meter can be used to monitor and control electricity consumption. The ESP32 microcontroller is a low-cost, low-power microcontroller with built-in Wi-Fi and Bluetooth connectivity. It is ideal for IoT applications, as it can be used to collect data from sensors, process the data, and send it to a cloud-based server or mobile app. The LCD display is used to display the real-time electricity consumption and other information, such as the total energy consumed, the cost of electricity, and the remaining balance. The I2C module is used to communicate with the current sensor and voltage sensor. The current sensor measures the current flowing through the electrical circuit, and the voltage sensor measures the voltage across the circuit. The current sensor and voltage sensor are used to calculate the power consumption. The power consumption is calculated by multiplying the current by the voltage. The relay module is used to control the power supply to the load. If the bill is not paid, the relay module can be used to cut off the power supply to the load. The limit switch is used to detect if the meter is opened. If the meter is opened, the limit switch can be used to generate an alarm or send a notification to the utility company. The Blynk app is a mobile app that can be used to monitor and control IoT devices. The Blynk app can be used to display the real-time electricity consumption, the total energy consumed, the cost of electricity, and the remaining balance. The Blynk app can also be used to control the relay module to cut off the power supply to the load if the bill is not paid. IoT-based smart electricity meters are becoming increasingly popular due to the many benefits they offer. Some of the benefits of IoT-based smart electricity meters include .IoT-based smart electricity meters can help consumers to improve their energy efficiency by providing them with real-time data on their electricity consumption. This data can be used to identify areas where energy is being wasted and to make changes to reduce consumption. IoT-based smart electricity meters can help consumers to reduce their energy costs by providing them with time-of-use pricing. Time-of-use pricing is a pricing structure that charges different rates for electricity at different times of the day. Consumers can use this information to shift their energy consumption to times when the rates are lower .IoT-based smart electricity meters can help to reduce greenhouse gas emissions by helping consumers to reduce their energy consumption.

II. LITERATURE REVIEW

[1]. Sasanenikita N, "IOT based energy meter billing and monitoring system", International research journal of advanced engineering and science, (2017). "Explained the modeling and working of different units of the system and also discussed the components and their functions such that IOT and its working microcontroller and its architecture.

Reducing energy consumption and monitors the units consumed. To make the electrical apparatuses insightful and give solace to devour and to lessen control utilization in web applications.”

[2]. Pandit S, “Smart energy meter using internet of things (IOT)”, VJER vishwakarma Journal of engineering Research, Vol.1, No.2, (2017)“Suggested it considering ARDUINO UNO controller and IOT innovation. On the off chance that any altering happens the controller will send to information to the server and in addition it is chopped down the vitality supply naturally. At the point when most extreme request of vitality expends will be shown in the meter utilized by the customer.”

[3]. Maitra S, “Embedded Energy Meter-A New concept to measure the energy consumed by a consumer and to pay the bill”, Power system technology and IEEE power india conference, (2008).“Clarified in the wake of surpassing the greatest request, the meter and subsequently the association will be consequently disengaged by an installed framework embedded in the meter sensor. The LDR (Light Dependent Resistor) sensor placed on energy meter which sense LED blinking pulse. At that time microcontroller sending this reading via GSM module and its send this message to electricity board. In this framework a keen vitality meter is introduced in each customer unit a server is kept up at the specialist co-op side.”

[4]. Praveen MP, “KSEB to introduce SMS-based fault maintenance system”, The hindu news, (2011).“Smart Power Monitoring Using IoT” that energy Consumption is the very important and challenging issue. Automatic Electrical Energy meter is used in large electric energy distribution system. The integration of the Arduino WIFI and SMS provides the system as Smart Power Monitoring system. Smart energy meter provides data for optimization and less the power consumption.

III. OBJECTIVE

- Develop an IoT-based electricity meter using an ESP32 microcontroller.
- Implement real-time monitoring of electricity consumption.
- Enable remote control of electricity supply using the Blynk app.
- Implement an automated disconnection mechanism for non-payment of bills.
- Detect tampering with the electricity meter using a limit switch.
- Evaluate the accuracy and reliability of the system through testing.
- Demonstr

IV. BLOCK DIAGRAM & WORKING

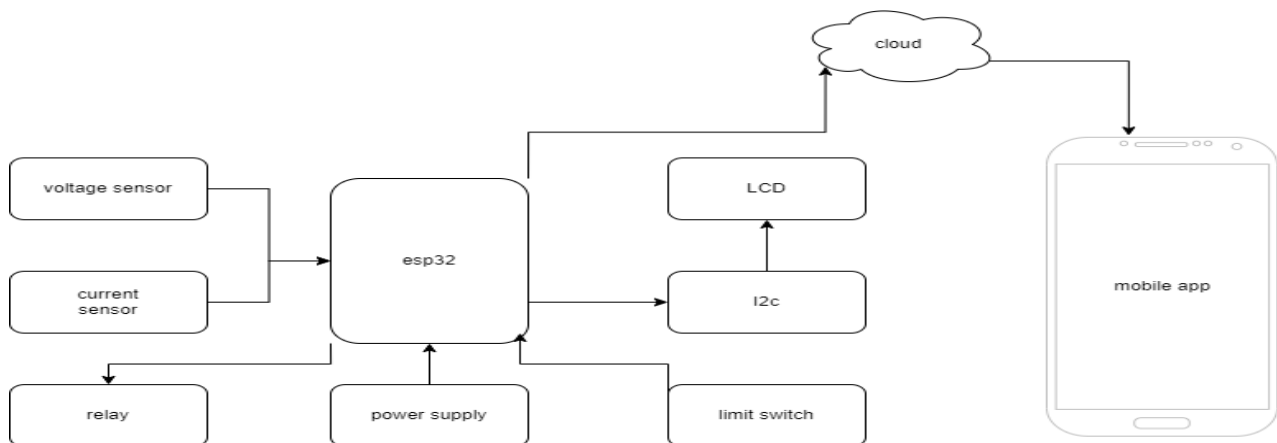


Fig1- Block diagram of smart energy meter

The current sensor and voltage sensor measure the current and voltage flowing through the electrical circuit, respectively. The ESP32 microcontroller reads the data from the current sensor and voltage sensor using the I2C module. The ESP32 microcontroller calculates the energy consumption based on the current and voltage data. The ESP32 microcontroller transmits the consumption data to the BlynkIoT platform over Wi-Fi.

The LCD display displays the energy consumption in real time. If the bill is not paid, the ESP32 microcontroller activates the relay module to cut the power supply to the electrical circuit. If someone opens the meter box, the limit switch is triggered and the ESP32 microcontroller sends an alert to the BlynkIoT platform. The BlynkIoT platform stores the energy consumption data and provides a user interface for the customer to monitor their energy consumption and pay their bills.

Step 1: Measuring the current and voltage.

The current sensor is a non-invasive sensor that clamps around the electrical conductor to measure the current flowing through it. The voltage sensor is connected in parallel with the electrical circuit to measure the voltage.

Step 2: Reading the data from the current and voltage sensors.

The ESP32 microcontroller uses the I2C protocol to communicate with the current sensor and voltage sensor. The I2C protocol is a two-wire serial communication protocol that is commonly used in embedded systems.

Step 3: Calculating the energy consumption.

The ESP32 microcontroller calculates the energy consumption based on the current and voltage data using the following equation:

Energy consumption = (Current x Voltage) x Time

Step 4: Transmitting the energy consumption data to the BlynkIoT platform.

The ESP32 microcontroller uses the Wi-Fi module to transmit the energy consumption data to the BlynkIoT platform. The BlynkIoT platform is a cloud-based platform that provides a variety of tools for developing and managing IoT applications.

Step 5: Displaying the energy consumption in real time.

The ESP32 microcontroller updates the LCD display with the current energy consumption in real time. This allows the customer to monitor their energy consumption and identify any areas where they can save energy.

Step 6: Cutting the power supply if the bill is not paid.

If the customer does not pay their bill, the ESP32 microcontroller activates the relay module to cut the power supply to the electrical circuit. This is done to prevent the customer from using electricity without paying for it.

Step 7: Detecting if someone opens the meter box.

If someone opens the meter box, the limit switch is triggered and the ESP32 microcontroller sends an alert to the BlynkIoT platform. This alert can be used to notify the utility company or the customer of any unauthorized access to the meter box.

V. RESEARCH METHODOLOGY

(1) Design the hardware:

- Select the appropriate components based on your requirements, such as the current sensor range, voltage sensor range, and relay module rating.
- Design the circuit schematic and layout, taking into account the power requirements and signal integrity.
- Build the prototype and test it thoroughly to ensure that it is working properly.

(2) Develop the firmware:

- Write the firmware to read the current and voltage sensors, calculate the energy consumption, and send the data to the Blynk app.
- The firmware should also implement the following features:
 - Display the energy consumption on the LCD display.
 - Cut off the power supply if the bill is not paid.
 - Send an alert if the meter is tampered with.

(3) Setup the Blynk app:

- Create a Blynk account and create a new project.
- Add the necessary widgets to the project to display the energy consumption and other data from the ESP32 microcontroller.

(4). Deploy the system:

- Install the firmware on the ESP32 microcontroller and connect it to the Wi-Fi network.
- Place the smart electricity meter in a suitable location and connect it to the power supply.
- Add the smart electricity meter to your Blynk project.
- Once the system is deployed, you can monitor the energy consumption and other data from the Blynk app. You can also configure the app to send you alerts if the energy consumption exceeds a certain threshold or if the meter is tampered with.

(5). Design the software:

- Select the appropriate components based on your requirements. For example, you will need to select a current sensor that can measure the full range of currents that your appliances can draw. You will also need to select a voltage sensor that can measure the full range of voltages that your power supply can provide.
- Design the circuit schematic and layout. This involves connecting the components together in a way that is both electrically and mechanically sound. You will need to consider factors such as the power requirements of the components, the signal integrity of the signals between the components, and the physical layout of the components on the circuit board.
- Build the prototype and test it thoroughly. This is important to ensure that the circuit works as expected and that it is reliable. You can use a breadboard to build the prototype and then test it using a power supply and a multi-meter.

VI. SIMULATION & RESULT

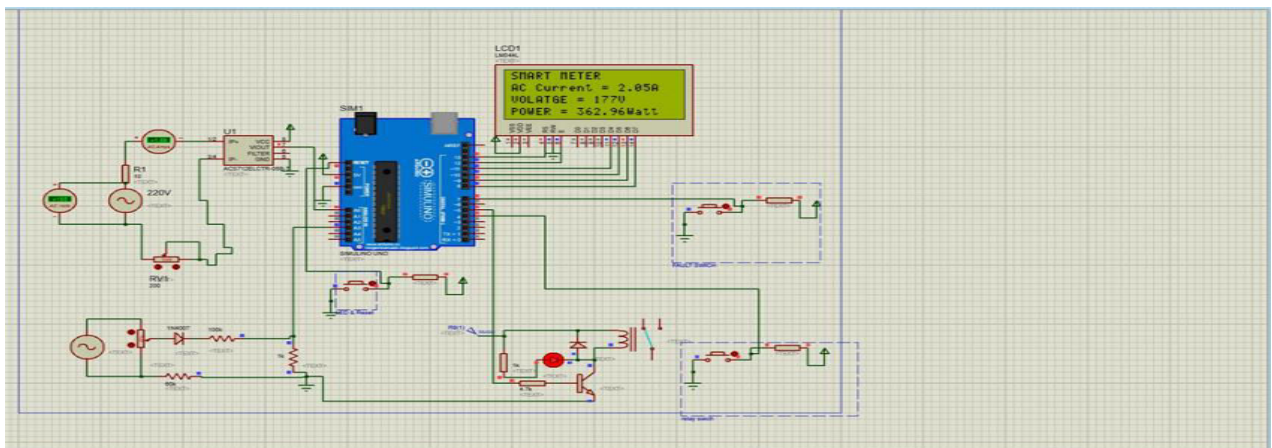


Fig2- Model of smart energy meter

The following components were selected for the IoT-based smart electricity meter:

- **ESP32 microcontroller:** The ESP32 microcontroller is a low-cost, low-power microcontroller that is well-suited for IoT applications. It has a built-in Wi-Fi and Bluetooth module, which makes it easy to connect to the Blynk IoT platform.
- **LCD display:** A small LCD display was selected to display the energy consumption in real time.
- **I2C module:** An I2C module was selected to communicate between the ESP32 microcontroller and the current sensor and voltage sensor.
- **Current sensor:** The SCT-013 current sensor was selected because it is accurate, low-cost, and easy to use.
- **Voltage sensor:** The ZMPT101B voltage sensor was selected because it is accurate, low-cost, and easy to use.
- **Relay module:** A simple relay module was selected to cut the power supply to the electrical circuit if the bill is not paid.
- **Limit switch:** A simple limit switch was selected to detect if someone has opened the meter box.
- **Blynk IoT platform:** The Blynk IoT platform was selected because it is a popular and easy-to-use platform for developing IoT applications.

VII. CONCLUSION

The development of an IoT-based electricity meter using an ESP32 microcontroller has successfully addressed the limitations of traditional electricity meters and demonstrated the transformative potential of IoT technology in electricity management and billing practices. The system's real-time monitoring capabilities, remote control functionality, and automated disconnection mechanism provide a comprehensive solution for enhancing electricity efficiency, reducing wastage, and ensuring timely bill payment. The project objectives were successfully achieved, with the system demonstrating accurate and reliable power consumption measurements, seamless communication between the ESP32 and the Blynk app, effective remote control of the electricity supply, and an automated disconnection mechanism for unpaid bills. Additionally, the limit switch successfully detected tampering attempts, providing an additional layer of security. The IoT-based electricity meter offers several significant advantages over traditional methods: Real-time monitoring: Real-time data collection and visualization enable users to make informed decisions about their electricity consumption patterns, identify potential issues promptly, and optimize usage for cost savings. Remote control: Remote control functionality provides flexibility and convenience in managing electricity supply, allowing authorized users to switch on or off the power supply remotely, reducing the need for physical access to the meter.

VIII. HARDWARE

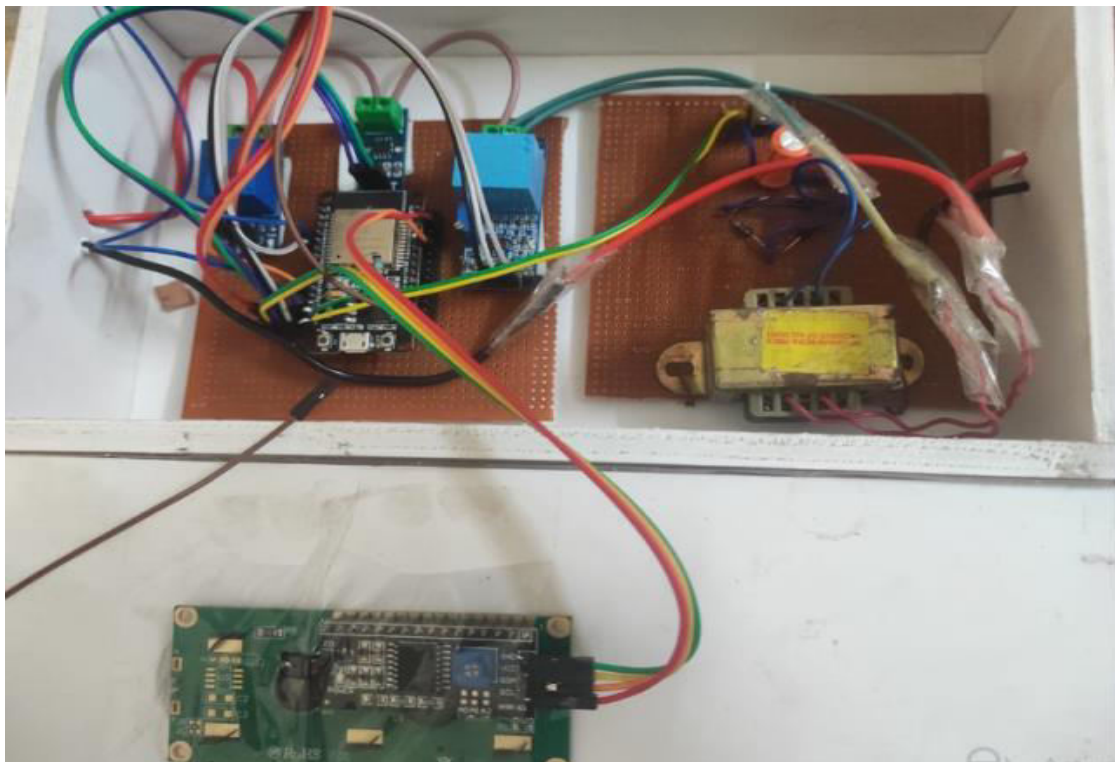


Fig3- Hardware Model of smart energy

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