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IoT Based Smart Metering Mirror System for Monitoring Electric Bills

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Abstract
This project proposes an IoT-based smart metering mirror system designed to monitor electric bills and enhance power efficiency. The system leverages the capabilities of IoT devices, along with integration with the Telegram application, to provide real-time monitoring and control of electricity consumption. Additionally, a prepaid units feature is incorporated to promote power efficiency and enable users to better manage their energy consumption.

The smart metering mirror system utilizes IoT sensors and a microcontroller to gather electricity consumption data from the utility meter. This data is then transmitted wirelessly to a central server for processing and analysis. Through the integration with the Telegram application, users can conveniently access and monitor their electricity usage, billing information, and related insights on their smart phones or other devices.

To encourage power efficiency, the system incorporates a prepaid units feature. Users can purchase a predetermined amount of electricity units in advance, which are deducted based on their consumption. The system provides real-time updates on the remaining units, allowing users to track and adjust their electricity usage accordingly. Notifications and alerts can be sent through the Telegram application to inform users about their consumption patterns and remind them to conserve energy.

Furthermore, the integration with the Telegram application provides a user-friendly and accessible interface for interacting with the system. Users can easily view their consumption data, billing history, and prepaid units information through the familiar Telegram platform. The system's real-time notifications and alerts enhance user engagement and promote proactive energy management.

In summary, the IoT-based smart metering mirror system presented in this project offers an innovative approach to monitor electric bills and improve power efficiency. By leveraging the capabilities of IoT devices and integration with the Telegram application, users can conveniently access and analyze their electricity consumption data, while the prepaid units feature encourages responsible energy usage. This system has the potential to empower users to make informed decisions, reduce energy waste, and optimize their electricity bills.

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Introduction

The energy consumption can be monitored by using an electric device called energy meter. The regular usage of Power consumption is informed to the user to overcome high bill usage. The Energy meter shows the amount of units consumed and transfers the data to both the customer and to the electrical board so this helps in reducing man-power. The user can check their Power usage from the LCD display. The IoT is used to turn on/off the household appliances using relay and ESP32 interfacing. The objective of this system is to monitor the amount of electricity consumed. The distributer and the consumer both will be benefitted by eventually reducing the total power consumption.

The Internet of Things (IoT) is a growing technology in which social surroundings are connected through different sensors networked together. The Internet of Things (IoT) gives an efficient and effective transfer of the information wirelessly of an energy consumer. It also detects the usage of the electricity. the IoT-based Smart Metering Mirror System is a project that aims to revolutionize the way electric bills are monitored and promote power efficiency. By utilizing IoT connectivity, prepaid units, real-time data monitoring, and user control features, the system empowers users to make informed decisions about their energy consumption. With the potential for future enhancements and integration with other technologies, this project contributes to the ongoing efforts in creating a more sustainable and efficient energy landscape.

Literature Review

Anitha et al., [1] proposed “Smart energy meter surveillance using IoT” about IoT, internet of things as an emerging field and IoT based devices have created a revolution in electronics and IT. The foremost objective of this project is to create awareness about energy consumption and. efficient use of home appliances for energy savings. Due to manual work, existing electricity billing system has major drawbacks. This system will give the information on meter reading, power cut when power consumption exceeds beyond the specified limit using IoT.

The Arduino esp8266 micro controller is programmed toper form the objectives with the help of GSM module. It is proposed to overcome all the disadvantages in the already existing energy meter. All the details are sent to the consumer’s mobile through the IoT and the GSM module and it is also displayed in the LCD. It is a time savings and it helps to eliminate the human interference using IoT.

Devadhanishini et al., [2] “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. This system also includes a motion sensor such that if there is no human in house or house it will automatically turn off the power supply.

Mohammed Hosseiu et al., [3] presented a paper titled “Design and implementation of smart meter using IoT” describing the growth of IoT and digital technology. The future energy grid needs to be implemented in a distributed topology that can dynamically absorb different energy sources. IoT can be utilized for various applications of the smart grid consisting

power consumption, smart meter, electric power demand side management and various area of energy production. In this paper, the Smart Energy Metering(SEM) is explained as the main purpose of SEM is necessary for collecting information on energy consumption of household appliances and monitors the environmental parameters and provides the required services to home users.

Himanshu K Patel et al., [4] demonstrated “Arduino based smart energy meter” that removes human intervention in meter readings and bill generation thereby reducing the error that usually causes in India. The system consists the provision of sending an SMS to user for update on energy consumption along with final bill generation along with the freedom of reload via SMS. The disconnection of power supply on demand or due to pending dues was implemented using a relay. The system employs GSM for bidirectional communication.

BibekKanti Barman, et al., [5] proposed “smart meter using IoT” on efficient energy utilization plays a very vital role for the development of smart grid in power system. Hence proper monitoring and controlling of power consumption is a main priority of the smart grid. The energy meter has many problems associated to it and one of the key problems is there is no full duplex communication to solve this problem, a smart energy meter is proposed based on Internet of Things. The smart energy meter controls and calculate the consumption of energy using ESP 8266 12E, a Wi-Fi module and send it to the cloud from where the consumer or customer can observe the reading. Therefore, energy examine has been by the consumer becomes much easier and controllable. This system also helps in detecting energy loss. Thus, this smart meter helps in home automation using IoT.

Garrab et al., [6] proposed AMR approach for energy saving in Smart Grids using Smart Meter and partial Power Line Communication” on the rising demand of energy. Smart meters are one of the proposed solutions for the Smart Grid. In this article, an AMR solution which gives detailed end-to-end application. It is based on an energy meter with low-power microcontroller MSP430FE423A and the Power Line Communication standards. The microcontroller includes an energy metering module ESP430CEl..

Landi et al., [7] presented "ARM-based Energy management system using smart meter and Web server about a low-cost real-time ARM-based energy management system. An integrated Web Server helps to collect the statistics of energy consumptions, power quality and is to interface devices for load displacement. The device is used to access the information. In this way it is possible to manage the power consumption of the power system leading to a consumption of power.

Koay et al., [8] explained "Design and implementation of Bluetooth energy meter" described around the year 2004, digital meter has started to replace the electromechanical meters in Singapore. A wireless digital power meter would offer greater convenience to the meter reading task. Bluetooth technology is a possible wireless solution to this issue. The power reader can collect the power consumption reading from the energy meter wirelessly based on Bluetooth. Two methods that can retrieve the meter reading with little human intervention, are added and implemented in the targeted applications, they are Automatic meter reading(AMR) and the Automatic polling mechanism(APM). Some commercial applications are applied for the Bluetooth-enabled energy meter.

Proposed System

We have made a system that allows users to monitor energy meter readings and also to reduce the power consumption. Our proposed system utilizes energy meter with microcontroller system to monitor energy utilization utilizing a meter.

An IoT Based smart metering system for monitoring electric bills is a technology that uses the Internet of Things (IoT) to measure, manage, and track energy consumption in real-time, with the goal of providing consumers with greater visibility and control over their electric bills. This system typically involves the installation of smart meters at each consumer's premise, which are connected to central network and can communicate with other devices and systems via the internet.

One of the key features of the system is the prepaid units functionality. Users have the ability to purchase and manage a predetermined amount of electricity units in advance. The system deducts the consumed units from the prepaid balance, allowing users to track their usage and make energy-efficient choices. This feature promotes power efficiency and helps users optimize their electric bills.

The system utilizes an ESP32 microcontroller to accurately measure energy consumption using an IR sensor. The collected data is processed and displayed in real-time on an LCD display, allowing users to monitor their electricity usage patterns conveniently. The relay and switch components enable users to control the electrical load, providing added convenience and control over energy consumption.

Block Diagram

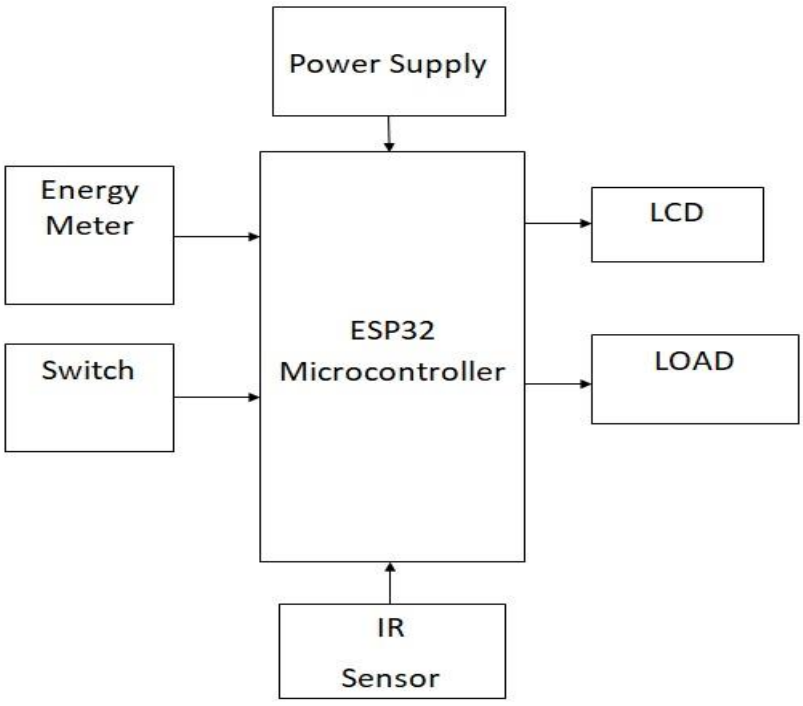

Figure 1: Block Diagram of IOT based Smart metering mirror system for monitoring electric bills

Hardware Components

Power supply

The power supply section is the section which provides +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.The ac voltage, typically 220V, is connected to a transformer, which steps down the ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

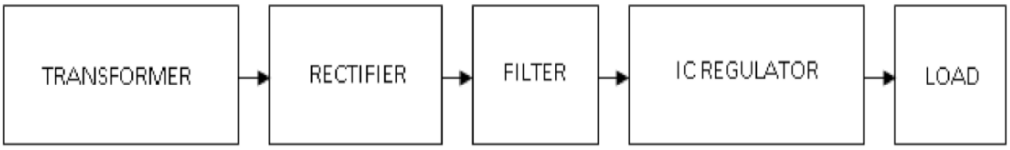

Figure 2: Block diagram of power supply

ESP32 Module

The ESP32 module is a low-cost, low-power system-on-chip (SoC) microcontroller with integrated Wi-Fi and Bluetooth capabilities. It is manufactured by Espressif Systems, and is designed for use in a variety of applications, including Internet of Things (IoT) devices, wearable electronics, and other embedded systems. The ESP32 module features dual-core processors running at up to 240 MHz, as well as a variety of built-in peripherals, including touch sensors, analog-to-digital converters, and pulse width modulation (PWM) controllers. It also includes support for a wide range of communication protocols, including Wi-Fi, Bluetooth, and Ethernet.

Figure: Esp32 Module

LCD (liquid crystal display)

The most commonly used Character based LCDs are based on Hitachi's HD44780 controller or other which are compatible with HD44580. The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters, whereas LCDs supporting more than 80 characters make use of 2

HD44780 controllers. Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections).

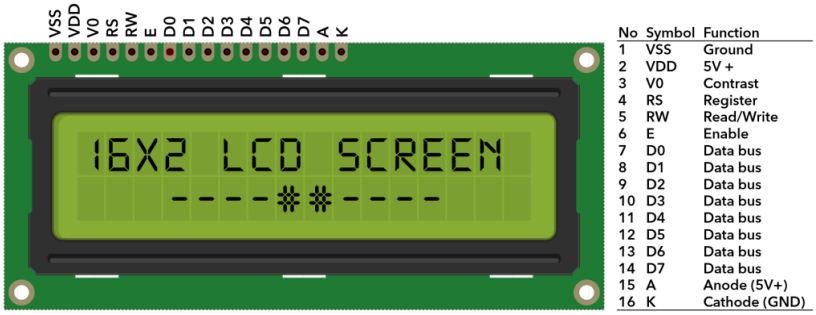

Figure 4: 16x2 LCD Display

Energy Meter

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. Its reading is highly accurate and electronic measurement is more robust than that of the conventional mechanical meters. Energy meters typically consist of a metering device, which measures the amount of electrical power consumed, and a display unit, which displays the energy consumption in kilowatt-hours

Figure 5: Energy Meter

IR Sensor

An IR (Infrared) sensor is a type of electronic device that is used to detect the presence of infrared radiation. Infrared radiation is a form of electromagnetic radiation that is invisible to the human eye, but can be detected by electronic sensors.IR sensors typically consist of an IR source, such as an LED, and an IR detector, such as a photodiode or phototransistor. The IR source emits a beam of infrared radiation, which is reflected off of objects in its path. The reflected radiation is then detected by the IR detector, which generates an electrical signal that is proportional to the intensity of the reflected radiation.

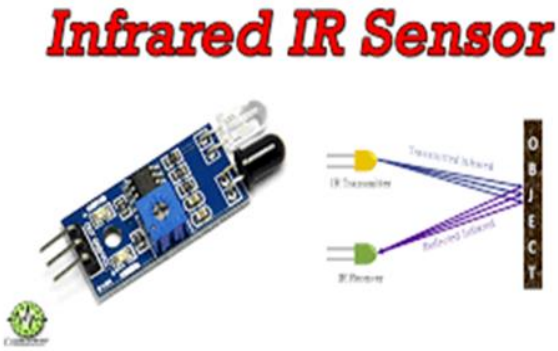

Figure 6: IR Sensor

Relay

A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

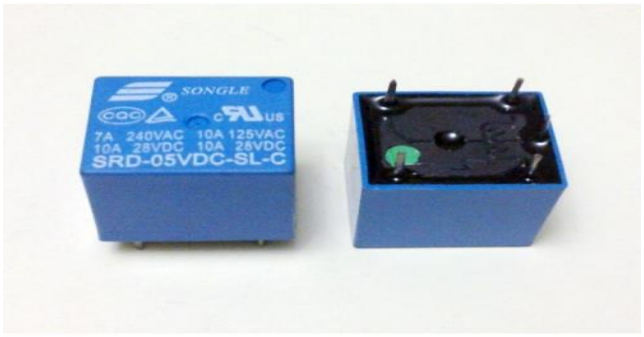

Figure 7: Relay

Result

The IoT-based Smart Metering Mirror System demonstrated promising outcomes in monitoring electric bills and promoting power efficiency. Through the integration of components such as the ESP32 microcontroller, energy meter, IR sensor, relay, switch, power supply, bulb as a load, and LCD display, the system successfully provided real-time monitoring of electricity consumption and empowered users to make informed decisions about their energy usage.

The inclusion of the prepaid units feature proved to be an effective mechanism for promoting power efficiency. Users could conveniently purchase and manage prepaid units, which were deducted based on their actual energy consumption. The remaining prepaid units were continuously updated on the LCD, serving as a constant reminder to users to conserve energy and make sustainable choices. This feature provided users with a sense of accountability and facilitated better energy In conclusion, the results of the IoT-based Smart Metering Mirror System project showed its effectiveness in monitoring electric bills and promoting power efficiency. The system's real-time monitoring, prepaid units feature, user control, and notifications provided users with valuable information and tools to make informed decisions about their energy consumption. The positive user feedback and suggestions for future

enhancements indicate the system's potential for further development and adoption in the field of energy management. Management practices.

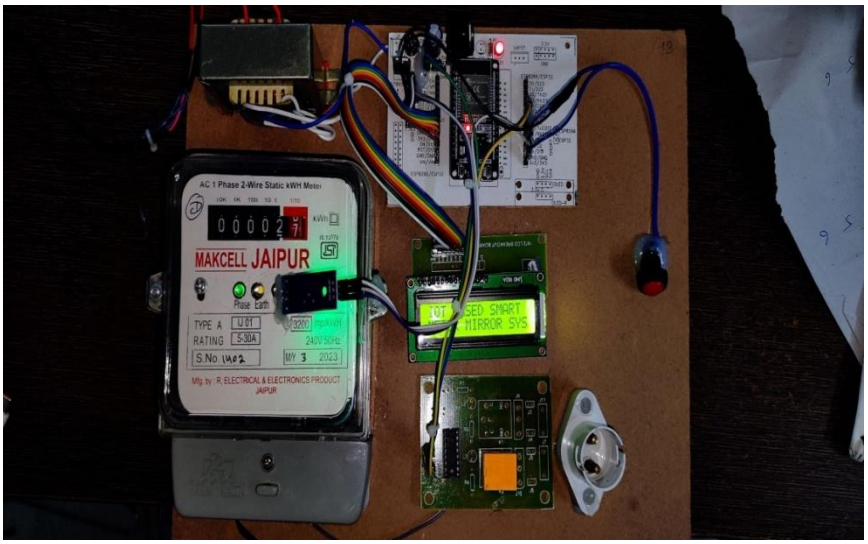

Figure 8.1: Picture of the proposed system

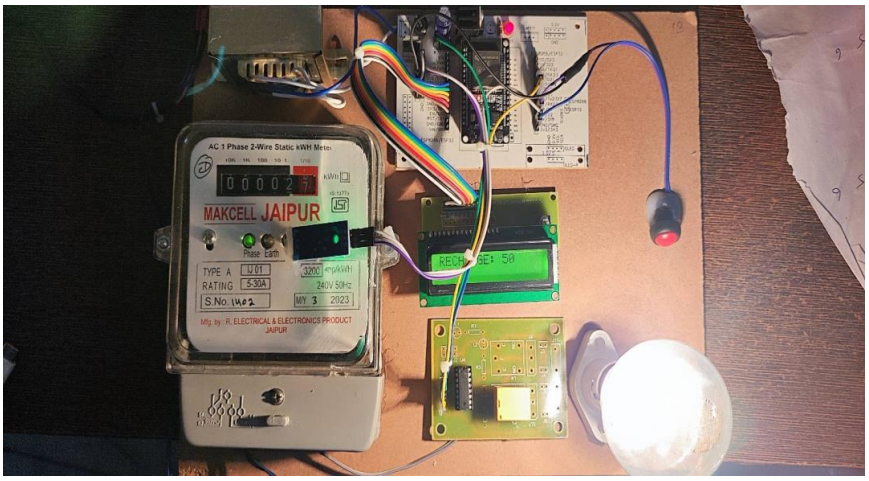

Figure 8.2: After recharging an amount of units, the bulb glows

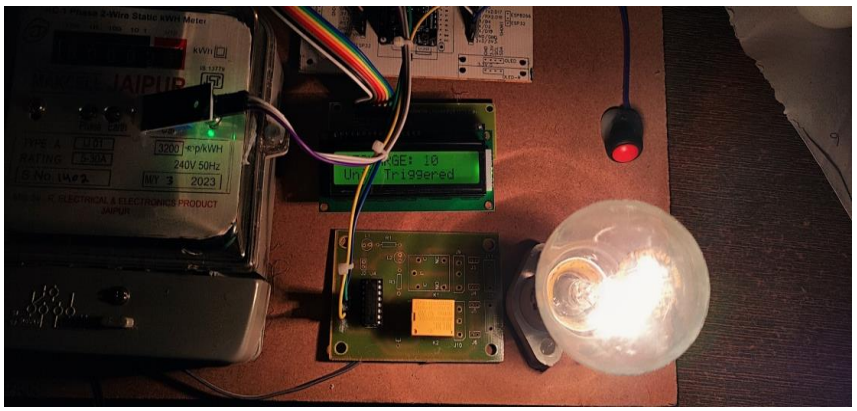

Figure 8.3: Display indicating the units getting triggered along with units remaining

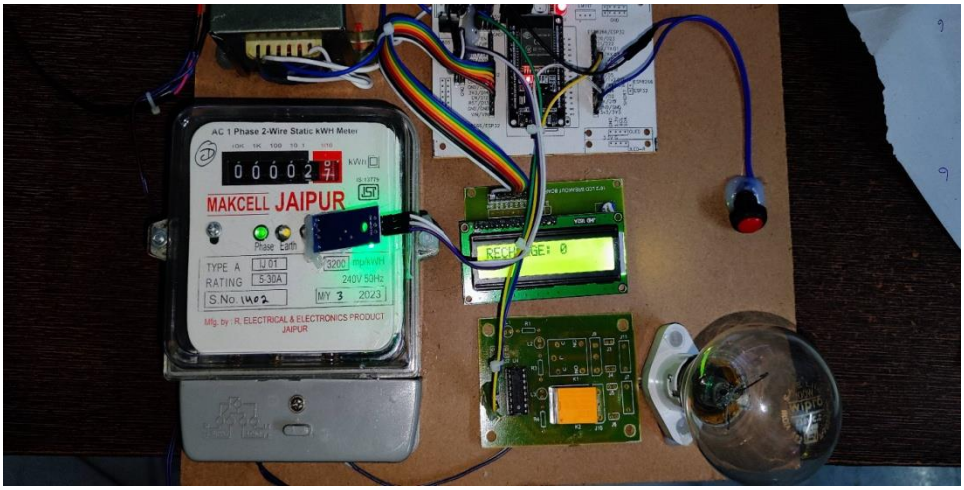

Figure 8.4: Bulb gets turned off after remaining units is 0

Conclusion

The project **"IOT based Smart Metering mirror system for monitoring electric bills"** has been successfully designed and tested. It has been developed by integrating features of all the hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly using highly advanced IC's and with the help of growing technology the project has been successfully implemented.

Future Scope

The future scope of the IoT-based Smart Metering Mirror System project includes potential enhancements and expansions in various aspects. Some potential future developments and areas of growth for this project are:

1. Integration with Smart Home Systems: The system can be integrated with broader smart home automation platforms, allowing users to control and monitor their energy consumption alongside other smart devices such as thermostats, appliances, and lighting systems. This integration would provide a comprehensive smart home energy management solution.
2. Integration with Renewable Energy Sources: The system can be expanded to incorporate renewable energy sources, such as solar panels or wind turbines. By monitoring the generation and consumption of renewable energy, users can optimize their energy usage and make informed decisions about utilizing clean and sustainable power sources.
3. Expansion to Commercial and Industrial Sectors: The project's concepts and functionalities can be extended to commercial and industrial sectors, where energy management and cost optimization are crucial. Monitoring energy usage, billing, and power efficiency in large-scale buildings and industrial facilities can lead to significant energy and cost savings.

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