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## AUTOMATIC WIRELESS ELECTRICITY METERREADING SYSTEM

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**Abstract:** The system is designed for reading electrical energy consumed in units and in rupees to display on an LCD screen as well as in the dedicated application to the user. Owing to high electricity cost these days it becomes necessary for the consumer to know as to how much electricity is consumed to control electricity bill within his budget. This system aims to develop an IOT-based energy meter reading system using Node-MCU. The system is designed to monitor and control the energy consumption of a household or an industry in real-time. Node-MCU is an open-source platform that provides a micro-controller with built-in Wi-Fi capabilities, making it an ideal platform for developing IOT-based systems. The energy meter is connected to Node-MCU, and the energy consumption data is transmitted wirelessly to a cloud-based server. The data can be accessed and analyzed remotely using a web application.

**Index Terms -** Automatic meter reading (AMR), Power Line Carrier (PLC), Radio Frequency (RF).

### I. INTRODUCTION

Electrical power has become indispensable to human survival and progress. Apart from efforts to meet growing demand, automation in the energy distribution is also necessary to enhance people's life standard. Traditional meter reading by human operator is inefficient to meet the future residential needs. So, there is a need for Automatic Meter Reading (AMR) system using Node-MCU, which collects the meter reading electronically, and its application is expanding over industrial, commercial and utility environment. An automatic energy meter reading system is a modern approach to monitor the energy consumption of households and industries. In this system, the Node-MCU acts as the main controller that reads the energy consumption data from the energy meter and transmits it wirelessly to a central server or cloud-based platform for monitoring and analysis.

At present, most of the houses in India have the traditional mechanical watt hour meters and the billing system is not automated. At the end of each month a person from the electricity board goes to every house and takes the meter reading manually. These meter readings are used for electricity bill calculation and this bill sent to consumer house. Customer goes to electricity department for paying this bill amount. But in this technique, we require a number of persons for reading the meters which becomes inefficient. The increase in the population and industrialization in the countries like India, require huge human operators and long working hours to complete the meter reading task, this increases the cost of the energy provider operation for meter reading. Hence AMR concept is used in which an effective mean of the data collection is done that allow saving through the reduction of meter re-read ,more data accuracy, allow frequent reading , accurate billing and customer service, long timely energy profiles and consumption trends updates and better development of human resources. AMR is the technique of automatically collecting consumption, diagnostic, and information from energy meter devices and transferring that, So a system which will provide the units consumed in users mobile will be more suitable in the current scenario.

The concept of AMR dates back to the early 1900s when electricity companies began installing electromechanical meters that could measure and record electricity usage. However, it was not until the 1980s that AMR technology began to be widely adopted. The first generation of AMR systems used a technology called PLC, which used the existing power line infrastructure to transmit data between the meter and the utility company. This technology was limited in its range and reliability, and was eventually replaced by newer wireless technologies such as RF and cellular networks.

In the early 2000s, the development of smart metering technology began to gain momentum. Smart meters are digital meters that can communicate with the utility company in real-time, providing more accurate and detailed information about energy usage. They also have the ability to detect and report power outages, which helps utilities respond more quickly to outages and minimize their impact.

Overall, the automatic energy meter reading system using Node-MCU is a cost-effective and efficient way to monitor and manage energy consumption in households and industries. It offers real-time data, remote monitoring, and energy-saving opportunities. The system can be easily customized and scaled to meet the specific needs of different applications.

## II. LITERATURE REVIEW

System consists of GSM modem which is connected to energy meter. The SIM card is implemented in energy meter it sends message to the user about the due bill. For every 30 days, the number of units consumed is sent to electricity board office. User can pay the amount just by knowing the code that is fed in meter. [1]

System consists of GSM digital power meter installed in consumer unit and electricity e-billing system at energy provider side. GSM digital power meter utilize GSM network to send power usage reading through SMS to energy provider. At the power provider side Ebilling system is used to manage all received SMS meter reading, compute the billing cost and publish billing notification to consumer through SMS. [2]

The core component of Home Energy Management System (HEMS) is smart controller. It provides system management functionalities like logging, monitoring, and control. Smart controller collects real time electricity consumption data from schedulable and non schedulable appliances to implement optimal demand management strategies. [3]

The paper proposes two embedded energy meters one is placed at consumer's house and another is placed at street transformer. Consumer end energy meter measures consumption of electrical energy through sensing devices and output is given to ADC. The main energy meter placed at street transformer records total transferred electrical energy per month. [4]

The digital energy meter records amount of power consumption. Each time the LED blinks current flows through IR diode which emits infrared light proportional to current. This emitted infrared light incident on base of phototransistor causing it to switch on. The pulses from phototransistor are fed to microcontroller as an interrupt to count total consumption of user. The digital meter used here considers 3200 blinks of LED one unit of power consumption per hour. [5]

Paper presents the design of a simple low cost wireless GSM energy meter and its associated web interface, for automating billing and managing the collected data globally. The proposed system replaces traditional meter reading methods and enables remote access of existing energy meter by the energy provider. Also they can monitor the meter readings regularly without the person visiting each house. Here a new method of post paid electronic energy metering is introduced in this paper which will automatically sense the used energy, records these reading continuously, then sends it to the billing point through the existing GSM network. Finally after processing the collected data bill is generated using a web based system software and is send back to the customer as SMS. [6]

Paper presents a smart energy meter for an automatic metering and billing system. In this meter energy utilized and the corresponding amount will be displayed on the LCD continuously and communicated to the controlling base station. The feedback from the user helps in identifying the usages between authorized and unauthorized users which helps in controlling the power theft. Communication between user/household and substation is done using Zig-bee. GSM network is used for sending SMS to the local authorities regarding the theft cases. This meter can work as either prepaid or post-paid meter. [7]

They have done a development of an automatic meter reading system focusing on the design for an energy meter implemented with Zig-Bee wireless communication protocol conforming to IEEE 802.15.4 standard. [8]

They have presented the design and implementation issues of a Bluetooth- Enabled Energy Meter. The Energy Reader can collect the energy consumption reading from the Energy Meter wirelessly based on Bluetooth. Two methods, which can retrieve the meter reading with little human intervention, are proposed and implemented in the targeted applications. They are AMR (Automatic Meter Reading) and the APM (Automatic Polling Mechanism). [9]

It solves many issues of the traditional meter reading system like need for human resources, efficiency, accuracy, delayed work, unavailability of customer during metering visit by employee, etc. Moreover it is more economical and helps to save energy in a more efficient and effective way. Furthermore it has a very notable advantage of having the ability to predict the energy demands of the future, starting from every household to the entire planet. Instead of GSM network existing power lines can be used for communication. [10].

## III. METHODOLOGY

The prime aim of the system is to make an automated system for energy meter reading that reduces the need for human intervention. Here LED terminals of energy meter is connected to 1 and 2 terminals of Opto-Coupler and 3rd terminal of Opto-Coupler is connected to Vin of Node-MCU and 4<sup>th</sup> terminal, through resistor it is connected to Gnd and D3 pin of Node- MCU shown in Fig 1.

The energy meter produces pulses corresponding to the electricity usage of the connected appliances. The Opto-Coupler senses these pulses and converts into electrical signal of corresponding amplitude. Whenever the voltage in LED of the energy meter pass through Opto-coupler to Node-MCU, Current starts to flow from Vin to D3 Pin. As per the program when D3 pin goes High it should count for one pulse.

After receiving 3200 pulse signals it reads 1kWh of the electricity is consumed. So after every 3200 pulses from the energy meter the count is incremented. The data is updated regularly to the database via ESP8266. The database will contain all these data.

If someone doesn't have a Smartphone, the AMR system will have the LCD display which displays the consumed unit, so that user can still view the units displayed. For implementation of AMR a Node-MCU must be connected to the internet and communicate with other devices or servers without using a SIM card. The reading information is reverted back to the customer through app. The user can have a detailed look of the history as well in the app. Also, Since all user aren't connected with the internet and Smart phones, through LCD Display user can view the units consumed. If the user becomes aware of the leakage in the Electricity he can control load appliances by turning ON/OFF using Blynk App.

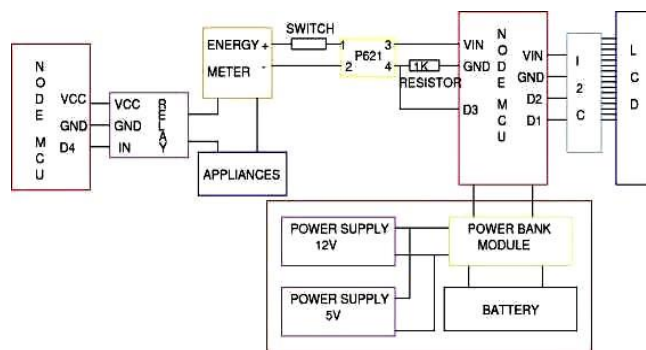


Fig .1 Block diagram of the proposed system

### ALGORITHM

**Step 1:** Energy meter and Wi-Fi module are initialized.

**Step 2:** The pulse generating from the energy meter is read through Opto-Coupler to Node- MCU.

**Step 3:** Node-MCU receives the pulses.

**Step 4:** Unit and Rupees calculation can be done by program.

**1 unit=1kWh=3200 pulse. 5 Rupees = 1unit.**

**Step 5:** The data (calculated units) is sent to the database through Wi-Fi module, data containing the units consumed, rupees of that unit is displayed on LCD and dedicated app.

**Step 6:** Appliances given as load can be remotely controlled using Blynk App.

### DETAILS OF COMPONENTS:

#### Energy Meter

An energy meter as shown in fig 3 or electric meter is a device that measures the amount of electrical energy by a residence, business, or an electrically-powered device. Electric meters are typically calibrated in billing units, the most common one being the kilowatt hour.

#### Power Bank Module

A power bank module is a portable device as shown in fig 4 that provides backup power to electronic devices such as smart phones, tablets, and laptops. It typically consists of a lithium- ion battery, a circuit board, and a set of connectors for input and output. The input connector allows the power bank to be charged from an external power source, such as a wall outlet or a solar panel.

The output connectors provide power to the device being charged. Power bank modules come in different capacities, ranging from 1000mAh to 100,000mAh or more, and can charge multiple devices simultaneously. They are widely used for outdoor activities, travel, and emergencies where a reliable source of power is needed.

#### Software

Firestore is a mobile and web application development platform that provides various backend services to help developers build high-quality and scalable applications. One of the key services that Firestore offers is the Firestore Server, which is a cloud-based server that allows you to store and manage your application data.

Firestore Server provides a real-time database that allows developers to store and synchronize data between clients and servers in real-time. This means that any changes made by one client will be immediately visible to all other clients using the same data. The Firestore Server also provides cloud storage for storing and sharing files, such as images, videos, and documents.

Another key feature of Firestore Server is its user authentication system, which allows developers to easily manage user authentication and access control. With Firestore authentication, developers can support various login methods, including email and password, phone number, Google, Facebook, Twitter, and other social media accounts.

Firestore Server also provides APIs for sending and receiving push notifications, allowing developers to send notifications to users even when the app is not open. Additionally, it offers cloud messaging, which allows developers to send messages to specific user segments or all users of the app.

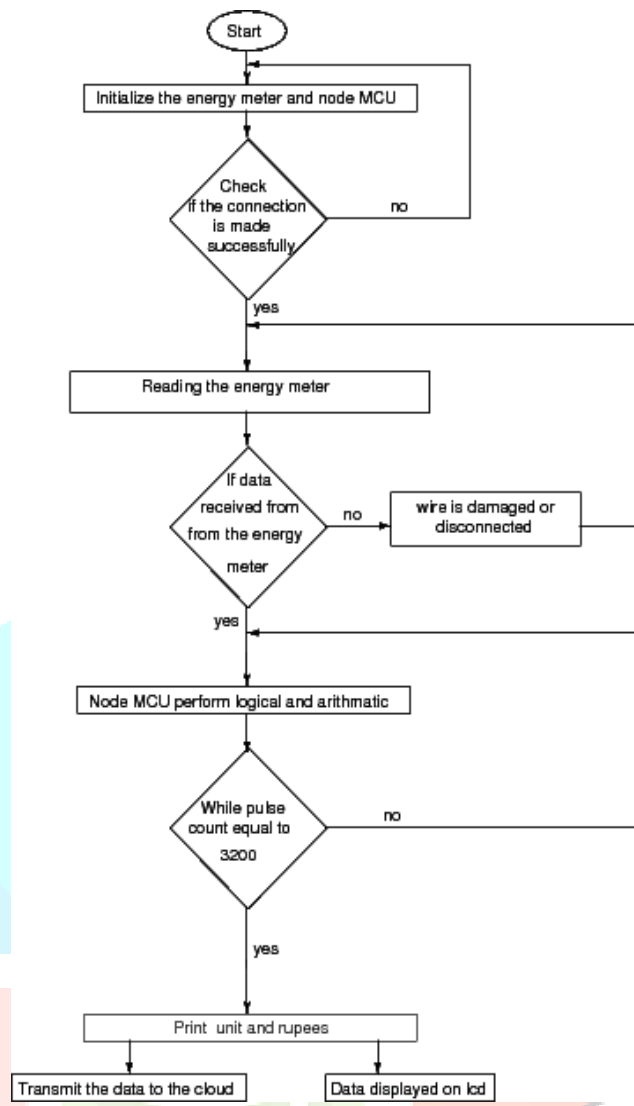


Fig.2. Flow Chart



Fig.3. Energy Meter



Fig.4. Power bank module

### IOT mobile application

Firestore acts as an interface between the hardware and IOT mobile application. The data from the Node-MCU is continuously uploaded accordingly. The IOT mobile application is built using MIT App inventor as shown in fig 5.



Fig 5. App layout

MIT App Inventor is a visual programming tool that allows you to create mobile applications for Android devices without needing to write any code. It provides a drag-and-drop interface for designing the user interface of the app and a blocks-based programming language for adding functionality to the app.

To create a system in MIT App Inventor, you would start by creating a new project and selecting a blank template or a template that fits your needs. You would then use the drag- and-drop interface to design the user interface of your app, which could include buttons, text boxes, images, and other components. You can also use the designer to set properties for each component, such as the text of a button or the image displayed in an image component. Once you have designed the user interface of your app, you can use the blocks editor to add functionality to your app. The blocks editor allows you to create code using visual blocks that represent programming concepts such as loops, conditionals, and variables. You can drag blocks from the blocks palette and snap them together to create code that controls the behavior of your app. It will notify the user about the Electric pulse count, Units, Rupees of Electricity consumed through this app.

### IV. RESULTS AND DISCUSSION

The prime aim of the system is to make an automated system to detect Electricity consumption. So that user comes to know his daily consumed Electrical units through Mobile App and LCD Display. Fig.6 shows a complete of Automatic Wireless Electricity meter reading system.



Fig.6. Working model of IOT Based Automatic wireless Electricity Meter Reading System

Below Fig.7 depicts the count of consumed electric pulses along with the corresponding unit of measurement and cost in rupees per unit.

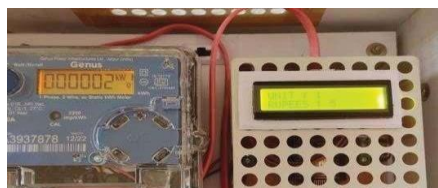


Fig.7. LCD displaying the units consumed and Rupees per unit

The calculated Electric pulse, Unit, Rupees values stored in the Node-MCU are uploaded to the Firestore as shown in fig 8. The data stored in the Firestore can be shown through mobile Application which is developed by using MIT App inventor as shown in the fig 9. If a customer becomes aware of electricity leakage or excessive usage in their house or industry, they can employ the Blynk software to address the issue. By using the Blynk mobile app the customer can control the power supply to their entire load

by tapping or clicking on button as shown in the fig 10, they can trigger the action to either turn on or turn off the power supply, depending on their requirements.



Fig.8. Data Entries in Real time Database of Firebase

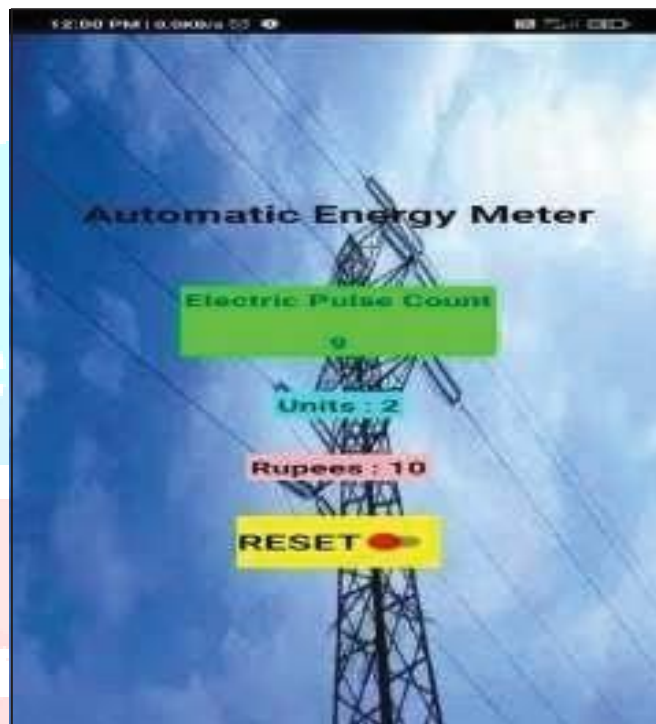


Fig.9. Data Visualization on Mobile Screen



Fig.10. Mobile view of Blynk App

#### IV. CONCLUSION

In conclusion, automatic energy meter reading offers numerous benefits over traditional manual meter reading, including increased accuracy, convenience, and cost savings. By leveraging advanced technologies such as IOT, automatic energy meter reading enables utilities to collect and analyze data in real-time, optimize energy usage, and improve customer service. Additionally, automatic energy meter reading helps reduce the carbon footprint by reducing the need for physical travel and resources used in manual meter reading. Overall, automatic energy meter reading is a significant step towards achieving a more efficient, sustainable, and technologically advanced energy sector. From this system, customer can easily know his daily energy consumption in his mobile phone.

#### V. FUTURE SCOPE

The Project can be modified by using machine learning algorithms and real-time data, such that automatic energy meter reading system can predict maintenance needs for energy equipment and prevent costly breakdown and outages.

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