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Smart Metering Infrastructure and Customer System Using IoT

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***Abstract*: In recent state of affairs, electricity saving has become a key factor in every household because of the raising awareness about the need for reducing excess consumption of energy. In the current scenario a designated person from the electrical department visits each and every house of a region, assess the meter board, takes the reading and generates true copy of the electricity bill to the customer. This whole process is tedious which involves much of time and human power. We have developed an IoT-based smart energy meter that is based on an energy tracking and bill estimation system as a solution. In our proposed system, the energy meter is connected to the MCU which takes the reading from the meter and updates it on the GUI system which is connected through Wi-Fi module. The reading of consumption is updated frequently in stipulated time. Here the customer gets notified about the energy consumption.**

***Keywords*: Smart meter, Smart grid, AMI, ZigBee.**

1. Introduction

The existing billing system employs a manual bill generation method that consumes a significant amount of manpower. It causes a large number of calculation mistakes and flaws.

The current device also lacks the capability of informing a user about his energy use on a daily basis, leaving the user surprised when he receives a large energy bill at the end of the month. The article outlines the assignment, which is entirely dependent on a "Smart Energy Meter," which specializes in delivering information about his daily energy usage and value via a user interface, as well as predicting his bill so that one may be prepared at the end of the month.

After he has successfully logged in to the portal using accurate information, all of his records will be shown on his dashboard.

Even if the user does not check his account on the portal, the system will send him an SMS informing him about his consumption when a threshold amount is reached.

2. Literature Survey

Mathur R., & Kalbande K. [1] expressed that by utilizing cost-effective binary actuators and a database maintained in the cloud to monitor power use. It can keep an eye on electrical equipment and gadgets that use various power phases. It has an IoT cloud interface that is compatible with every mobile device and can be utilized in both household and commercial settings.

Mir, S. H., Ashruf, S., Bhat, Y., & Beigh, N. [2] showcased an Arduino and GSM-based Smart Energy Meter that can read and send data wirelessly using GSM technology through a GSM modem and control both the meter and the line connection are used in the complex metering and billing system.

Veloso, A. F. D. S., Rodrigues, A. A., Sobral, J. V., Rodrigues, J. J., Feitosa, M. S., & Rabelo, R. A. [3] expressed that the Making and actual demonstration of Smart Meters (SMs) that use IEEE 802.15.4 to read and deliver data on home power consumption. The system was created to offer two-way communication between the residences and the Electronic Prescription of Controlled Substances in a Smart Grid. It was also created to be simple to use, inexpensive, ideal for integration with wireless technologies, and straightforward to install. An Advanced Metering Infrastructure (AMI) and several software implementations were developed to permit the use of SMs. An application was created for customers to track their power usage, consumption patterns, and expected pricing value.

Raju, R., Madhumathy, P., & Pavithra, G. [4] have said that a number of automated power billing systems have been proposed. These systems are designed to increase consumer and electricity board transparency in terms of invoicing and use. The main differences between the systems, their scope and potential improvements, as well as their benefits and drawbacks, have all been explored. It has been done to analyse the technologies utilised for smart metres, including ZigBee, wireless mesh networks, cellular communication systems, and wi-fi.

This study provided a broad overview of the evolution of energy billing, including its modes of operation and ways of payment. A quick study was conducted after classifying the systems according to their communication mechanism.

Pooja Raju Warghat, Ayushi Tiwari, Oshin Gaikwad, Roshani Bambal, Shubham Randhe. [5] expressed that the Arduino Uno board, Wi-Fi module and an LCD display. The Wi-Fi module serves as the foundation for IoT operations. The meter values are sensed by the Arduino Uno board, which is attached to a sensor, and are then processed and updated over Wi-Fi via the Wi-Fi module. The readings are updated over the webpage which can be easily accessed by the users. In this system the user will also be notified about the consumption

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through the SMS when the energy consumption reaches the threshold value. This allows the user to easily check the energy usage by using a simple web application.

Arduino Uno: 32 general purpose working registers are combined with a robust instruction set in the Atmel AVR® core. The resulting design is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

GSM Module: Using the internal Transmission Control Protocol/Internet Protocol (TCP/IP) stack of the Global Systems for Mobile/General Packet Radio Service (GSM/ GPRS) modem, you can access the internet using General Packet Radio Service (GPRS).

It is appropriate for machine-to-machine (M2M) interface applications involving short messaging service (SMS), voice, and data transfer. Several unregulated power supply can be connected to the onboard regulated power source. Through straightforward Asynchronous Transmission instructions, you may use this modem to make audio calls, send and receive SMS, answer incoming calls, access the internet, and more.

3. Proposed Solution

Nowadays, keeping track of your power usage is a difficult chore since it takes a lot of work to routinely check the meter room. However, it is crucial to know if you are being charged equally, so the requirement is obvious.

We have developed a solution that enables IOT users to keep an eye on energy meter data. To track energy usage, our suggested solution uses an energy meter and microcontroller system. The current sensor is used to track the cost and number of units used. In this manner, the energy meter will be able to monitor consumption from any point in the globe, and the user will also be able to turn on and off loads via IOT cloud services.

A. Methodology

The current sensor is connected to the Arduino microcontroller for unit measurement. The microcontroller gathers the current's real-time readings. An LCD monitor that is attached to the micro controller is used to see this.

The user will able to Switch on and off the load from remote location using IOT smart phone. Based on load on or off status the consumption will be show on IOT App. The LCD display shows the unit count readings.

B. Design Procedure

Place your components on the circuit board. Plan the wiring on the board based on pins of components Connect the components using Kynar wire.

C. Programming

- Open-source software called Arduino IDE is mostly used for authoring and compiling code into Arduino Modules.
- Code compilation is so straightforward because it is an official Arduino application that even the typical person without prior technical knowledge may begin learning.
- It runs on the Java Platform, which is readily available for MAC, Windows, and Linux operating systems. For debugging, editing, and compiling the code in the environment, this platform includes built-in functions and commands.
- Several Arduino modules are available, including the Uno, Mega, Leonardo, Micro, and many others.
- A microcontroller that is really programmed and accepts data in the form of code is located on the board of each of them.
- The primary code, often referred to as a sketch, written on the platform of an integrated development environment (IDE) will eventually produce a Hex File, which is then transferred and uploaded into the controller on the board.
- The Editor and Compiler are the two main building blocks of the IDE environment; the Editor is used to write the necessary code, while the Compiler compiles and uploads the code into the given Arduino Module.
- Both C and C++ are supported in this environment.

4. Smart Meter Design and its Parts

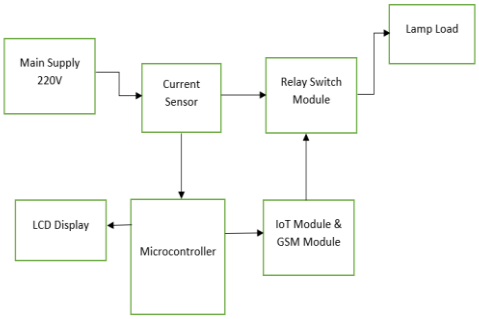

Fig. 1. System architecture

Figure 1 depicts the hardware architecture of the system. As we can the power is taken from main supply and fed to the current sensor, which senses the current and forwards the data to the microcontroller. The microcontroller is connected with The Global Systems for Mobile & Wireless Fidelity module. The instruction is provided by the user is received from the IoT module and preform the related tasks of controlling the loads. The consumption of the loads is displayed on the Liquid-crystal display. The description of the hardware components is given below:

Hardware Part used,

- Microcontroller
- LCD display
- IoT Module
- GSM Module
- Current Sensor
- Relay module
- Load lamp
- Lamp Holder
- 1N4007
- BC547
- Power Supply

- Connecting wire

5. Result

A. Experimental Results of Smart Energy Meter

HARDWARE IMPLEMENTATION

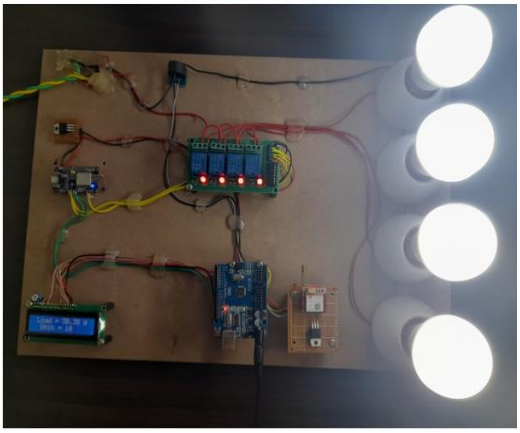

Fig. 2. Hardware implementation

The intended Device's tested effects are included in this section. In Fig. 2, a smart meter's hardware implementation is shown with a liquid crystal display for the output and relays that are switched in response to commands sent from the Blynk IoT app using NodeMCU.

Real-time results of total Watts consumed by all connected loads are computed and shown on the LCD display as shown in Fig. 3. Average load consumption details for all connected loads are calculated.

LCD DISPLAY

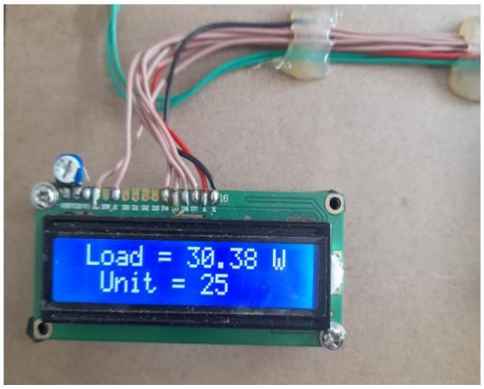

Fig. 3. LCD display

All the loads which are connected to the system are controlled by the Blynk IoT app with the help of Relay module. And the total unit consumed by the loads, Bill of the total consumption is displayed on the Blynk IoT app. As shown in the Fig. 4.

It is possible to get power usage notifications through SMS on this network, using the GSM module that has been used, which has nationwide coverage. This SMS is sent to the users registered mobile number at every 25 units with the amount as shown in the Fig. 5.

Blynk IoT App

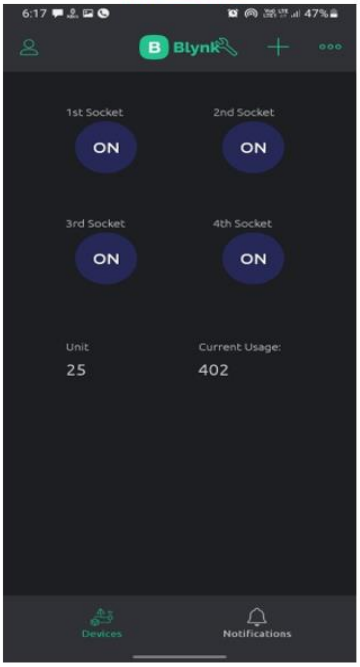

Fig. 4. Blynk IoT app

SMS NOTIFICATION

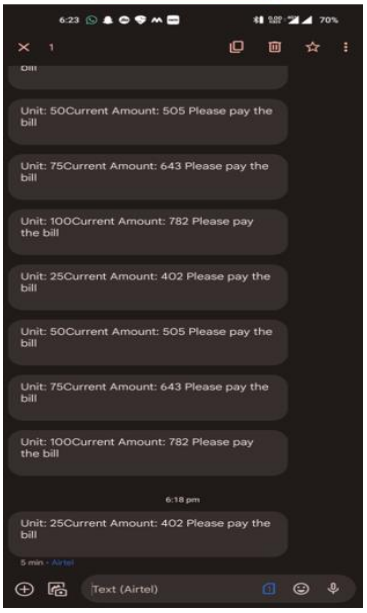

Fig. 5. SMS notification

6. Conclusion

The Energy Meter based on Microcontroller is used to update to the user about the usage of unit count. With this information user can get help in saving electricity and also keeping the electricity bills under limits. User will able to control the load from anywhere of world location using smart phone IOT platform. We are interfacing relay module with microcontroller to switch ON and OFF the load. Based on load status, user will able to see the consumption in from of watt.

7. Future Scope

For future work, we suggest expanding the smart meter to work with three-phase system and to replace the display module with another device that has the ability to display the results in a graphical form. Following changes are recommended in future the implement of this project to make it more accurate and reliable.

- Three-Phase measuring
- Graphical display
- Increase LCD size
- More compact size

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