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SMART ENERGY METER FOR SMOOTH AND UNITERRUPTED ELECTRICITY SERVICE

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Abstract: While innovative solutions are being developed continuously to meet ever increasing energy demands, progressive applications and technologies that need more energy are being developed simultaneously. Given that smart grids are being installed at various locations in the country to solve the problem of ever increasing energy demand and with the change in the grid type there is a change required to the conventional metering system. Therefore, a smart meter has been designed to address this problem. This smart energy meter incorporates Energy Management System and it is connected to the internet to provide a smooth and uninterrupted control over home loads. The designed energy meter presents the following characteristics:

1) CONTROLLING HOME EQUIPMENTS VIA IOT
2) SMART PLUG
3) LOAD SCHEDULING
4) ENERGY METERING
5) BI-DIRECTIONAL FLOW OF POWER

The designed smart meter is focuses around the concept of real time prices of electricity which fluctuate with time in the installed smart grids and a generalization that Electricity pricing is high during the day time and vice versa has been taken into consideration.

Index Terms - ***Smart energy meter, Arduino, Android, Smart-meter, Measurement system, Monitoring Arduino.***

I. INTRODUCTION

A Smart Grid is a digital electrical grid that makes it easier to gather and distribute the information with regard to the usage of power by suppliers and consumers. This will enable the electricity services to become more reliable, efficient, cost-effective, and environmentally conscious. Smart grid always comes equipped with smart meters which are actually a next generation meter for both gas and electricity. They are replacement for standard meters, which use technology created decades ago which were very venerable to the conventional meters and require households to track their own readings and submit them to suppliers if they want accurate bills. Smart meters use a secure national communication network (called the DCC) to automatically and wirelessly send your actual energy usage to your supplier.

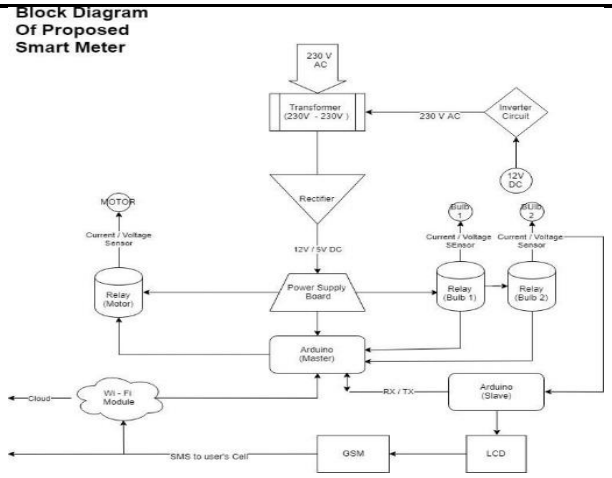

FIG I: Block Diagram of proposed smart meter

This means households will no longer depend on estimated energy bills or have to provide their own regular energy readings. Smart meters will also have an in-home display. This display gives the household real-time usage information, including kWh usage and cost. In this project, the designed system depicts a smart meter where in a smart house is created with the help of NODE MCU, Smart Plugs, Digital Meter, BLUETOOTH Module, Arduino and an online interface.

With the rise in energy demand, the sustainable energy systems have gained popularity in both residential and commercial areas. Smart meters are becoming an integral part of smart grids in the distribution side connected to local electricity utilities to know about the day to day energy usage and billing information on a daily basis. These smart meters are replacing the existing digital and analog electric energy meters. The energy consumption information can be transmitted back to the utility on a much more frequent schedule by the Digital meters than analog meters that require a meter reader to transmit information. Electric energy use will be recorded every hour or less at your home.

II. SMART ENERGY METER

Proposed system is a smart meter with control and automation capabilities. The smart meter to be made must exhibit Load Scheduling, bi-directional flow of power i.e. achieved with the help of an inverter circuit. Microcontroller (Arduino UNO), power supply board (12V, 5V), loads (AC / DC), NODE MCU (for enabling IoT), Relays, LCD and BLUETOOTH are the major components used in the design. An online user interface is provided for control of the load appliances and the synchronous response is obtained through any stable internet connection. The proposed system has a current sensor, Voltage sensor, Arduino board, relay, loads and a BLUETOOTH module. The current and voltage sensor will sense the current and voltage if the load is turned on, i.e. the current and voltage values will be recorded by the sensors and the values will be uploaded to the cloud services. It can be also seen on the LCD display. The values and the billing amount will be sent via a message to the user mobile with the use of BLUETOOTH once the loads are turned ON.

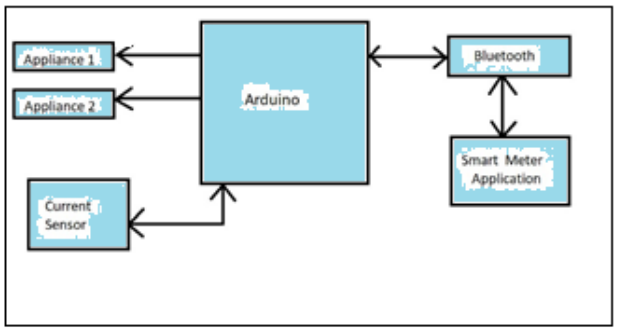

FIG II: Interface of Arduino with software and Hardware

An active switch for power scheduling is provided which facilitates the users to automate the loads during low pricing conditions i.e. during the night hours. Once the load scheduling switch is turned on it does not allow manual control over the loads. All these operations are controlled and via internet. Thus, we get to know the amount of energy consumed by different loads and the billing amount need to be paid.

III. Related Work

Several studies approached the problem of designing a smart energy meter. Numerous amount of research focused on using BLUETOOTH based meters. In a BLUETOOTH energy meter was developed and a database that provides the information to the consumer. The paper in designed a power meter based on BLUETOOTH network, with the main communication way is GPRS and SMS as secondary. In a BLUETOOTH based automatic meter reading system was developed, the meters are equipped with Zigbee that sends the data to a data collector device which uses BLUETOOTH to communicate with the central computer. In addition, the paper in developed a Zigbee based smart meter that collects the data and acquire outage event data. In our work, a complete system from smart meter to data management system is developed in addition to a mobile application and a website. The smart meter is a BLUETOOTH is based to developed using Arduino microcontroller. Like other BLUETOOTH approaches, there is no need for external wiring as all data are transferred wirelessly. The data is provided to the user through the website, SMS and mobile application.

IV. Flowchart

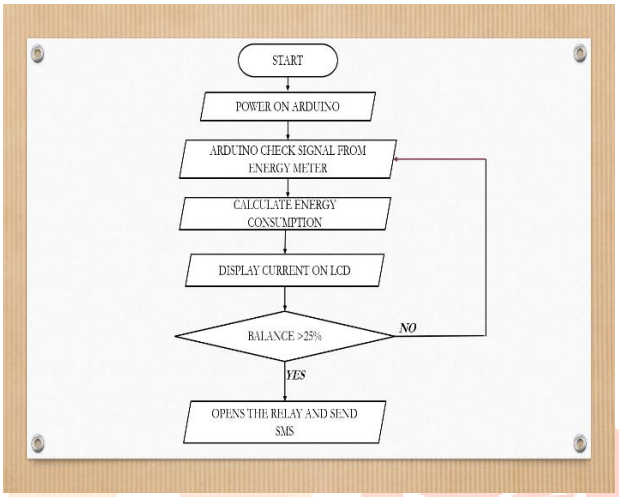

FIG III: Flow chart for the smart metering system

V. Modules

The whole system consists of two modules. Module one is responsible for registration of the particular consumer and module 2 is responsible for doing recharge and taking some actions regarding usage of light.

5.1 Module 1

This module depicts the communication interface of the designed system. With the help of embedded system, a perfect communication protocol was achieved. An Embedded system is a controller programmed and controlled by a real-time operating system (RTOS) with a dedicated function within a larger mechanical or electrical system, often with real-time consumption of embedded systems computing constraints. Figure 3 shows the block diagram of embedded computer assembly wherein an input is fed to the software via user interface and gives the output variable.

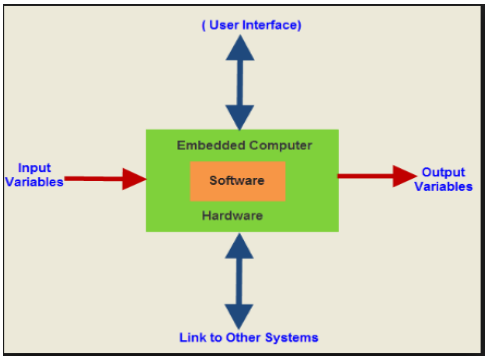

FIG IV: Embedded Computer Sub-Assembly

5.2 Module 2

This module is developed by using android studio. In this module user can register or already registered user can login by using username as mobile number and password. The input information is saved in the database of the system.

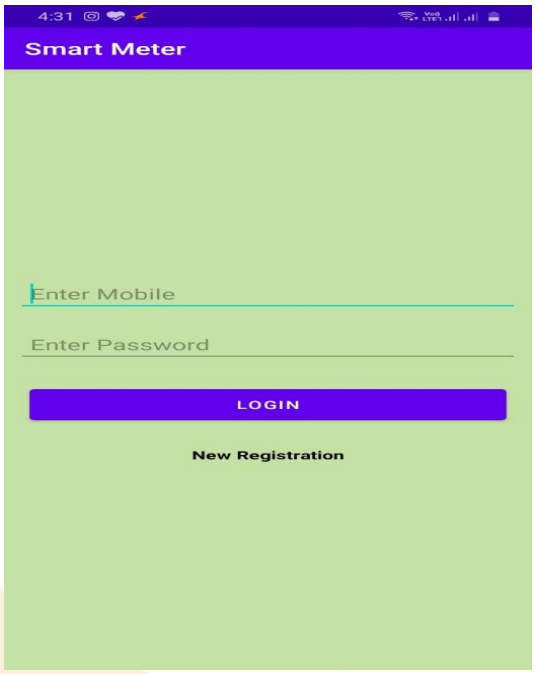

FIG V: Android Application Registration page

5.3 Module 3

This module is also developed on android studio. After logging in the user reaches this page of the application. In this module we are providing facilities for consumer for doing recharge to their smart meter and taking actions for their appliances. The actions are like which appliances they want to be keep on. It's like assigning priority on the basis of consumer wish. This module consists of loads. Two types of loads have been used i.e. 2 bulbs as AC load and a motor as DC load. Bulb is being supplied with line and the controlling is achieved via a relay which actuates the neutral of the ac supply to light up the bulb. Upon turning on the bulb via user interface the relay gets excited and in turn lights up the bulb which again can be turned off via the same switch. Similarly control over DC motor is achieved by turning on the respective switches which again excites the 2 channel relay. The actions are reflected on our hardware with the help of Bluetooth and the Arduino microcontroller through which the android application and hardware are connected. The energy consumed by these loads gets summed up and the same is displayed on the LCD screen. This enables the user to monitor the energy consumed by the loads over a period of time.

FIG VI: Smart meter facilities for consumer

VI. TESTING AND RESULTS

The accuracy of Smart Energy Meter is checked by comparing the readings that are displayed on the LCD of SEM and that are received by SMS. The energy consumed is multiplied by per unit pricing (price per unit kWh) and the bill incurred is send to the user's registered mobile number with the help of Bluetooth from the android application of smart metering system. Smart Energy Meter is also checked by connecting and disconnecting the customer's connection. We connected different loads 100W, 200W, and 1000W and checked its performance.

FIG VII: The internal circuitry of Smart Energy Meter

The testing of smart energy meter provided accurate results, hence verifying the performance and accuracy of the system.

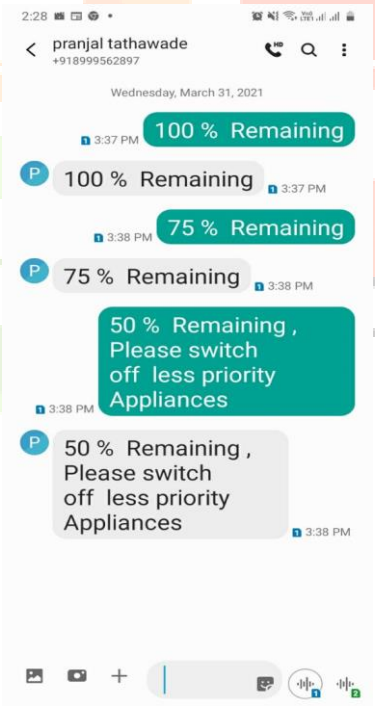

FIG VIII: SMS message to the consumer

VII. APPLICATIONS

1. Smart Meter can be used in houses, factories and companies.
2. Energy consumption can be monitored by users.

VII. Future Recommendations

We thought there are few possibilities which can also be done on this project in future as I have provided flexibility in the project especially in controller section. The future research should include the proper methodology for measuring the power factor of the load. Recommendations for future are as follows:

- Instead of Bluetooth networks, some other means of communication should be used.
- We can also use GSM networks. In case of GSM, there must be security of GSM so that it can't be hacked.
- Power factor must be measured by different techniques.
- Linking of the data received by GSM to computer and developing a program which incorporates the tariff related to specific consumer and calculating the bill directly on the computer. In this way the computer will calculate the bill directly using the data received through GSM network.
- Smart energy Meter can be modified for the detection of illegal use of electricity.

VIII. Conclusion

With the help of Proposed System the users will be able to monitor the energy consumption easily and regularly. They will also be able to recharge the smart meter online as per their needs and due to the use automated online computerized system the process of payment procedure for electricity will be accurate and easy for users as well as electricity board.

IX. Acknowledgement

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