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IoT Based Smart Energy Meter Monitoring and Theft Detection for Home Management System

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Abstract— **with the vast developmental changes that is overtaking the world, energy is the most basic utility required and so monitoring and controlling of energy consumption is a major priority and doing this starting at the domestic level is the best solution. The Existing domestic Energy meter reading systems universally exist many problems, such as difficulty in construction, too narrow bandwidth, poor real time, no quick two way communications etc. Thus, a smart meter is proposed based on the wireless technology internet of things [1]. The proposed smart energy meter system for home management makes use of an Arduino microcontroller and a raspberry pi processor. The voltage and current sensor measures the current and voltage consumed by the load and is fed to the microcontroller for calculating the power consumed. This value is then sent to the central server for electricity bill calculation through the internet and also the same is displayed in a monitor at home at regular intervals. The central server can also cut the power supply to the user in case of electricity bill payment failure or power theft. Displaying the energy consumed creates awareness about the amount of energy used by the user and enables him to analyze and reduce the energy used. Further, this system enables equal power management from the central server's side and minimizes power shut downs. With this smart energy meter, the user can also be notified about the energy consumption at regular interval through GSM. The proposed system also helps in detecting power theft.**

Keywords— power monitoring, controlling device; internet of things.

I. INTRODUCTION

Internet of Things (IoT) intertwines the physical world of devices, vehicles, building etc. with the internet through electronics items embedded with electronics devices and software. Such smart electronic items can share information and communicate with each other through the internet. This wireless technological innovation is estimated to reach almost fifty billion interconnected gadgets by 2020.

With the vast developmental changes that is overtaking the world, energy is the most basic utility required. Any crisis in the supply of energy would hamper the whole financial economy, thus monitoring and controlling power consumption starting at the domestic level is one of the best solutions. An interesting method for such management and awareness development of the expenses of the energy is smart metering. Smart meter is exceptionally

intended for monitoring energy utilization and controlling of different electronic equipment. IoT products can be integrated in all energy consuming equipment (air conditioning systems, electrical switches and sockets, lamps, appliances, plumbing, etc.) or in building envelope elements such as doors and windows, offering users the possibility to optimize energy efficiency, micro-climatic conditions and safety [2]. The power usages of electrical devices are calculated by utilizing such intelligent smart meter and are sent to a central server for monitoring and controlling the electronic devices. Smart meter can also be used to detect electricity theft as theft of electricity increases the costs paid by customers and can have serious safety consequences.

II. RELATED WORK

Many techniques are already available for measuring the energy consumption of electronic devices and for reporting this data over the network like plug load monitoring system[3], non-intrusive load monitoring system[4], device-level load monitoring system[5] etc. But such techniques do not provide benefits of controlling the electronic devices as available in IoT.

Previously, many researchers have also done immense work on smart meters using power line communication (PLC) [6] and IoT, as they improve the efficiency of power system and helps in analyzing the unnecessary loss of power. The already existing system of IoT based smart meters only provides feedback to the customer at the end of the month regarding the power consumption in the form of bill. The consumers in such cases do not have the options of tracking their energy usage on a more immediate basis. Also, tampering can be done easily on the existing smart meter which is one of its major drawback for an energy crisis. Thus, we propose a smart meter which provides the consumer with the energy consumption details from time to time for better power management and also an user kit for checking the energy consumption of different energy consuming devices at will. This proposed system would help in managing equal power supply from the central server and also monitor unusually high power consumptions leading to analyzed and managed power supply system. This method would be able to reduce power supply shut off to a maximum level.

III. PROPOSED SMART METER SYSTEM

Fig. 1 shows the proposed block diagram. The proposed system comprises an analog measurement unit, a controller unit, an IoT unit and a power theft detection unit.

The proposed smart energy meter makes use of the following:

- Arduino Controller
- Raspberry Pi
- ESP Chip (WiFi Module)

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- GSM Module
- Current Sensor
- Voltage Sensor
- IR Sensor
- Relay
- Load

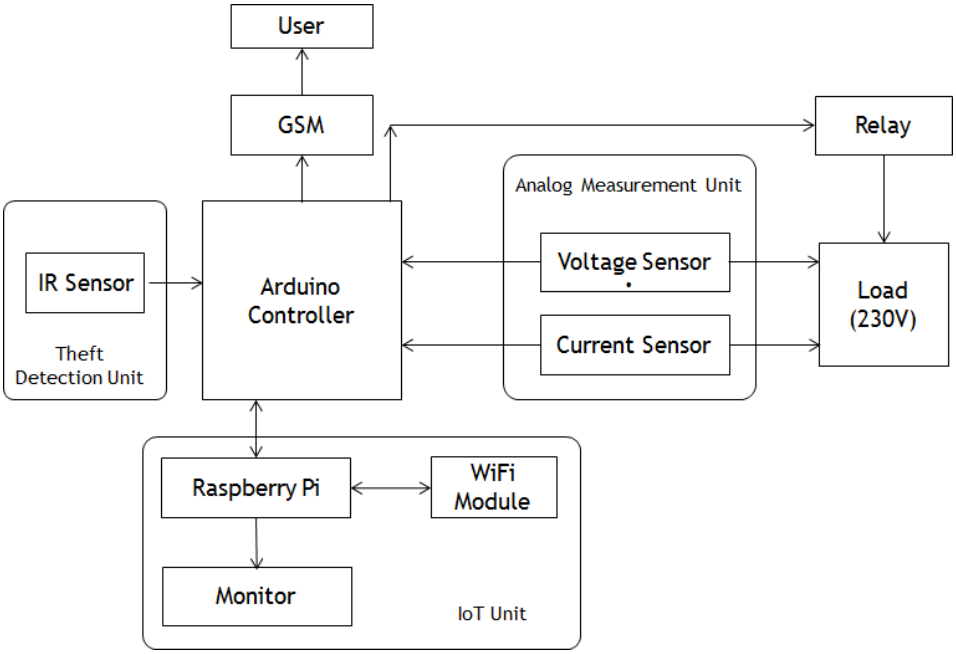

Fig 1: Block Diagram of the proposed smart meter

A. *Analog Measurement Unit*

In the proposed smart meter system, the analog measurement section is the unit consisting of the voltage and current sensor for measuring the power use of electronic equipment. A current sensor is connected between the supply and load to measure the current flowing through load and similarly the measure the voltage through the load. The microcontroller then reads the measured current and voltage values through the ADC channel. Power is then calculated using the measured current and voltage data in the microcontroller for sending it to raspberry pi processor. A Relay is also present in the analog measurement section which is used for controlling action (e. g. on/off) of the electronic equipment. The user can control the load by a control signal sent to the Relay circuit through the raspberry pi processor.

B. *Controller*

Arduino uno microcontroller ATmegha328 is used as the microcontroller in the proposed smart meter system and is connected with the analog measurement unit, a GSM

module and also with the raspberry pi processor. The readings of current and voltages of the load are measured using the current and voltage sensor in the analog measurement section and is given to the microcontroller for further calculation of the power consumption units. This power calculation is done by programming it in the Arduino software (IDE) which is a open source platform. The calculated power is then sent to the raspberry pi processor for further action. The Arduino controller and the raspberry pi processor have serial communication. The calculated power consumption units in the Arduino microcontroller can also be shared with the user through SMS using the GSM module. This message can be programmed to be sent to the user at regular intervals of time or when the power consumption units exceed a certain peak amount etc.

C. Internet of Things Unit

In the proposed smart meter system, raspberry pi processor is used as it is a key learning platform for IOT. Raspberry pi is connected to the microcontroller and the internet. Python programming language is used for working with raspberry pi. Raspberry pi sends the collected energy consumption information through the internet to the central server for processing the electricity bill and also to the monitor which displays the energy use information from time to time on a regular basis. Displaying the energy consumption values on the monitor helps in creating awareness about the energy consumed and would help in reducing it.
The central server is also able to control the electronic devices by sending control signals to raspberry pi for device on/off, for regulating speed of the electronic devices.

D. Relay

In the proposed smart energy meter system, two types of relays are used. One relay is for full power shut off of the home power supply from the central server's end on failure of electricity bill payment or on power theft detection. The other relay is used with PWM technique for controlling the speed of the electronic devices from the central server's end. This speed regulating relay is more useful in the commercial sectors power management systems like industries.

E. Power Theft Detection Unit

In the power theft detection unit of the proposed smart meter, an infrared sensor is used for theft detection. The IR sensor is fixed on energy meter for identifying the tapering of the seal and when any one tries to break the seal, it detects power theft. A message is sent to the user immediately through GSM and also the central server is notified about it through the internet.

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IV. PROPOSED USER KIT

Fig. 2 shows the block diagram of the user kit. The proposed user kit is a portable wattmeter. It comprises the following:

- AVR Controller
- Current Sensor
- Voltage Sensor
- LCD Display

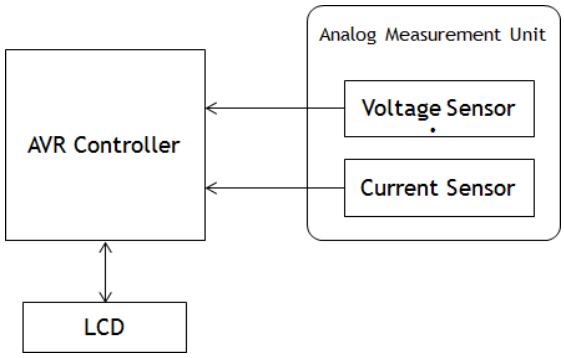

Fig 2: Block Diagram of the proposed user kit

The user kit makes use of a AVR microcontroller, a voltage and current sensor and an LCD to display values. The user kit helps the user to monitor the power consumption details of individual energy consuming devices on will. By connecting the voltage and current sensor of the user kit with the electronic device's supply, the sensors are able to read the voltage and current values which are further given to the AVR controller to calculate the consumed power values. This power consumption values are then displayed in the LCD.

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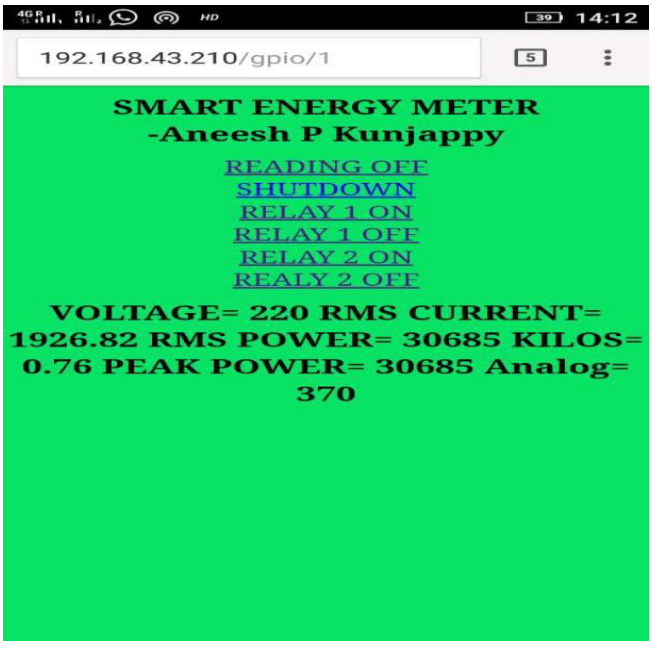

Fig 3. Output of IOT

V. WEB PORTAL

At the software side, a web portal is designed to display the current and voltage usage details along with the total power unit consumed. Apart from these, it also displays the three load controlling option (including PWM).

VI. RESULT

The Arduino Microcontroller operations were studied and it is programmed and the smart meter system was developed in order to provide the objective of a smart energy meter based on IoT which creates awareness about the user's energy consumption level at home. The entire system is based on the wireless technology of IoT which is a 2.5G mobile technology. The operation of calculating the power consumption units is programmed in the Arduino microcontroller which further passes through raspberry pi to be sent to the central server and the monitor. This project accomplishes it goal perfectly.

VII. CONCLUSION

In the era of technology advancement, monitoring and controlling of energy consumption is very important. In this project, an energy consumption monitoring and controlling smart energy meter is proposed which would increase awareness of energy consumption amongst devices and users. Energy awareness at the domestic level enables the user to control the

power state of the devices as per their needs which minimizes the energy use. Thus, using such smart energy meters in home management system is very important.

This project achieves the objectives of

- Improving awareness of energy consumption at domestic level.
- Monitoring and controlling energy consumption at home through IoT.
- Power theft detection

Future enhancement of the smart energy system is likely an important aspect. It is possible to connect all the energy consuming appliances at home to IoT and smart meter to monitor and control individual electronic devices automatically without any human interference.

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