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IOT Based Smart Energy Monitoring and Controlling

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ABSTRACT: This article proposes and analyse a system which is used for energy meter monitoring and controlling. The system is fully Internet of Things (IOT) based and highly desirable in field of energy. In this system consumer can do power management by knowing energy usage time to time and power utilization of each load. The power calculated will be of two ways .One, will be calculated from the overall power from the energy meter. And the other, will be calculated from the module should not exceed the predefined limit which will the maximum power defined. If couldn't, the electric power for that load can be turned off autonomously from the distant host. The prototype "IOT based smart energy monitoring and controlling system" is successfully implemented and its working is tested. This project provides the solution for conventional electricity billing system. By implementing this project in real time, the unwanted power cut from the electricity bill without prior intimation will be avoided.

KEYWORDS: IOT, Smart Energy Billing, GSM, Relay, Current Transformer.

I. INTRODUCTION

The Existing domestic Energy meter reading systems universally exist many problems, such as difficulty in construction, too narrow bandwidth, too low rate, poor real time, not two way communication quickly etc. To solve above problems, this paper uses the wireless technology for Automatic Meter Reading system. A proposed method provides the communication between the Electricity Board section and the consumer section using Internet of things (IOT) for transmitting the overall customer's electricity consumption, each load's power consumption and bill information that is calculated using microcontroller. The power fluctuations are monitored using the voltage sensor and current sensors are fed to the microcontroller which indicates it to the Electricity Board. Depending on the power generation, the house hold devices are controlled automatically. From Electricity Board section the information regarding the bill amount are communicated to the consumer via Global System for Mobile communication. The power and billing information is continuously transmitted by the use of Internet of Things and monitored by the Electricity Board section. Whenever power exceed on the load is identified can be sent from the Electricity Board section to cut the supply to the customer.

From thorough review of related work and published literature, we have observed that many researchers have done rigorous work on Power Line Communication (PLC) and IoT. It is observed from the careful study of reported work that in the real world, PLC and IoT based meter can improve the efficiency of power system and can help to analyze the unnecessary loss of power in different areas.

IOT: The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. "Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring or field operation devices that assist fire-fighters in search and

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rescue operations. These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.

II. RELATED WORK

The present system only provides feedback to the customer at the end of the month that how much power is consumed in the form of bill. The consumer has no way to track their energy usage on a more immediate basis [1]. The consumers are growing exponentially fast and load on power providing divisions is rapidly rising. In the existing system meter tampering can be done easily and it's one of the major drawbacks for an energy crisis. Ke Meng et al (2017) proposed that a challenge to organize several groups of aggregate air-conditioners for delivery system load managing. This projected method aim to present a challenge to synchronize compound group of Virtual Power Storage Space Scheme (VPSSS) to deal with complex load [2]. A circulated manage system is future to distribute the essential dynamic control reduction among the aggregators during limited announcement to switch in order with nearby aggregators and an balance position can be met between complicated aggregators. In a distributed manage approach; the essential dynamic energy restriction can be collective amongst the participate aggregators.

Mario Collotta et al (2017) has proposed system present an Artificial Neural Network (ANN) as maintain for a Home Energy Management (HEM) arrangement base on Bluetooth low energy, called BluHEMS [3]. In this proposed system a profound examination for the pattern of the ANN in arrange to get the one that achieve the best presentation. This system supply widespread simulative assessment, perform all the way through the Network Simulator Version-2 (NS-2), in conditions of energy utilization, demand profit, delay practiced by consumers for the planned HEM solution and in conditions of package delivery relation, delay, and jitter for the wireless networks. Siyun Chen et al (2017) gives a human-centric Smart Home Energy Management System (SHEM) with the intention of mechanism at the "butler" plane [4]. In this proposed system a human-centric smart home construction by the combination of considerate the behaviours of person being, infer the user's weight and utilization preference and optimally running the energy plans in smart home. The SHE system can be comprehensive for respond to a variety of require response signal and contribution expensive maintain for programming and result make at all levels of usefulness based on the people-centric framework.

S. L. Arun et al (2017) has deals with an Intelligent Residential Energy Management System (IREMS) for producer of neat housing buildings are planned. The most important purpose of IREMS is decrease in electrical energy bills whereas maintain the power require less than the maximum demand limit subjected to the variety of constraints principal the procedure of household demand and Renewable Energy Resource (RER). Through demand manage and Real Time Pricing (RTP) is two ordinary techniques in Demand Side Management (DSM) projected by special energy suppliers. Daniel Minoli et al (2017) has residential the representation of energy larger than Ethernet, as measurement of an Internet of Things (IoT) -based solution, offer disrupting chance in transform the in-building connectivity of a huge swath of policy [5]. A Building management System (BMS) is a complete platform that is working to observe and organize a building's automatic and electrical apparatus. Bharatkumar et al (2017) has presented to expand the Neural Network (NN) base tidy demand estimator, practical data from a real power hub managing system is use for supervise preparation [9].

III. PROPOSED SYSTEM

In the proposed system, consumer can do power management by knowing energy usage time to time and power utilization of each load. The power calculated will be of two ways .One, will be calculated from the overall power from the energy meter. And the other, will be calculated from the module should not exceed the predefined limit which will the maximum power defined. If couldn't, the electric power for that load can be turned off autonomously from the distant host. The statistical analysis of each load is as given in Table. 1 as follows. The project has a current transformer connected to a data logging system. The data logging system consists of a ARM CORTEX M4 processor. The processor send the data to the webserver every second by means of IoT. The consumption of energy at all

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monitoring points are displayed in the LCD Module. The whole system is powered by a 9v/500mA battery which is used in processor to extract the necessary current and voltage.

Table 1. Statistical data of each load.

APPLIANCE	POWER CONSUME IN WATTS	USED HOURS/DAY	POWER CONSUME/MONTH	ELECTRICITY BOARD CHARGES/MONTH
Fan	80watts	8hours	19.2kwh	76.8/-
Standard bulb	60watts	5hours	9kwh	36/-
Washing machine	700watts	2hours	42kwh	168/-

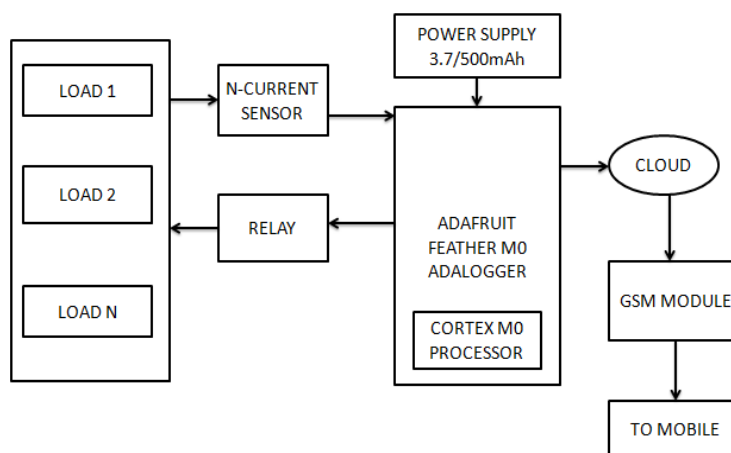


Fig 1: Block diagram of Proposed Module.

System Model and Components Analysis

The proposed system consist of Relay, GSM, display device, microcontroller, Bluetooth module and IOT web server. A relay is attached to all home appliances. Microcontroller will count that pulses of energy usage and decrement the balance count. In addition to that, it sends SMS send through GSM to the consumer to intimate the power limit of the load. If the load exceeds the power limit, microcontroller will turn off the relay in the meter and energy supply will be interrupted to the customer. The proposed system displays the information about the energy consumed in terms of units, power consumed by each load and if the power exceeds, that will be displayed in the website. Hence every user can check the information anywhere globally. Thing speak web page is used for displaying the information of the system. The hardware components used in the proposed system includes Node MCU, Current transformer, GSM, and Relay.

Node MCU: NodeMCU is an open source IOT platform.it includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif systems and hardware which is based on the ESP-12 module. The term “nodeMCU” by default refers to the firmware rather than development kits. The firmware uses the LUA scripting language.

Current Transformer: Current Transformers (CT’s) are instrument transformers that are used to supply a reduced value of current to meters, protective relays, and other instruments. CT’s provide isolation from the high voltage primary, permit grounding of the secondary for safety, and step-down the magnitude of the measured current to a

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value that can be safely handled by the instruments. The most common CT secondary full-load current is 5 amps which matches the standard 5 amp full-scale current rating of switchboard indicating devices, power metering equipment, and protective relays. CT's with a 1 amp full-load value and matching instruments with a 1 amp full-range value are also available. Many new protective relays are programmable for either value.

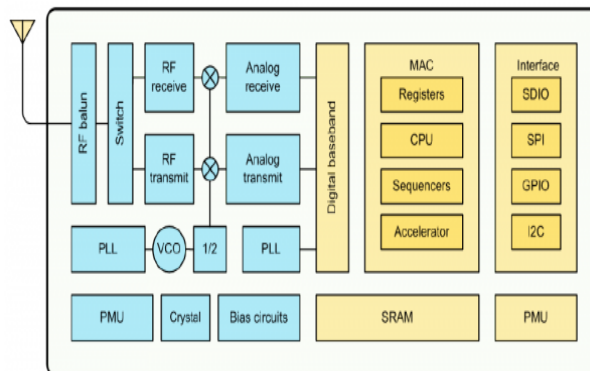


Fig 2: Block diagram of Node MCU

The most common CT secondary full-load current is 5 amps which matches the standard 5 amp full-scale current rating of switchboard indicating devices, power metering equipment, and protective relays. CT's with a 1 amp full-load value and matching instruments with a 1 amp full-range value are also available. Many new protective relays are programmable for either value. CT ratios are expressed as a ratio of the rated primary current to the rated secondary current. For example, a 300:5 CT will produce 5 amps of secondary current when 300 amps flows through the primary [8]. As the primary current changes the secondary current will vary accordingly. With 150 amps through the 300 amp rated primary, the secondary current will be 2.5 amps ($150:300 = 2.5:5$). When the rated primary amps is exceeded, which is usually the case when a fault occurs on the system, the amount of secondary current will increase but, depending on the magnetic saturation in the CT, the output may not be exactly proportional.

GSM: GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine- SIM900A. The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable us to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface.

Relay: A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

Energy Meter: Electromechanical meter consists of an aluminium disc positioned between two electromagnets, one of whose coil is connected to the load and is the current coil and the coil of another electromagnet is connected to the supply voltage. The interaction of the fluxes between the two coils is responsible for providing a torque to the disc, which starts rotating, with the revolutions proportional to the load current. The counter records the number of revolutions and displays them, which indicates the energy consumed.

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Fig3: Block diagram of Node MCU

Arduino IDE: The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino board.

Applications: The proposed model can be used in different areas such as residential and commercial building in a public energy supply system, Municipal Corporation and public power sources, and govt. energy plant.

IV.RESULTS AND DISCUSSION

Experiment was conducted on the proposed system and its working was tested successfully. Fig.4 (a) shows the experimental setup of proposed system. From the results, it is observed that the proposed system effectively predicts the power consumption of each load and it automatically curt down the supply of each load when it exceeds the limit.

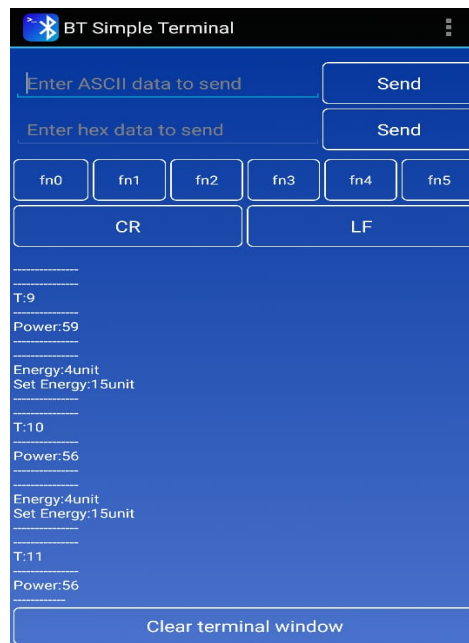
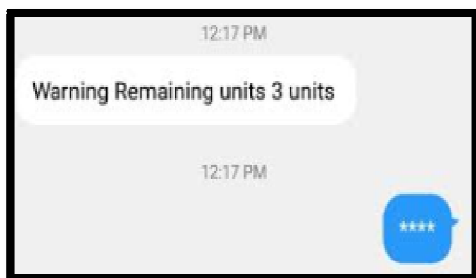
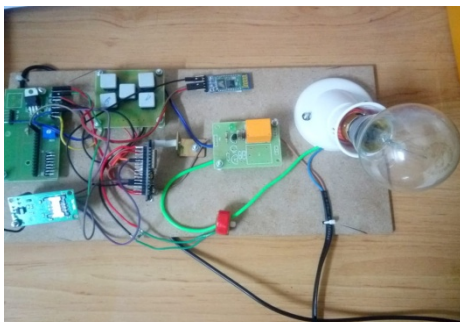


Fig 4(a): Experimental Setup of proposed system.

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Fig 4(b): Simulated results of proposed system.

The simulated results are shown in Fig. 4(b). It clearly indicates the total power consumed and individual power consumed by the home appliances. The graph is plotted between watts and date.

IV. CONCLUSION

The prototype “IOT based smart energy monitoring and controlling system” is successfully implemented and its working is tested. This project provides the solution for conventional electricity billing system. It automatically reads the energy consumption of each and every unit whenever it is required. Therefore, it saves the energy consumption and thereby reduces the man power for electricity board. By implementing this project in real time, the unwanted power cut from the electricity bill without prior intimation will be avoided.

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