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Automatic Power Demand Controller using IoT

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***Abstract*: The main idea is to provide the power cut solution. Power cut is the major problem in our country. Nowadays power cut generally happens in rural area than in the urban side. So the small scale industries are facing economic problems due to the power cut. This will be able to solve the power cut by proving the idea of power demand controller using internet of things. There will be two modes, normal mode and demand mode. In normal mode there will be no limitation for the power usage. In demand mode, the system limits its usage. This control will be fixed by the EB station. It has 3 process, when the consumer causes the limitation there will be intimation to the consumers by the EB station and the buzzer alert will be produced by the system. Then if the consumer neglect the warning alert and the power will be cut down after 5 min. If the consumer limits their usage then the system will turn on. Mobile application is developed for the consumers to know about the tariff details and track their usage. The consumers can track their usage and can be able to limit their usage which reduces the monthly bill. By this there can be no use of man power to take the reading and the bill will be generated in the month end.**

***Keywords*: Enter key words or phrases in alphabetical order, separated by commas.**

1. Introduction

An embedded system is combined working of hardware and software or additional mechanical or technical component to perform desired function. Any sort of device which includes programmable computer but itself is not intended to be general purpose computer is said to be embedded system. The lower layer of an embedded system is printed circuit board that includes busses and semiconductor devices. The upper layer is mainly application layer in between these two layers there are another two essential layers called device drivers and communication protocols. These features enable embedded systems to be relatively static and simple in functionality. However, there is a requirement for low cost, small physical footprint and negligible electrical or electronic radiation and energy consumption. Simultaneously they need to be physically rugged and impervious to external electrical and electronic interference. Therefore, embedded systems invariably are limited resources available in terms of memory, CPU, screen size, a limited set (or absence) of key inputs, diskless operations-these parameters play a crucial part during the design, development and testing of such systems. Power cut is the major problem in our country. Nowadays power cut generally happens in rural area than in the urban side. This will be able to solve the power cut by proving the idea of power demand controller using internet of things. In this paper we have extended the disadvantages of existing power demand controller by using IoT technology. Electricity demand forecasting is the primary prerequisite for achieving the goal of sustainable energy management and economic and secure operation of modern power systems. The task of knowing the electricity demand in advance is needed to sustain supply/demand balance and to manage the process of electricity production, distribution and consumption on a variety of temporal scales. In particular, the accurate very short-term load fore-casts (VSTLF) are needed for the real-time scheduling of electricity generation as well as load-frequency control and economic dispatch functions. With the deregulation of electricity markets and the growing penetration of renewable energy sources into the energy matrix of today's power networks, such predictions are also of importance to market participants to mitigate the effects of renewable energy sources intermittence on grid stability and reliability. An automatic remote meter-reading system based on GSM is used to obtain meter reading when desired so meter readers don't need to visit each customer for the consumed energy data collection and to distribute the bill slips.

2. Overview

Microcontroller can be used to monitor and record the meter readings. In case of a customer defaulter, no need to send a person of utility to cut-off the customer connection. Utility can cut off and reconnect the customer connection by short message service (SMS). Furthermore, the customer can check the status of electricity (load) from anywhere. In this system energy meter readings are being transferred by making use of GSM.

A. Smart meters

The size of smart meters and traditional meters is same and smart meters are digital .Smart Energy Meter measures more detailed readings than Kwhr so that utility can plan the expansion of network and power quality. The Smart Energy Meter is designed so that it measures voltage and load currents by the use of voltage and current sensors instead of potential and current transformers and then feeds these values of voltage and current into power factor controller IC and energy metering IC the power factor and power calculations respectively. The design of Smart Energy Meter involves the measuring of load

current and voltage using sensors and then feeding them to energy metering IC which converts it into the real power consumed by the load. Power factor is measured by measuring the phase shift between voltage and load current. Microcontroller used to perform the calculations related to power and energy consumed and shows the reading on LCD as well as it sends the reading of Smart Energy Meter with the help of GSM modem. Active power, reactive power, voltage, load current, power factor and units (kWh) are measured and displayed successfully. Meter reading are sent from GSM modem and received on mobile successfully. Two-way communication is done by smart energy meter between the meter and utility administration as well as between meter and customer so that customer is able to check the status of his consumed energy units and can manage his load accordingly to reduce his bill.

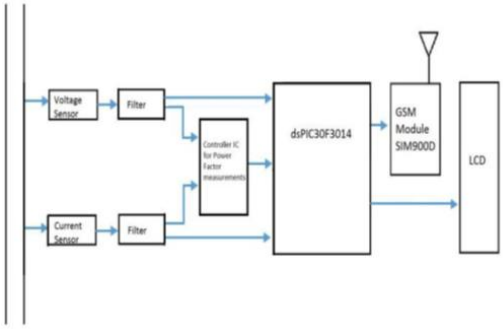

Fig. 1. Smart energy meter block diagram

B. Working of smart energy meter

GSM communications network is used to transfer the electricity consumed data to the utility administration as well as to the customer when demanded. Antenna, attached on or near meter box, can be used for improvement of signal strength in GSM communication. Smart metering communication is centralized meter reading, so meter readers don't need to visit each customer for data collection. However, for testing and maintenance meters may need to observe occasionally. The main duty of Smart Energy Meter is to measure the meter reading and sends it to utility when demand as well as to costumer. The voltage and current sensors measure the RMS values of voltage and current and feed them to microcontroller, where calculations for active and reactive power are performed. In Smart Energy Meter we used sensors to measure voltage and current instead of current and voltage transformers. The reading from utility administration SMS is being received by smart energy meter programmable interface and the action is performed by the meter according to provided information. A major feature of Smart Energy Meter is that utility company can cut off and reconnect the connection of energy of any user with the help of SMS without sending the person to perform the task manually. It can be utilized in case when the utility company needs to disconnect a consumer due to non-payment of bills or some other reasons. Another major feature of Smart energy meter is that it gives alarm when the consumer load is exceeding the upper limit for which he got the utility connection. In case consumer does not reduce his load meter automatically cut off the consumer connection. GSM communications network is used to transfer the electricity consumed data to the utility administration as well as to the customer when demanded. Antenna, attached on or near meter box, can be used for improvement of signal strength in GSM communication. Power cut is the major problem in the country. There is the need to find the permanent solution for power cut. It will provides the permanent solution for the power cut by controlling the meter using the IoT technology which permanently reduces the power cut.

C. Main parts of smart energy meter

Smart Energy Meter is comprised of three main parts:

- Voltage and current measurements
- Power factor measurements
- GSM portion

1) Voltage and current measurements.

ACS712ELC-20A as current sensor that gives us RMS value of currents. Both AC and DC signals current measurement is precisely obtained by this current sensor. Current is measured by this sensor up to 20A. Overall power consumption, metering and measurements are taken by these sensors. Sensitive measurements of current are handled by using OPAMP stage. By adjusting the gain we measure very small currents. ACS712ELC-20A output voltage has linear variation with measured currents. Similarly we measured voltage by ACS712ELC-20A.

2) Power factor measurements

Power factor is the cosine of angle between voltage and current. It actually measures how effectively the power is being converted into useful work. In this we measured it by taking XOR of voltage and current waves with the help of microcontroller and LM358. We used LM 358 to convert weak sinusoidal signals to large square signals.

3) Wireless portion.

There are many technologies that are being used for AMR as Power Line Carrier (PLC) communications, Supervisory Control and Data Acquisition (SCADA), telephone modem, internet, Ethernet, Embeded RF Module, WiFi, Bluetooth, and ZigBee. Power Line Carrier (PLC) and Telephone Line Network are the example of wire-based AMR system and GSM and Bluetooth are the examples of wireless AMR system. The transmission system of Smart Energy Meter utilizes the existing GSM network. A GSM modem is used as mobile equipment/ Data Communication Equipment to send the information regarding the numbers of units of electricity consumed to our desired mobile number. Power Line Communication (PLC) can also be used for obtaining the meter readings but interference and noise makes it inadequate. Metering information can be transmitted via Wi-Fi and Zig Bee but their range is limited and they do not provide a cost effective solution. However for lager remote distance GSM communication system is much efficient.

D. Features of smart meter

The main features of smart energy meter are listed as follows;

- Get automatic reading of Energy Meter and sent it to consumer as well as to utility.
- In reading it measures Voltage, Load Current, Real power, Reactive power, Power factor and units consumed.
- Utility is able to cutoff/restore the supply of the defaulter through SMS.
- Smart Energy Meter responds to the SMS and sends you back the readings whenever it is asked.
- Consumer is able to check the status of his load from anywhere in the world by SMS.

E. Drawbacks of smart metering

- The current reading cannot be monitored often by using GSM.
- There is no security measure for illegal use of electricity.
- Power consumption cannot be controlled by this.
- Instead of GSM use of any other communication device.

3. Proposed system

There is a need to develop a power demand controller and energy auditing device which completely reduces the power cut. Power demand controller works with the IoT technology. This is used for the consumers to reduce the usage of the electricity. Mostly the power cut happens in the rural side than the urban side so only the rural side are affected by the power cut because the urban side which has most of the small scale industries than the rural side. So power demand controller device is used to give the efficient solution for the consumer.

A. Features

There is an added advantage by using the IoT device. We can get the power consumed and the tariff details using the gsm which helps the consumers to know the detail of their household charges. In the demand controller 2 modes are used. One is normal mode and the demand mode. In the demand mode the demand is set by the supplier and if the consumers cross demand set by the system there will be the buzzer alert and the consumer should reduce the power usage. If the consumers fail to do then the system will shut down and repower after the 5 minutes of the power usage reduction. By using the IoT device there is no need for the man power to take the reading and the give the bill. The meter will automatically reset the meter at the month end. These are the features of the power demand controller and energy auditing system. These proposed ideas which are advantage for both the consumer and the supplier. PIC microcontrollers are a family of specialized microcontroller chips produced by Microchip Technology in Chandler, Arizona. The acronym PIC stands for "peripheral interface controller," although that term is rarely used nowadays. A microcontroller is a compact microcomputer designed to govern the operation of embedded systems in motor vehicles, robots, office machines, medical devices, mobile radios, vending machines, home appliances, and various other devices. A typical microcontroller includes a processor, memory, and peripherals.

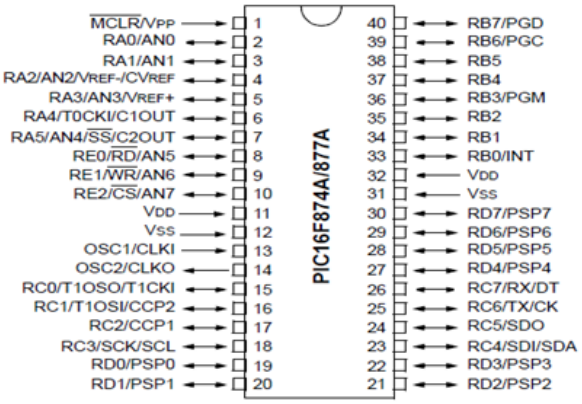

Fig. 2. Pic microcontroller

The hardware capabilities of PIC devices range from 6-pin SMD, 8-pin DIP chips up to 144 pin SMD chips, with discrete I/O pins, ADC and DAC modules and communication ports such as UART, 12C, CAN and even USB. Low power and high power variations are available for many types. PIC devices are popular with both industrial developers and hobbyists due to their low cost, wide availability, large user base, extensive collection of application notes, and availability of low cost or free development tools, serial programming, and re-programmable Flash-memory capability. The hardware description of pic microcontroller with different sensors for desired applications is done. The descriptions of those applications are given below accordingly.

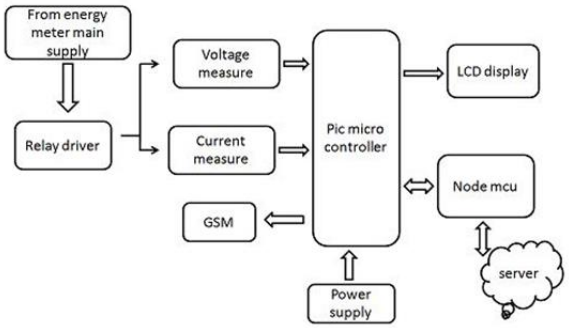

Fig. 3. Block diagram

B. GSM (Global System for Mobile communications)

GSM is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation digital cellular networks used by mobile devices such as tablets. It was first deployed in Finland in December 1991. GSM is a trademark owned by the GSM Association. It may also refer to the (initially) most common voice codec used, Full Rate.

1) GSM carrier frequencies

GSM networks operate in a number of different carrier frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G), with most 2G GSM networks operating in the 900 MHz or 1800 MHz bands. Where these bands were already allocated, the 850 MHz and 1900 MHz bands were used instead (for example in Canada and the United States). In rare cases the 400 and 450 MHz frequency bands are assigned in some countries because they were previously used for first-generation systems.

Fig. 4. GSM

C. LCD

A liquid-crystal display is a flat planned device or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. Since LCD screens do not use phosphors, they rarely suffer image burn-in when a static image is displayed on a screen for a long time, e.g., the table frame for an airline flight schedule on an indoor sign. LCDs are, however, susceptible to image persistence. The LCD screen is more energy-efficient and can be disposed of more safely than a CRT can. Its low electrical power consumption enables it to be used in battery-powered electronic equipment more efficiently than CRTs can be. By 2008, annual sales of televisions with LCD screens exceeded sales of CRT units worldwide, and the CRT became obsolete for most purposes. Node MCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espress if Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.

D. Pins of Node MCU

Node MCU provides access to the GPIO (General Purpose Input/output) and for developing purposes below pin mapping table from the API documentation should be referenced.

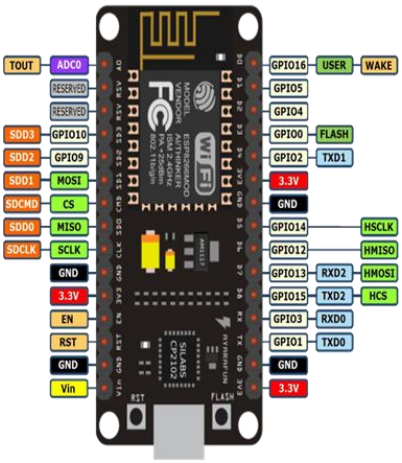

Fig. 5. Pin configuration

4. Conclusion

The advancement in power distribution system is non-stop process and new technology is always in progress. In this the automatic power demand controller, the demand is set by the pic microcontroller and the system produces the buzzer when the consumer consumes more power when the demand mode is set. The demand mode is set by the electricity department when there is need for the power cut. This enables the system to switch to the demand mode. When the consumer fails to reduce the power usage then there will be power shutdown and the system repowers automatically when the consumer reduces the power usage. This helps both the consumer and the distributer to manage the power in the useful way and control the demand. The GSM module is used to communicate between the controller and the server. It is used to send the message to the consumer about the monthly bill and the tariff details. Thus the automatic power demand controller is used control the power demand.

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