GSM based Automatic Energy Meter

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Abstract— Traditional metering method for retrieving the energy data by human operator is inefficient to meet the future residential development needs, when the number of customer increases the task becomes tedious. The design and implementation of Automatic Meter Reading (AMR) with Global System for mobile communication (GSM) technology is to monitor the power consumption of the meters automatically. An energy meter is an electronic device that records the consumption of electric energy and communicates that information periodically to the utility for monitoring. It also displays information in LCD. The proposed energy meter system is incorporated with embedded controller (ATMEGA16) and GSM modem to transmit the data such as energy consumption in kWh and it alerts the consumer about the energy usage when it reaches the threshold level set in the microcontroller by means of voice playback module and sent SMS through GSM.

Key words: Automatic Energy Meter, ATMEGA16

I. INTRODUCTION

Electrical power has become significant to human distribution is necessary to enhance people life stated. Traditional meter reading by human operator is inefficient to meet the future residential development needs. So there is increased demand for (AMR) automatic meter reading, which is collect the meter reading electronics AMR, can be incorporated with embedded controller such as GSM modem to transmitted data over mobile networks.

The GSM technology is used so that the consumer would receive message about the consumption of power and if it reaches the minimum amount, it would automatically alert in voice. The project will help in better energy management, conservation of energy and also in doing away with the unnecessary hassles over incorrect billing the automated will keep track of the real time consumption and will leave little scope for disagreement on consumption and billing.

II. PROPOSED SYSTEM

The proposed system replaces traditional meter reading methods and enables remote access of existing energy meter by the energy provider. Also they can monitor the meter readings regularly without the person visiting each house. A GSM based wireless communication module is integrated with electronic energy meter of each entity to have remote access over the usage of electricity. The system consists of digital energy meter, an microcontroller and GSM modem. For every switching of power the microcontroller and GSM modem, turn on the relay and connects the energy meter to load. Power consumed by load is given to microcontroller by interfacing with optocoupler.

If the consumed unit reach the first limit it will intimate the user through LCD and voice play back module and message as “going to reach limit1” is sent to consumer mobile. If the consumed unit reach the second limit it will intimate the user through LCD and voice play back module and message as “going to reach limit2” is sent to consumer mobile. The power consumed by the user exceeds limit 2, the relay disconnect the load from the relay. The power consumed within the limit then the message of amount of units used and the bill for usage is sent to consumer mobile. In normal case the system is run by the power supply and when there is a power cut, microcontroller unit will continue to work without any power off with help of battery. Also the microcontroller unit will send information about the power cut to the provider by means of SMS and also alerts in voice module.

III. HARDWARE DESCRIPTION

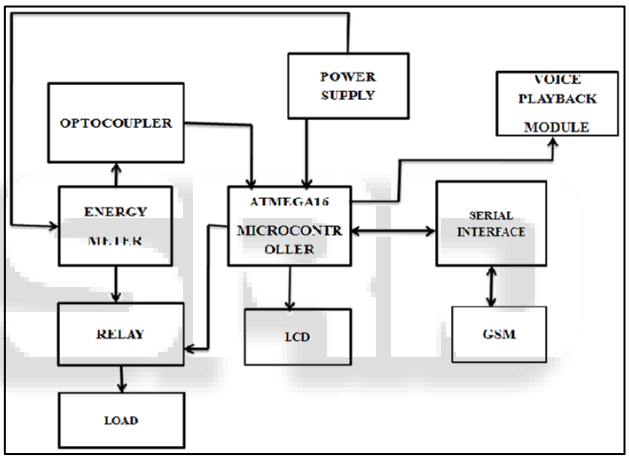

Fig. 1: Block diagram of proposed system

A. Power Supply Unit

The supply of 5V DC is given to the system which is converted from 230V AC supply. Firstly, the step down transformer will be used here for converting the 230V AC into 12V AC. The microcontroller will support only the DC supply, so the AC supply will be converted into DC using the bridge rectifier. The output of the rectifier will have ripples so we are the output from the regulator will be filtered using the 1000uf capacitor, so the pure 5V DC is getting as the output from the power supply unit. Here we are using the PIC microcontroller which will be capable of getting the supply of 5V DC so we have to convert the 230V AC supply into 5V DC supply.

B. Energy Meter

Energy meter is an instrument which measures amount of electrical energy used by consumer. The amount of energy represented by one revolution of the disc is denoted by the symbol Kh which is given in units of watt-hours per revolution. The value 7.2 is commonly seen. Using the value of Kh one can determine their power consumption at any given time by timing the disc with a stopwatch.

$$P=3600.Kh/t$$

The first step to monitor the energy meter is counting of the LED pulses per unit (kWh). Usually the pulse rate will be 800 to 3600 imp/ kWh. Imp.3200 is the pulse rate of most EEMs. The pulse rate can be calculated by counting the blinking of LED. Suppose the pulse rate is "X imp. / kWh". (In most meters it is 3200 imp. / kWh). This indicates the pulse rate of LED if 1000 Watts / second is consumed in 1 hour. Suppose a 100 watt bulb is switched on for 1 minute.

Fig. 2: Energy Meter

C. ATMEGA16 Microcontroller

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhancers Architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves Throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. The device is manufactured using Atmel's high density nonvolatile memory technology. This microcontroller unit is used to measure the energy consumed by user and the measured data stored in EEPROM. For reducing the excess the power consumption two limits (i.e., maximum and minimum limits) are set in the microcontroller. The controls lines from microcontroller are given to LCD, voice module and GSM.

D. GSM (Global System Monitoring)

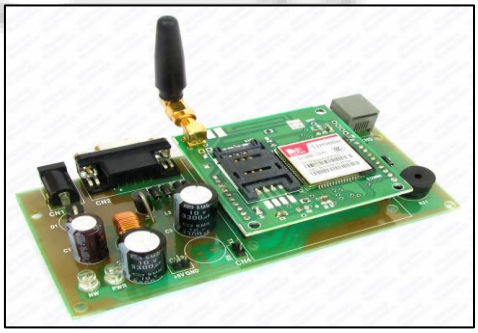

Fig. 3: GSM Module

GSM (Global System for Mobile Communications, originally Groupe SpecialMobile), is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second generation (2G) digital cellular networks used by mobile phones. SIM is used for communication purpose. There are majorly two types of SIM modules. They are SIM300 and SIM900. SIM900To implement Automatic Meter Reading system, a GSM modem is connected to a microcontroller which would transmits data from a meter to cell phone and also receive command from cell phone to energy meter. The modem will send unit or pulses (power consumption) on a regular interval. GSM is used for communicating between meter, energy provider and consumer. It transmits the information about the load and bill amount to the consumer. Power supply can be disconnected and reconnected the through call provider in case of delay in payment.

AT commands set which stands for Attention terminal are used by microcontroller to communicate with the GSM modem. The GSM/GPRS modem comes with serial interface through which the modem can be controlled using AT commends interface. An antenna and a power adaptor are provided.

AT commands	Description
AT+CMGR	READ SMS MESSAGE
AT+CMGS	SEND SMS MESSAGE
AT+CMGC	SEND SMS COMMAND

Table 1: AT commands

E. LCD

The display unit is mainly achieved by the 16X2 LCD. A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals (LCs). LCs does not emit light directly. The monitored data from the patient is viewed in the display.

Fig. 5: LCD display

LCD requires 3 control lines as well as 8 input/output lines for the data bus. So this LCD requires a total of 11 data line. The three control lines are referred to as EN, RS and RW. The EN line is called "Enable". This control line is used to tell the LCD that you are sending it data. The enable pin used by the LCD latches the information presented to its data pin. When data is supply to this "EN" pin in order to latch data present at the data pin. This pulse must be a minimum of 450 ns wide.

F. Relay

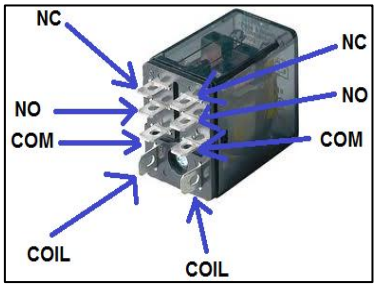

Fig. 4: Relay

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.

The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and retransmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

G. *Voice Module Playback (Apr33a3)*

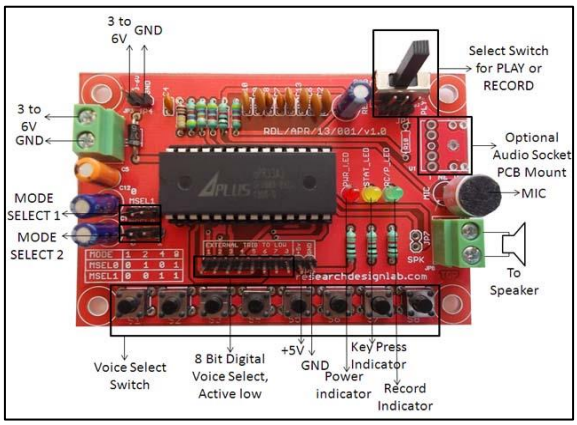

Fig. 6: Voice Playback Module

These chips can record audio for a few seconds and play that audio when you press the play button. The record and play control functions are controlled by microcontroller IO pins. These chips have inbuilt pre-amplifier, so that you can connect the microphone directly to the chips input pin. And also come with inbuilt output audio amplifier, so that you can directly connect an speaker to the audio output of APR9600 chip. The recording time is limited to a few seconds, APR33A3 provides an increased recording time of 680 seconds compared to the predecessor APR9600. The input is given from the microcontroller. Here the purpose of the module is alerts "when the consumed power going to reach limits".

IV. FLOW CHART

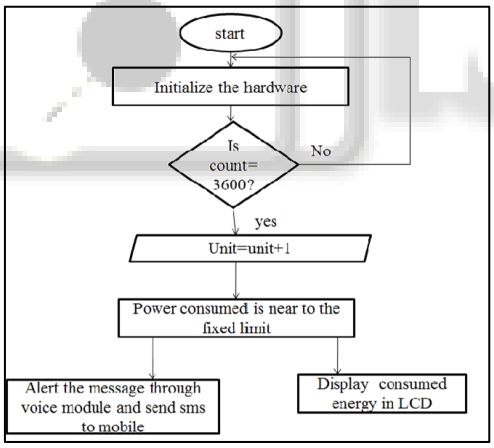

Fig. 7: Flow chart for power reach the limit

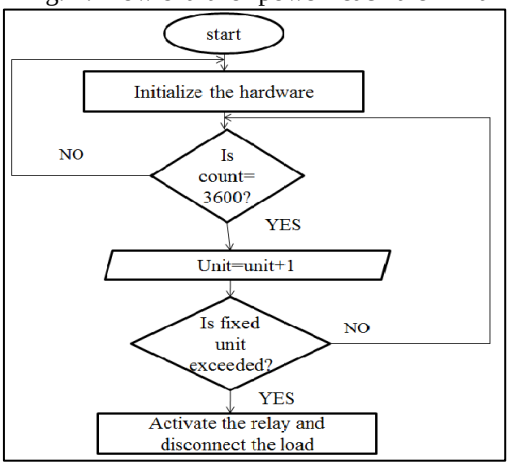

Fig. 8: Flow chart for power exceed the limit

V. SOFTWARE DESCRIPTION

Output pulses from the metering are counted using the default timer of MCU. The signal from meter through Opto coupler is normally high (5V) and the high to low transition of this voltage wave indicates the occurrence of a pulse. The counting of low pulse is an inefficient method as improper grounding issues may even be counted as a pulse by the device. So the produced pulse is reversed before applying to the counter. A TTL compatible inverter circuit is used for this purpose. The microcontroller is programmed to read data from them metering every second. When microcontroller reads the power consumption, it is stored and current reading is incremented in its software. In this design meter is calibrated such that for 1 unit of energy (kWh) consumption, it generates 3200 pulses in LED. (It can be calibrated for a meter constant of 1000 imp/kWh or 100 imp/kWh or 3200 imp/kWh etc. as per the requirement).

VI. EXPERIMENTAL RESULTS AND IMPLEMENTATION

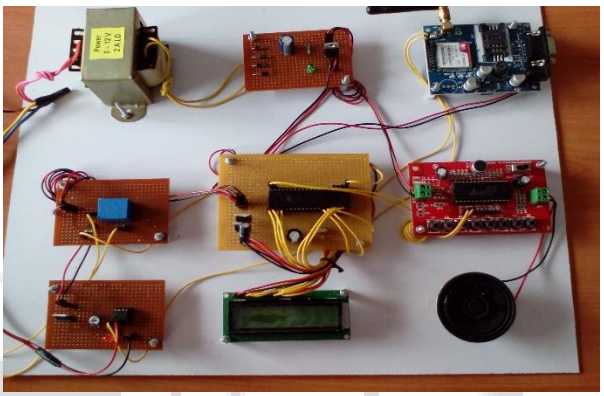

Fig. 9: Circuit setup

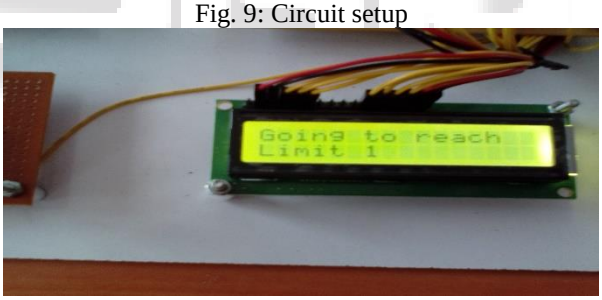

Fig. 10: Power indication Limit1

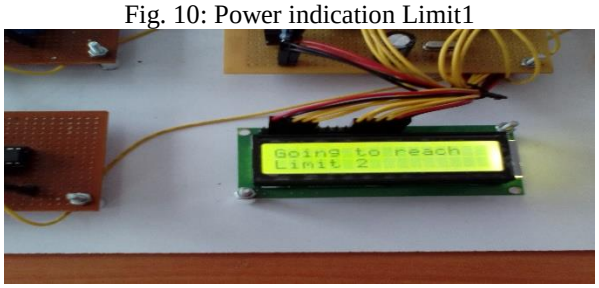

Fig. 11: Power indication Limit2

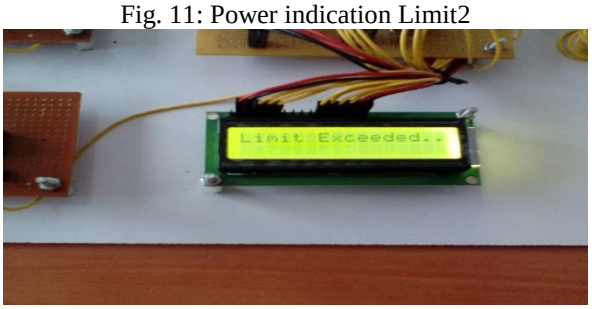

Fig. 12: Power Exceeds the limit

VII. APPLICATION AND FUTURE ENHANCEMENT

The AMR (automatic reading system) used at large industries, hospitals, and home applies. By using the microchip three phase IC MCP3909 the same idea can be extended to three phase system also. In future with the help of GSM data voice calls the electricity bill can be sent as voice calls to the consumer. Separate data base software can also be created by the energy provider to store the information about the electricity bill of different customers without manual interpretation, more if the database is interlinked along with hosted web page of the internet than instant payment of the bill by the consumer is possible from anywhere in the world.

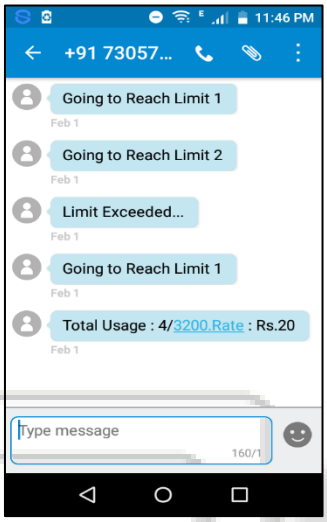

Fig. 12: Power Indications through SMS

VIII. CONCLUSION

The GSM based automatic energy meter is designed and implemented using ATmega16 microcontroller. It is easy to installation and beneficial for both energy provider and consumers. GSM based automatic energy meter contains control module, amplifier module, transceiver module, microcontroller unit along with energy meter. GSM based automatic energy meter overcomes the drawbacks of manual meter reading, also provides the additional features such as disconnection of power in case if consumer fail to pay bill within specified period and again power can be given to the consumer after paying dues through calls, power limitations alerts through LCD, voice module and GSM.

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