

Intelligent Energy Meter Using GSM Modem with Arduino

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ABSTRACT: In this paper we are focusing on automatic billing and metering, firstly, we have simulated the project in PROTEUS 8.0 then successfully implemented on the circuit board in laboratory. The integration of the GSM Short Message Service (SMS) and Arduino provide the meter reading system with some automatic functions that are predefined. The energy consumption and electricity bill will be providing through GSM module to the customer and to the concern electricity department. An alert message will be send to the customer and vigilance squad when the consumption unit reading reaches beyond the specific threshold. This paper contains energy consumption details in terms of power units and power units will be displayed on the LCD and will be notified to the customer via SMS and customer will also be able to recharge with the help of GSM module as well as PIC microcontroller.

KEYWORDS: Arduino, LCD display, GSM modem.

I. INTRODUCTION

An Energy meter is a electronic device that measures the total amount of electric energy mostly consumed by areas like commercial area, domestic. A smart energy meter (SEM) is electric device having energy meter chip for electric energy consumed measurement and for data communication using wireless protocol and peripheral devices for security purpose, data showing, meter controlling etc [1]. It is clear that today's emerging developments in every sectors with growing demands of electric power , so electricity has become high priority for each individual and also for organizations like a daily needs. The very basic procedure of power supply includes power generation, power transmission and power distribution to the various consumers and consumer may be corporate or domestic. Technically observed that naturally due to some technical faults, losses may occur. These losses can be resolve or minimized using the advanced technologies, but some losses unpredictable. These are the losses caused by human beings for their illegal access to the power distribution, and that we said the power theft [4]. Proposed system, introduced method of post-paid electronic energy meter. This paper which will automatically sense the used energy, and continuously records the reading, then sends it for the billing to billing section through the Wi-Fi module. Finally, after processing the collected data bill is generated using a web based system software and is send back to the customer as SMS (Short Messaging System) using GSM network.

II. RELATED WORK

Mr. Paraskevagos was firstly introducer of Automatic Meter Reading system, he used a advance technology developed by Theodore George [3]. For server communication two options are available like wired or wireless such as, power lines, cable networks, RF modules, GSM modules, LCD Display for just view purpose. Mr. Jain Abhinandan et al. [8] develop of a complete Automated Energy Meter which has feature such as remote monitoring and energy meter controlling. The AMR continuously observe and monitors the energy meter then sends meter reading to the service provider via SMS. The bill was allowed to pay online and option for payment by credit card or debit card or even by

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net banking. Using a GSM, automatic power meter reading was built to demonstrate an automatic power meter reading in this network. Meter reading may have lots of errors because of manual system. The government employee who took meter reading from the EB he take approximately more than 150 meters photo each day. Then data of these photos are check and put these data at server. Reading taking person has to revisit that place may be one to two times, in case of if the home is closed. Some meters are also not reachable. Second option to take reading is by taking average of preceding bills, if home is closed for more than 2 months. Such problems are because of human involvement and to avoid this, billing process AMR is used [6]. For future scope we can also update the tariff within the energy meter by writing a program. This process will flexible for both user and the company [7].

III. ENERGY METERING SYSTEM

A) Conventional system

Electricity meters operate by regularly measuring the voltage in volts and current in amperes unit to give energy used in joules, kilowatt-hours. The meters fall into two basic categories, electromechanical and electronic. In energy meter when the pulses of energy meter is 3200 times then we get 1kwh energy and 1pulse is equal to 0.3125wh. The most common type of electricity meter is the electromechanical induction watt-hour meter. The electro-mechanical induction meter operates by measuring the revolutions of a non-magnetic, but electrically conductive, disc of metal which is rotate at a speed proportional to the electric power passing through the meter. The number of rotation or revolutions is directly proportional to the power utilization. Electronic meters display the energy used on an LCD or LED display, and some can also transmit readings to remote places [8]. There are many errors in conventional billing. Some human mistakes may also occur in manual billing [1]. Analysing the conventional billing some of the common are:

- It's a time consuming procedure
- There is always a chance of human error while taking the manual meter reading.
- There is most chance of power theft and corruption.
- More man power is required
- Consumer is not updated of his usage.

Consumer may not get the bill slip within due date

B) Proposed system

A smart energy meter works by directly communicating with GSM module and wireless data protocol with company of energy supplier, so that energy supplier will always give a meter reading accurately and there is no need to the customer to take a meter reading by them. The smart energy meters can work in a different ways, like wireless mobile phone to send data. There are many benefits of smart energy meter such as:

1. The smart energy monitor shows you how much energy you're using in money. So you can see what you're spending by the minute.
2. The smart meters send accurate, regular information about energy use by customer. So bills of consumer will be more accurate.

The proposed system consists of digital energy meter, an Arduino (microcontroller) and GSM modem. After switching power on the Arduino and the GSM modem, turn on and connects the energy meter to load via relay. Then read the EEPROM and display the current data. Arduino checks the impulse from energy meter i.e. If impulse occur increase the data and display current data. GSM modem checks the new SMS. If there is a new SMS and read it. If the SMS is "DATA", send data to the specific number. If the SMS is "LINE CUT", turn OFF the relay, so load will disconnect.

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Again the SMS is "LINE OK" and then turn ON the relay so load will connect. If there is any other SMS in any other formats, then delete the SMS. If Arduino found any flaw or tampering into energy meter then Arduino reply with buzzer or it turn OFF the relay similarly it inform via SMS to service provider.

IV. SYSTEM DEVELOPMENT OF SMART ENERGY METER

The system architecture of Arduino and GSM based smart energy meter is shown in the Fig. 1. The energy consumption is being calculated using the energy meter IC and Arduino (Uno 3). In order to prevent a tampering, detection program is present in the Arduino. Arduino and GSM based smart energy meter can be divided into several parts as Energy Meter IC, LCD, Arduino, GSM modem [11], Relay, Optocoupler, Control Unit, Display Unit and Power Supply Unit etc. The hardware description of different parts is separately introduced as follows:

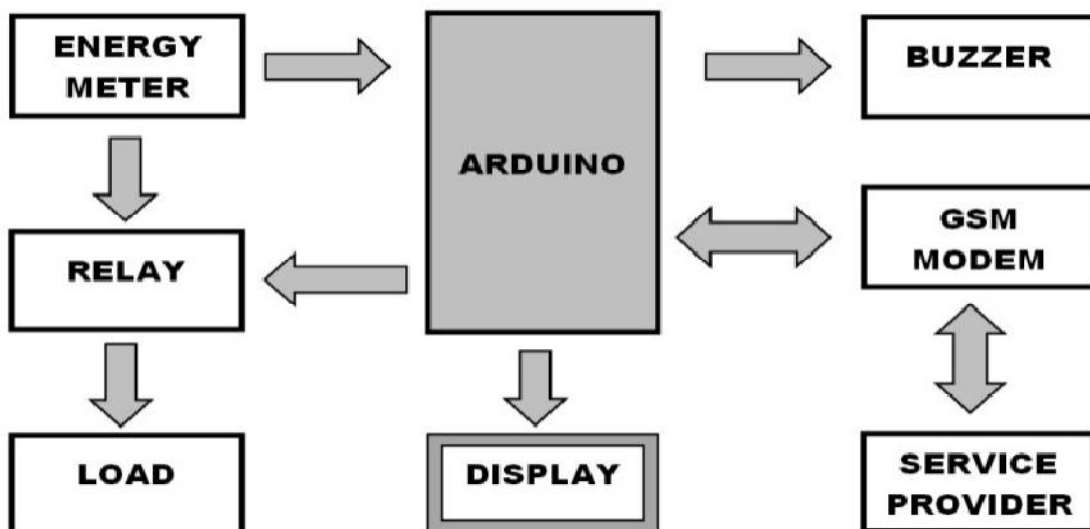


Figure 1: Block diagram of the proposed smart energy metering system.

B. Arduino (Uno R3)

The Arduino Uno is a microcontroller board which is based on the datasheet like ATmega328. This microcontroller has upto 14 digital I/O pins from which 6 can be used as PWM pin for outputs also six analog inputs. Arduino has a 16 MHz crystal oscillator with a USB connection and having a power jack, an ICSP header, and one reset button. It holds everything which required supporting the microcontroller, it just connect to a PC through a USB port. Actually Arduino is follow open-source platform which is used for building project of electronics projects. The Arduino made up of both a programmable circuit board (i.e. microcontroller) and some software, Integrated Development Environment that runs on our PC and upload computer code to the physical board. The Arduino [12] platform has become quite popular with people just starting out with electronics, and for good reason. The Arduino doesn't require a separate hardware to load new code on the board - it can simply connect through USB port. The Arduino IDE can also uses C++ platform for more effectiveness. The new popular board is introduced i.e. Uno best for beginner.

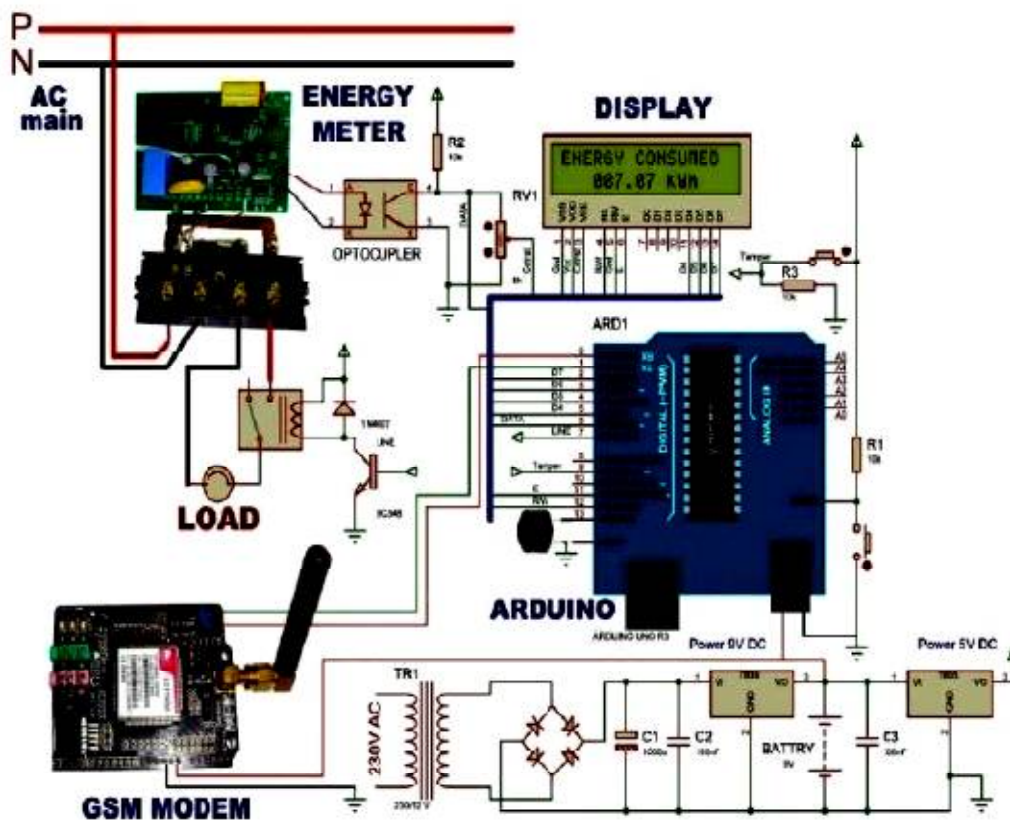


Figure 2: Schematic diagram for energy meter

C. Arduino GSM Shield (SIM 900)

The GPRS Shield is depended on module SIM-900 from SIMCOM also it is compatible with Arduino. The special Modem of 3V3/5V TTL interfacing circuitry is designed, which allows to directly interfacing to the microcontrollers of 5v and 3V3 Microcontrollers i.e. ARM, ARM Cortex XX. At very first stage Modem is in Auto-baud mode. This GSM/GPRS TTL Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS as well as DATA transfer application in M2M interface. The GPRS Shield provides you a way to communicate using the GSM cell phone network. The shield allows to achieve SMS, MMS, as well as GPRS and Audio via UART by sending AT commands .The shield also has the 12 GPIOs, 2 PWMs and an ADC of the SIM900 module (They are all 2V8 logic) present onboard. This Shield connects Arduino to the wireless internet using the GPRS

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wireless network. Plugging this module to the Arduino circuit board, which is plug in a SIM card from an operator which also provides GPRS coverage and follow some simple instructions to start controlling via the internet.

D. Opto-coupler

An opto-coupler works as circuit breaker in power system. It is a device commonly used to electrically separate microcontroller electronics from any potentially dangerous current or voltage in its surroundings. An Opto-coupler is electronic device and high power device .It is 4N35optocoupler has 6 pin, pin 1and 2 connected to meter 1 connected to anode 2- cathode, pin 3-NC, pin 4-Emitter, 5-collector, 6-Base. Each opto-coupler made up of material gallium arsenide infrared LED and a silicon NPN phototransistor. Its features are Isolation test voltage 5000 VRMS Usually have one, two or four light sources (LED diodes) on their input while on their output, opposite to diodes, there is the same number of elements sensitive to light (phototransistors, photo-thyristors or phototriacs). The point is that an opto-coupler uses a short optical transmission path to transfer a signal between the elements of circuit, while keeping them electrically isolated.

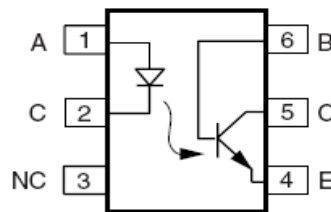


Figure 3: Opto-coupler

E. Relay

A relay is an electrically operated switch. Most of relay circuit use an electro-magnet to mechanical switch, some other principles can be also used, like solid-state relays. This relay circuit is operated over electrically switch which allows switching on or off a circuit using voltage or current which is higher than a microcontrollers handling capacity. The function of relay is to protect each circuit from each other. There are three connections for each channel in the module and these are NO, COM, and NC.

F. Power Supply Unit

A power supply is an electronic device that supplies electric energy to an electrical load. As all know any invention of latest technology cannot be activated without the source of power. All the electronic components starting from diode to Intel IC's only work with a DC supply usually ranging from $\pm 5v$ to $\pm 12v$. We are utilizing for the same, the cheapest and commonly available energy source of 230v-50Hz and stepping down, rectifying, filtering and regulating the voltage to convert it into suitable DC voltage. In our project the required voltage is +5V & +6V to run Energy meter IC, Microcontroller and the display unit.

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G. Result:

The following are the results of my project in transmitting section

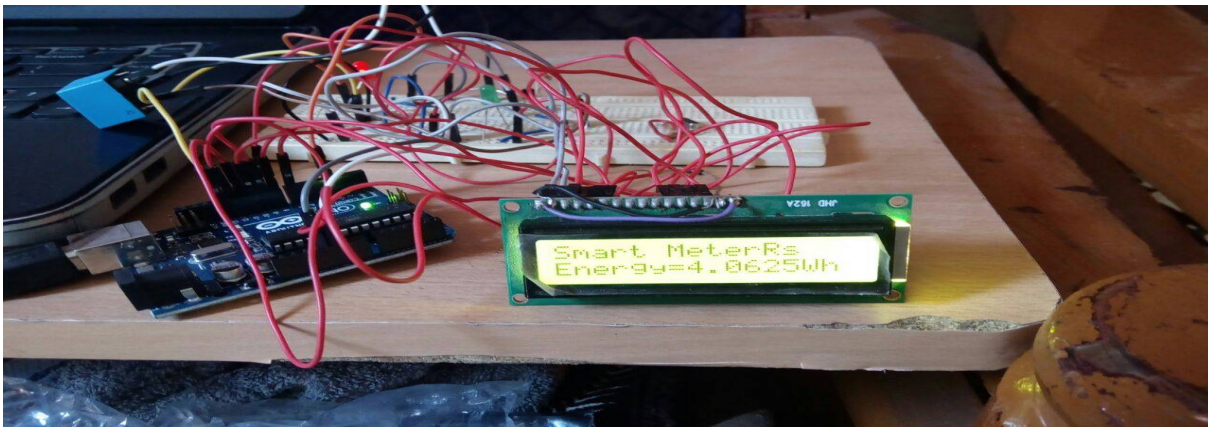


Figure 4: Output on LCD screen

V. CONCLUSION

In the proposed system wireless energy meter reading is designed to continuously observed or monitor the reading of meter and turn OFF the power supply remotely whenever the consumer not to pay the bill. It avoids the human involvement also gives precise meter reading. It shows the corresponding information on display screen (i.e. LCD) for user. The customer can easily know his bill in his mobile phone at the month's end via an SMS and can pay his bill using his debit card without having to go anywhere, using the card reader embedded energy meter from his household's perimeter.

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