Intelligent Energy Meter using GSM Modem with Arduino

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Abstract: Automatic billing and metering is focused in our paper. Our proposed project is simulated first and then it is to be implemented on the circuit board. The energy meter reading system which has some predefined functions are done in our proposed system with the help of the GSM and Arduino. The GSM module is used to provide the energy consumption details and the electricity bill to the customers and to the concerned electricity department. When the consumption unit reading reaches beyond the specific threshold, an alert message will be sent to the customer and to the vigilance squad.LCD is used to display the power units and a notification will be sent to the customer via SMS and recharge can be done with the help of GSM module as well as PIC microcontroller.

Keywords: Arduino, GSM modem, Energy meter.

I. INTRODUCTION

The main operation of a conventional energy meter is to measure the voltage in volts and current in Amperes which is used to represent energy consumed in joules or in kilowatt-hours.

The Electromechanical energy meter and electronic energy meter are the two categories of a basic energy meter. When the pulses of an energy meter is 3200 times then we get 1 Kilowatt-hours in an energy meter and one pulse is equal to 0.3125 Watt-hour. The most commonly used energy meter is the electromechanical induction watt-hour meter. The electromechanical induction meter which measures the revolution of the electrically conductive and a non-magnetic metal which is rotating at the speed which is proportional to the power that is passing through the meter. The number of rotations or the number of revolutions is proportional to the power utilization. The energy that is consumed is then displayed on a LCD or a LED display in an energy meter and some meters can transmit readings to the places which are remote. Conventional billing includes many errors due to human mistakes. Some of the common problem which is analyzed from the conventional billing are:

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- It's a time consuming procedure.
- The manual meter reading always includes a chance of human error.
- It includes a lot of power theft and corruption.
- Increased man power requirement.
- Consumer is not continuously updated with his power usage.

II. IMPLEMENTATION

Components

- Arduino UNO
- Power Supply
- Energy Meter
- LCD Display
- GSM modem
- Relay

III. HARDWARE DESCRIPTION

Arduino UNO: The Arduino UNO comes under the type of microcontroller. The version of board used is ATmega328P. It consists of 14 digital input pins and the number of output pins out of which 6 pins are configured as PWM outputs. And also it contains 6 inputs pins which are analog, 16 MHz quartz crystal, USB connection, a power jack, an ICSP header and a reset button. It consists of everything that are needed to support the microcontroller, to start the microcontroller, it should be connected to a computer by means of USB cable or it is powered by means of an AC-to-DC adapter or an external battery. "Uno" means one in Italian. The reference versions of the Arduino are the Arduino UNO board and the Arduino software version 1.0 and it is now evolved to newer versions. The UNO board which is the reference for the Arduino platform is the first in a series of USB ARDUINO boards.

IV. POWER SUPPLY

The Arduino UNO can be powered in two ways, (i.e.) by connecting it by means of USB or by an externally supplied power. The power source can be selected automatically. The AC-to-DC adapter or battery can supply the external or the non-USB power. To power the Arduino by means of the adapter, it should be plugged to a center-positive plug which is around 2.1 mm length into the board's power jack. To power it by means of a battery, the leads from it should be connected to the GND and pin headers of Vin to the power connector. The supply of 6-20 volts is required to operate the board.

When the board is supplied with the voltage of less than 5V then it becomes unstable. If it is supplied with more than 12V the board may get damaged due to overheat. Therefore the voltage range which is recommended is 7-12 volts. The power pins of the board are given as follows:

- When it is using the external power supply, the input supply voltage is given to the Vin pin. The input voltage can be supplied by means of an input voltage pin or by means of a power jack that can be accessed through this pin.
- The regulator on the board gives the output of 5V from the 5V pin. The Arduino board can be powered either by the power jack which provides power of 5-12V or the USB which provides power of up to 5V or the Vin pin which can supply the power of 5-12V. The regulator get bypassed and the board may get damaged when the voltage is supplied via the 5V or 3.3V.So the usage of it is not advisable.
- 3.3V is supplied by the 3V3 pin which is generated by the on-board regulator. Maximum current that can be drawn is 50 mA.
- The pins can be grounded using the GND.

Fig. 1 Arduino board

V. CURRENT SENSOR

Current sensor actually senses the flow of the current of any wired system. In this project, it senses the current from the load and the value of current that is sensed will be in the form of a signal i.e. the standard value will be in the Analog pin of the Arduino board.

The current sensor does the work of an Energy meter in this project. It measures the current and voltage that is consumed and calculates its product which results in power. The power that is calculated is analyzed over a time interval, and calculates the energy consumed over the time period.

VI. LCD DISPLAY

There are many devices that is made up of Liquid Crystal Displays (LCDs) like computers, digital watches and also DVD and CD players which are most common in day to day life. In the screen industry it is used as a replacement for Cathode Ray Tubes (CRT) as CRT draws more power and it is also heavier and bigger. The displays of LCDs are thinner than CRTs. LCD works on the basic principle of blocking light rather than dissipating so the power consumption is lesser in LCD when compared to LED.

We have seen a LCD, but many doesn't know about its working. Let's take a look on the working of LCD. The material “liquid crystal” was discovered by the botanist Frederic Reinter accidentally as early as 1888. Until the late 1960’s the commercially available Liquid Crystals were not developed. The name "Liquid crystal "gives the definition of LCD. The LCDs are the combination of solid and the liquid. They have both the properties and maintains with respect to one another. Solids maintain their state whereas liquids changes its orientation and move everywhere in the particular liquid. Further studies shows that liquid crystal materials shows more of a liquid state than that of a solid state. The liquid crystals are more heat sensitive than usual liquids. The liquid crystal can be easily get turned into liquid with only a little amount of heat. This is the reason why liquid crystals are also used to make thermometers.

VII. GSM MODULE

It is actually a GSM Modem (like SIM 900) connected to a PCB. To interface the GSM Modem with a PC TTL output and RS232 output are taken from the board. The board has the pins to attach the microphone and the speaker and to take out +5V or other values of power and for ground connections. These type of pins has different modules. There are many types of GSM Modem and GSM Modules which are available in the market.

For our project, a GSM modem or module should be connected to the Arduino for sending and receiving messages, it’s better to choose an Arduino with compatible GSM Module i.e. a GSM module that has TTL Output provisions.

In our project, SIM900 GSM Module is used. This module supports communication in 900MHz band. For People from other country mobile network band have to be checked in their area and the wiki entry band around the world has to be read.

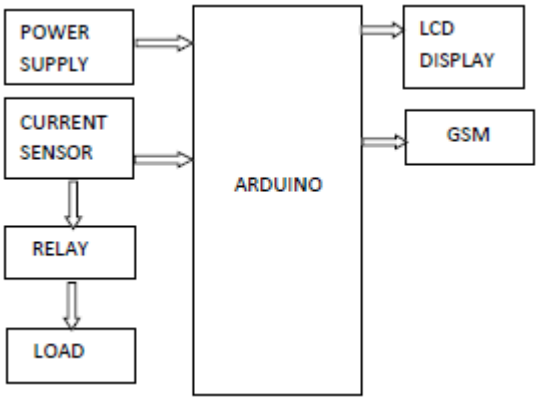
The power requirements of GSM module have to be checked. GSM Modules are manufactured by many companies. They possess various input power supply specifications. So it is necessary to double check the GSM modules power requirements. For this, the GSM module requires a input in the range of 12 volts. Hence we feed it using a 12V, 1A DC power supply.

Second is to Check for the TTL Output Pins in the module. The data from GSM module can be directly fed to the Arduino only if it is enabled with TTL output pins. If the TTL output is not enabled, the RS232 data must be converted to TTL using MAX232 IC and should be fed to the Arduino. The Modules are mostly equipped with TTL output pins. The right one should be bought while buying.

VIII. RELAY

A relay consists of coil and it acts as a electromechanical switch. The magnetic field is induced in the circuit and causes the switch to close or open the electrical connection when small current flows through the circuit. The relay can control the High voltage circuit using small DC voltage circuit without any direct electrical connection (i.e.) the high and the low voltage circuit are magnetically separated and electrically separated.

IX. BLOCK DIAGRAM



X. WORKING PROCEDURE

This project consists of blocks like Arduino UNO, Energy Meter, Power Supply, GSM modem, LCD display, Relay. Out of this Arduino UNO is controlling part of this smart energy meter. Energy meter plays another important role in this system and it is used for live reading of electricity consumption that is interfaced with the controller to communicate with server and to operate according to server commands. Various Household Appliances consumes energy, the energy meter also consumes energy from the load and analyses the reading continuously. The load consumed is seen on the meter continuously. The Supply to the Energy Meter is controlled by the Relay Circuit that avoids the excess voltage to the Energy meter thereby saving the Energy meter from damage. The LED on that meter will continuously blink and the meter readings are counted. Normally, 3200 blinks is one unit.

Arduino Uno act as main controller, and it continuously monitors the energy meter. The Arduino is provided with the External Power Supply. Based on the blinking of LED on energy meter, the Arduino will measure the unit consumption. The measured reading and the cost will be displayed on the LCD and the amount of energy consumed and the bill amount to be paid will be sent to the Consumer and to the Electricity board through the GSM Module. Finally the overall monthly bill will be sent to customer as well as service provider in the form of text at first day of every month.

XI. SIMULATION RESULT

Reader with Load Control Capacity and secure

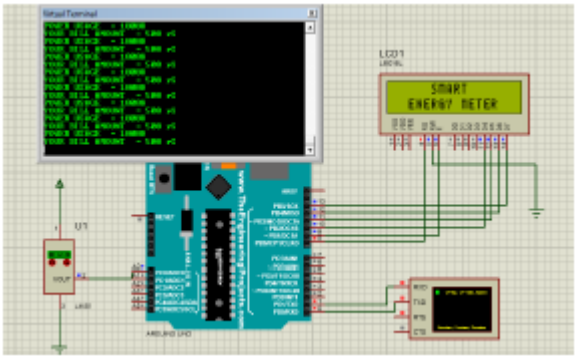


Fig. 2 Simulation output using GSM

XII. CONCLUSION

A wireless energy meter is designed to continuously observe or monitor the meter reading and to turn off the power supply whenever the consumer does not pay the bill in this proposed system. Human involvement is avoided and also a precise meter reading is provided. The corresponding information is shown on the display screen (i.e. LCD) to the user. Through a SMS, the customer at the month's end and the customer can pay his bill using his debit card without moving to anywhere by using the card reader embedded energy meter within his household's perimeter.

REFERENCES

1. Win Adiyansyah Indra, Fatimah Bt Morad, Norfadzlia Binti Mohd Yusof, "GSM Based Smart Energy Meter with Arduino Uno", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13,November 6,2018.
2. Kumar Sehgal,V.et.al,"Electronic Energy Meter with instant billing, "Proceedings-UK Sim 4th European Modelling Symposium on Computer Modelling and Simulation, EMS,2010,pp.27-31.
3. Himshekhar Das, L.C.Saikia,"GSM Enabled Smart Energy Meter and Automation of Home Appliances",PP-978-1-4678-6503-1,2015 IEEE.
4. Yingying Cheng, Huaxiao Yang, Ji Xiao, Xingzhe Hou, "Running State Evaluation of EnergyMeter",PP978-1-4799-4565-8, 'Workshop on Electronics, Computer and Applications', IEEE 2014.
5. Ofoegbu Osita Edward, "An Energy Meter Switching Using a Password Based Relay Circuit", PP-978-1-4799-8311-7, 'Annual Global Online Conference on Information and Computer Technology.