Effective Energy Measurement and Billing System Using Arduino GSM Shield

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Abstract - *The technology of automatic electronic metering has gone through emerging technological advancements in an effective Automatic Meter Reading system or AMR system. The paper represents the design of a simple concept with low interface, for automating billing of energy consumption sporadically and managing the collected data globally. The proposed energy meter system replaces old traditional meter reading methods and enables remote access of existing energy meter. Also the proposed method can monitor the meter readings regularly without the person visiting each house. A GSM based communication module is integrated with electronic energy meter of each entity to have remote access over the usage of electricity in each house. A PC with a GSM receiver at the other end, which contains the database acts as the billing point and customer details. Real-time energy meter reading from the GSM enabled energy meter is sent back to this billing point sporadically and these details are updated in a central database. With proper validation, users can access the utilized details from anywhere in the world by a use of corresponding webpage. The complete monthly usage and due date of bill is messaged to the customer after processing the measured data through the GSM. If the bill is not paid on time, the connection to the household will automatically switched off by use of relay. And the remainder of the due bill is sent back to the customer again and also displayed the same message in the LCD display provided in energy meter.*

Key Words: *Automatic Meter Reading (AMR); Global System for Mobile communications (GSM); Arduino GSM Shield V2; Short Messaging System (SMS); Liquid Crystal Display (LCD; Electronic Energy Meter (EEM;*

1. INTRODUCTION

Energy measurement and management is one of the most challenging tasks of the energy provider. In the existing energy meter billing system is not effective due to the irregular and erroneous inspection of the energy meter data and most often these bills are prepared with error reading of the human. The more problems occur during the bills payments and human errors in meter readings are also involved in the billing system. Electromechanical Meter has very little accuracy and there is no communication models are involved in that for automatic energy measurement system. This existing metering system becomes very difficult in rainy season.

If any consumer did not pay the bill, the electricity provider assigns a person to go to their houses to disconnect the power supply until the payments of bills. The proposed system replaces existing electromechanical meter reading methods and enables remote access to existing energy meter by the energy provider. And also, this method monitors the meter readings frequently without the help of human involvement.

A GSM module is integrated with electronic energy meter of each entity to have remote access to the usage of electricity and sent a SMS to the consumer. The proposed AMR system is very useful method for remote area or small villages which are not connected by means of transport such as island or isolated area. This GSM based automatic data collection system is very fast, accurate, efficient and effective method of load blocking. The status of energy consumption bill payment is stored into the Webpage and also displayed in the display attached to the Automatic Meter Reading system.

2. EXISTING SYSTEM

2.1 Electromechanical System

Electro-Mechanical Energy Meters are obsolete now but some countries are still using it due to its low-cost and simple in structure. Other name is Disk meters. Electro-Mechanical Energy Meters are the combination of Mechanical system and Electrical system.

Aluminum is disk present inside the meter and it rotates when the load applied. The speed of disk is directly relative to the amount of load applied to the connected system. With the rotation of disk, the counter dials of the Energy Meter increase its value.
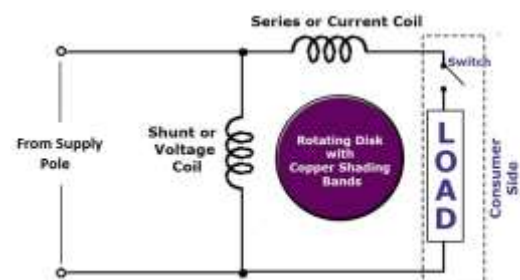

Fig. 1: Equivalent Circuit

The above image is giving idea about the equivalent circuit and working principle of disk meters. There are two coils present in the diagram and in between these two coils a rotating aluminum disk is present.

One coil is current coil which is series with load, other coil is voltage coil connected in parallel with the load. When both coils are energized they will induce an EMF of eddy current in the aluminum disk.

There is a copper shading ring present in the above disk which gives 90 degrees' phase shift of eddy currents, which results in the direction of rotation of the disk. If the switch is open then there is no rotation in the disk.

The speed of the disk depends on the load applied from the energy meter. In case of heavy load requires large current, thus when large current passes through the current coil, large amount of eddy current will produce which will rotate the disk faster.

2.2 Electronic Energy Meter

In present system the energy meter reader needs to visits each house for taking reading manually then issues the bill. In manual reading system human error is major involvement of energy calculations. In the present system people try to manipulate meter reading by adopting corrupt practices such as current reversal, bypass meter, magnetic interference, etc.

 After calculating the energy consumption the message was sent to the customer through SMS. If the network is failure then the message are not delivered to the customer. If the payment period exceeds the energy provider employee need to go to each and every house to disconnect power supply. Fig. 2 shows the electronic energy meter.

Fig. 2: Electronic Energy Meter

2.3 Drawbacks of Existing Systems

Monitoring the electric system and disconnection of the power system is needs human interface, dynamic pricing is not possible in case of demand change, more expenses of salary for allocating the energy meter readers, human error is involved in manual reading system and This existing metering system becomes very difficult in rainy season.

3. PROPOSED AMR SYSTEM

The arduino unit is interface with energy meter, Relay, Aurdino GSM Shield and LCD. Arduino unit monitor the energy meter sporadically and corresponding data's displayed on LCD. Arduinos gives the information of Power consumption in a house with the information about phase Current and phase Voltage. The information of power shutdown/Power Cut also stored in Arduino frequently.

AMR require a real time clock (RTC) that also carries on running in the event of a power cut. A back-up battery is needed to achieve this task regularly. In addition to that, a CMOS-RAM can be used instead of an Electrically Erasable Programmable Read-Only Memory (EEPROM) if a buffer battery is in place anyway.

For communication purpose, Arduino unit is also interfaced with GSM module by using MAX 232 communication. Relay is used to disconnect the power supply connection automatically when bill is in unpaid.
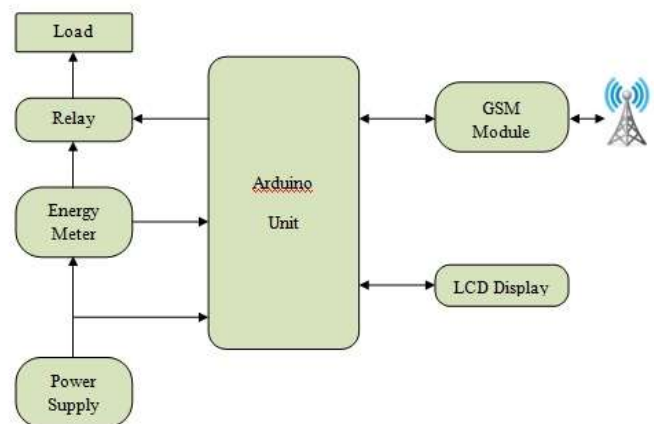

Fig. 3: Proposed AMR System Block Diagram

3.1 Electronic Energy Meter (EEM)

An EEM functionally the traditional Ferrari's wheel meter. One advantage of EEM is that in non linear loads, its metering is highly accurate and electronic measurement is healthier than that of the conventional meters. The Power companies benefits from EEM in following significant ways.

- ✓ It reduces the cost of theft and corruption on electricity distribution network with electronic design.

- ✓ Electronic energy meter measures current in both Phase and Neutral lines and calculate energy consumption based on the larger of the two currents.

- ✓ EEM improve the expenditure and quality of electricity distribution.

3.2 Arduino GSM Shield

The Arduino GSM shield allows an Arduino board to connect to the internet, send and receive SMS, and make voice calls by means of the GSM library. The shield wills exertion with the Arduino Uno out of the box. The shield wills exertion with the Mega, Mega ADK, Yun, and Leonardo boards with a small modification.

The Arduino Uno is a microcontroller based board on the ATmega328. It has 14 digital Input / Output pins , Six analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains the whole thing needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC to DC adapter or battery to get started.

The Arduino Uno differs from all preceding boards because it does not use FTDI USB to serial driver chip. As an alternative, it features the ATmega8U2 programmed as a USB to serial converter. Revision 2 of the Arduino Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to set into DFU mode.

Fig. 4: Arduino GSM shield V1

3.3 Relay

Relay is an electrically operated switch. Most of the relays use an electromagnet to mechanically operate a switch, but other operating principles are also considered, such as solid state relays. Relays are used where it is necessary to control (NO or NC) a circuit by a low power signal, or where several circuits can be controlled by one signal. The first relays were used in extended distance cable circuits as amplifiers: they repeated the signal coming from one circuit and retransmitted it on another circuit. Relays were used extensively in telephone connections and early computers to perform logical functions.

3.4 Power Supply Unit

A power supply is an electronic device that provides electric energy to an electrical load. As all well know any invention of latest technology cannot be activated without the electrical source of power. All the electronic components from diode to Intel IC's only work with a DC power supply usually ranging from ±5v to ±12v. We are utilizing for the same power supply, 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 which is required for the circuit. In our project the required voltage is +5V to run Energy meter IC, Microcontroller and the display unit.

3.5 Liquid Crystal Display (LCD)

LCD is the new technology which is used for displays in notebook and other smaller computers. Like light emitting diode (LED) and gas plasma technologies, LCDs allow displays to be much thinner and smaller than cathode ray tube (CRT) technology. LCDs consuming low power than LED and gas display. Because they work on the principle of blocking light somewhat than emitting it.

4. IMPLEMENTATION

The connection all the circuit components of the project is shown in Fig. 5. Established all the equipment in a board and connected with a energy meter, Opto-coupler and Arduino on a board. Direct connection of GSM shield with Arduino through male connector. Relay placed on the board to control the circuit and circuit contains a socket and a bulb. While connecting all the loads by replacing the socket and a bulb combination. The 230V AC power supply may interfere data communication of the Arduino and GSM modem. All the connection has to connect properly with good quality of male

connector.

Fig. 5: Circuit Components

The Arduino board should supply with 5V DC and the current ratting must not be 700mA to l000 mA. A 5V l000mA adapter may use for power supply. A 5V rechargeable battery may connect in parallel with power supply will work in case of power failure. Three mobile phone set with GSM SIM, where one is used as customer end and the second is used as service provider end, the last one is customer end. As the Arduino has been programmed via PC with predefined functions like energy meter reading code, SMS reading, displaying the Voltage, Current, Power, checking codes and sending code, After powering ON the Arduino goes to its initial condition and powering ON the GSM modem and delete

all the SMS and checking the real time data base with stored database.

After a short delay the Arduino will read the EEPROM and calculate the data then display the data in the LCD provided. After that relay will ON and load will connect via relay from the energy meter. If there is any impulse occurs from energy meter IC, the Arduino will count it, increase the data and show in the LCD. Arduino will continuously check.

5. ADVANTAGES OF AMR SYSTEMS

AMR system based meters has the following advantages

- ✓ Eliminating error in manual meter reading.
- ✓ Automatic load control for unsettled customer.
- ✓ More efficient.
- ✓ Providing real-time data, it is useful for balancing electric loads and reducing power outages in the power distribution side.
- ✓ Possibilities of dynamic pricing in case of tariff change.
- ✓ Optimized income with existing components.
- ✓ Regular alert to the consumer through the display attached in the energy meter.

6. CONCLUSION AND FUTURE WORK

Arduino and GSM based Smart Energy Meter is the one of the best and also advanced metering and billing system. It can able to read the data and send data via wireless protocol communication using GSM technology through GSM modem. However this project needs more modification and development for more reliable and higher grade of satisfaction and safety.

For GSM module the network coverage of the SIM which is used in the project is one of the important facts. The network strength should be strong so that the GSM module can work well and efficiently. One of the most important facts for this project is high cost of the component so that the overall cost of this project is will be very high rather than the electromechanical type. As a result of the manufacture cost is somewhat high.

But when we implement this project commercially, then the cost may be reducing by two or three times or more than that. In commercial production for this project all the necessary component should provide only necessary pin connection and features. As a result overall cost may reduce more. We needs to ensure the data security while using the GSM technology.

7. REFERENCES

[1] Bharathy R, Jhanani Shree U and Anithamary M "Innovative Energy Meter With Load Control" International journal of pure and applied mathematics volume 119 No.7 2018.

[2] Kamlesh Kumar Singh and Shri A.G. Rao, "GSM Based Smart Energy Meter Reading and Billing System using Arduino" International Journal for Scientific Research & Development Vol. 4, Issue 08, 2016.

[3] Maitri C Kotecha, Prof. Manjula R " IOT Based Energy Meter" International Journal of Engineering Science Invention Volume 7 Issue 5 Ver. 1 May 2018

[4] Himshekhar Das, L.C.Saikia, "GSM Enabled Smart Energy Meter and Automation of Home Appliances", 2015 IEEE.

[5] Sahana M N, Anjana S, Ankith S,K Natarajan, K R Shobha, "Home energy management leveraging open IOT protocol stack ", 'Recent Advances in Intelligent Computational Systems (RAICS)', IEEE 2015.

[6] Yingying Cheng, Huaxiao Yang, Ji Xiao, Xingzhe Hou, "Running State Evaluation Of Electric Energy Meter", 'Workshop on Electronics, Computer and Applications', IEEE 2014.

[7] Ashna. K., "GSM Based Automatic Energy Meter Reading" IEEE 2013.

[8] Abhishek T. Katyare, Shireen H. Khan, Alisha H. Shaikh, Mohd.Juned S. Shaikh, "Smart Energy Metering and Billing System Using Arduino" International Journal for Scientific Research & Development Vol. 5, Issue 03, 2017.

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