Abstract

Most of the houses in India use the conventional watt hour meters and the billing system is not automated. Presently in India from the electricity board a person goes to every house at the end of each month and takes the meter reading manually. The meter readings done by the person from Service provider office and read data used for electricity bill calculation and this bill sent to consumer residential address through post. For paying this bill amount Customer goes to electricity department. But in this technique we require great number of people for reading the meters. The process involved in sending bills to customer is very laborious and cumbersome. A new technology named Automatic Meter Reading System is introduced in this paper. Automated Meter Reading system wipes out all the drawbacks of conventional Meter Reading systems. Automatic Meter Reading System is system which let the Service Provider to collect the reading without visiting the place using GSM. In our proposed system the reading is sent through SMS to the user and same is updated to the Service Provider office. Proposed system helps the Service Provider to get the accurate and updated readings from the energy meter.
1. Introduction

In the Conventional Meter Reading System reading is done manually using meter reading Instrument and then the data is transferred to the base station for generating a report or a bill. The generated report is sent to the customer through post. The Existing system involves lot of human intervention and time consumption which increases the cumbersome. The Figure 1.1 below show the conventional system.

![Fig 1.1 Meter Reading System](image)

To overcome the drawbacks of conventional meter reading system the new technology named Automatic Meter Reading System is introduced. It is a sophisticated system which allows Service provider to collect the reading without visiting the place. The previous research works on Automated Meter Reading shows that various technologies used for meter reading such as power line communication, Zig-bee, Radio Frequency (RF Method) and GSM network but GSM network is proved to be the best among all. In this paper the Programming is done using language Embedded C.

1.1 Applications of the Automatic Meter Reading System are as follows

- Automatic collection of data with specified intervals.
- On-demand electric meter reading and time of use based meter reading.
- Remote services for connection and disconnection.
- Messaging to customers on real-time prices and the change in price information.
- Automatic detection and reporting of power outages and restorations of service.
- Automatic customer meter "connect" and "disconnect" through Interact (Total revenue management system) or (via AMR system).
- End-use load surveys of electric, gas, and water usage.
- Third party integration with SAP, CRM etc.
- Integration with Interact - Total revenue management system for the utility industry.
- Integration with windows mobile and android mobile.

1.2 Objective

Automated Energy Meter has capabilities like remote monitoring and controlling of energy meter. Automatic Meter Reading system continuously monitors the energy meter and sends data through SMS. It saves huge human labour. Using the meter reading, the bill amount is calculated and converted into a transmittable form. Transmit it over a GSM network in the form of a message to the Service Provider office and the customer. This system provides freedom to Service Provider to take
action against lenient customers who have outstanding dues, otherwise Service Provider can disconnect the power of customer. Service Provider can re-connect the power after deposition of dues. This project also gives the power cut information and tempering alert.

2. Problem Definition

The Indian power sector faces a serious problem of revenue collection for the actual electric energy supplied due to tampering of energy and network losses. One of the reasons is the traditional billing system which is inaccurate many times, slow, costly, and lack in flexibility as well as reliability. The upcoming digital energy meters are aimed at rectifying this particular problem of data tampering. A Post-paid Energy Meter extracts power data and sends electricity bills to the consumers within duration of a month. The meter has the capability of Automated Meter Reading along with the ability to exchange information with the suppliers and consumer pertaining to customer’s consumption details. A suggested method is to design of a system which can be used for automatic power meter reading using ARM 7 micro-controller integrated to a GSM module.

2.1 Existing System

In India, we have a lineman who shows up at each one’s residence to manually deliver their electricity bill. It is a waste of valuable human resources and natural resources such as fuel for his travel, paper for the bill, etc. Therefore, to save the valuable resources mentioned above, we propose to make use of available technology.

2.2 Proposed System

Our proposed system can be achieved in 2 steps:
Step 1: Using the meter reading, the bill amount is calculated and converted into a transmittable form.
Step 2: Transmit it over a GSM network in the form of a message to the Service Provider office and the customer.

The kind of Energy Monitoring System which is called AEMRS (Automated Energy Meter Reading System) is appropriate for Large Scale Industries, manufacturing companies, commercial used Buildings or any place where an huge amount of electrical system is used. The Energy Meter reading System leads to overall cost reduction. This reduction may be from less utilization of manpower, no tampering in the data and time saving both for the customers as well as for the energy service providers.

3. Literature Survey

Thirty years ago Automatic meter reading system was first trialed by AT&T in cooperation with a group of utility companies and Westinghouse. After that successful result, AT&T offered to provide phone system-based Automatic Meter Reading Services to customers. But the program was considered economically unfeasible due to cost incurred was four times more than the monthly cost of a manual labor to read the meter.

The automatic meter reading era began in 1985, when several major full-scale projects were implemented. Hackensack Water Co. and Equitable Gas Co. were the first to commit to full-scale implementation of automatic meter reading on water and gas meters, respectively. In 1986, Minegasco initiated a 450,000-point radio-based automatic meter reading system. In 1987, Philadelphia Electric Co., faced with a large number of inaccessible meters, installed thousands of
distribution line carrier automatic meter reading units to solve this problem. Thus, each day automatic meter reading system is becoming more feasible.

AMR System includes hand held devices, mobile and network technologies such as wired and wireless, radio frequency (RF), or power line transmission. A person from service Provider who read the energy meter carries a hand held computer or data collection device. The device automatically collects the readings from a meter by touching read probe in close proximity to a reading coil enclosed in the touch pad. When a button is pressed, the device sends signal to the touch component to collect the meter reading. The software in the device matches the serial number to one in the route database, and saves the meter reading for later download to a billing or data collection computer. Since meter reader has to go to the residential of the meter this is not changing the current situation. Radio frequency based AMR can take many forms. The more common ones are Hand held, Mobile, and Fixed network. There are both two-way RF systems and one-way RF systems in use that use both licensed and unlicensed RF bands. Hand held AMR is where a meter reader carries a Hand held computer with a built-in or attached receiver/transceiver (radio frequency or touch) to collect meter readings from an AMR capable meter. Mobile or "Drive-by" meter reading is where a reading device is installed in a vehicle. The meter reader drives the vehicle while the reading device automatically collects the meter readings. Fixed Network AMR is a method where a network is permanently installed to capture meter readings. This method can consist of a series of antennas, towers, collectors, repeaters or other permanently installed infrastructure to collect transmissions of meter readings from AMR capable meters and get the data to a central computer without a person in the field to collect it.

Power line communication is very popular in AMR field. Power line (PLC) AMR is a method where electronic data is transmitted over power lines back to the substation, then relayed to a central computer in the utility's main office. This would be considered a type of fixed network system the network being the distribution network which the utility has built and maintains to deliver electric power. Such systems are primarily used for electric meter reading. Some providers have interfaced gas and water meters to feed into a PLC type system.

All of the above technology have some limitation and is not feasible for Indian perspective. In the touch technology, handheld technology and in mobile technology still the meter readers have to go to the houses, offices and other places where the meters are placed. So still the meter reading person is required. In addition we need extra devices which are very expensive. As a result they are not cost feasible. The PLC technology is not also feasible for Indian perspective. In Indian high voltages transmits through the power line cable. As the voltage is high so the transmitted data will be corrupted by the attenuation. All the power line cable of our country is not placed under the ground. It situated in the open air. So the cable faces different environmental problems. So the actual data may not transmit to the provider end. As a result this technology is also not feasible in our country. The fixed RF technology has small coverage area. As a result, this method consist of a number of series of antennas, towers, collectors, repeaters, or other permanently installed infrastructure to collect transmissions of meter readings from AMR capable meters. So this is not cost efficient for the customers.

4. Requirements

I) The following shows the hardware requirements for the meter reading system

- Energy meter
An electricity meter, electric meter, or energy meter shown in Figure 4.1 is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. Electric utilities use electric meters installed at customer’s premises to measure electric energy delivered to their customers for billing purposes. They are typically calibrated in billing units, the most common one being the kilowatt hour [kWh]. They are usually read once each billing period.

![Energy Meter](image)

**Figure 4.1: Energy meter**

- Arm 7 board (microprocessor chip)
  
  Its an open source physical computing platform based on a simple micro-controller board and a development environment for writing software for the board. It can be used to develop interactive objects taking inputs from a variety of switches or sensors and controlling a variety of light, motors, and other physical outputs. It also helps in changing the clocking rate and helps in real time programming. The image of a typical ARM 7 board is shown in figure 4.2.

![Arm 7 Board](image)

**Figure 4.2: Arm 7 Board**

- GSM module
  
  A GSM module shown in figure 4.3 is a specialized type of modem which accepts a sim card and operates over a subscription to a mobile operator just like a mobile phone. When a GSM modem is connected to a computer, it allows the computer to use the modem to communicate over the mobile network. They can be used for sending and receiving SMS and MMS messages.

![GSM Module](image)

**Figure 4.3 GSM Module**
• **Optocouplers**

   In electronics, an optocoupler, is a component that transfers electrical signals between two isolated circuits by using light. Optocouplers prevent high voltages from affecting the system receiving the signal. Commercially available optocouplers withstand input-to-output voltages up to 10 kV. A typical optocoupler is shown in the figure 4.4.

   ![Optocoupler Image](image)

   **Figure 4.4: Optocoupler**

5. **System Design**

   The Block diagram representation of the Automated Energy Meter Reading system is as shown in Fig 5.1. The Power is supplied to houses from an electric pole to the energy meter. The energy meter is connected to the ARM 7 Board which is the brain of this system. The Arm 7 board continuously monitors the energy meter and takes the meter reading as input and calculates the amount that has to be paid for the consumed energy. These are displayed on a LCD Screen connected to the ARM 7 board. The Arm 7 board sends SMS to both the user and SERVICE PROVIDER every month with the help of the GSM module. The relay circuit is used to cut the power supply if the customer fails to pay the bill on time.

   ![Block Diagram of ARM System](image)

   **Figure 5.1: Block Diagram of ARM System**

5.1 **Working**

   An ARM 7 processor based board is used. It uses a 32-bit processor with on-chip ADC, timer/counter module, PWM and UART module to interface a GSM modem and energy meter. The energy meter which generates the pulses as well as count the energy consumed is used. The digital
energy meter is having a LED which blinks for a specific number of times to indicate the energy consumed (e.g., 1 Unit = 10 pulses). These pulses are fed to ARM 7 based system which is programmed to count these pulses. The system reads these pulses and after counting specific number of pulses it increments the internal counter by one which indicates the number of units consumed. Now, when the service provider sends a message to read the energy meter data, GSM modem, which is connected through UART interface, interrupts ARM 7 board. This causes ARM to read the number of units burnt and sends the data to the UART. Further, the UART sends the data to GSM modem which sends this meter reading data to service provider. If, now, the service provider detects that the previous bills are pending for a specific user, the message will be sent by the service provider, which results in disconnection of energy supply for that user.

5.2 Hardware design

5.2.1 Arm 7 Data Sheet

The ARM7 is part of the Advanced RISC Machines (ARM) family of general purpose 32-bit microprocessors, which offer very low power consumption and price for high performance devices.

The architecture of ARM7 is based on the principles of Reduced Instruction Set Computer (RISC), and they are much simpler than micro-programmed Complex Instruction Set Computers. This results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective chip.

The instruction set comprises eleven basic instruction types:

• Two of instruction types use on-chip ALU, barrel shifter and multiplier to perform high-speed operations on the data in a bank of 31 registers, each 32 bits wide,

• Three classes of instruction control data transfer between memory and the registers, one optimized for flexibility of addressing, another for rapid context switching and the third for swapping data.

• Three types of instructions control the flow and benefit level of execution.

• Remaining three types are committed to the control of external co-processors which allow the functionality of the instruction set to be extended off-chip in an open and uniform way.

ARM7DI has a 32 bit address bus. All ARM processors share the same instruction set, and ARM7DI can be configured to use a 26 bit address bus for backwards compatibility with earlier processors.

ARM7DI is a fully static CMOS implementation of the ARM which allows the clock to be stopped in any part of the cycle with extremely low residual power consumption and no loss of state. ARM7 Block diagram is as shown in figure 4.1 and ARM7 Functional Diagram is as shown in figure 5.2.
5.2.2 GSM Data sheet

A GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine-SIM900 and it works on frequencies of 900/1800 MHz. The Modem is coming with RS232 interface, which allows user to connect PC as well as micro-controller with RS232 Chip(MAX232). The baud rate is configurable from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The on-board Regulated Power supply allows you to connect wide range unregulated power supply. Using this modem, user can make audio calls, Send and read SMS, attend the incoming calls etc through simple AT commands. The GSM board orientation is shown in figure 5.4.

GSM Board orientation
5.5 Software Design

5.5.1 Data flow diagram

The data flow diagram of an Automated Energy Meter Reading System is shown in Fig 5.6. Once the power is supplied to the board it initializes all the hardware components. It then monitors the pulses consumed. If the number of pulses consumed is 10 then it increments the units value by 1. Every month end it sends a message to both user and SERVICE PROVIDER. Next it checks if any message is received from the service provider. If there is no interrupt, it sends another message to...
the user with the help of GSM. If there was an interrupt then the power is shut down with the help of the relay circuit.

![Data flow Diagram](image1)

**Figure 5.6 Data flow Diagram**

The below figure 5.7 shows the initial LCD Display which gives the message GSM Based Power Meter reading and Billing System.

![LCD Display](image2)

**Figure 5.7: LCD Display**

The Figure 5.8 shows the LCD Display with Time and Units consumed and rate for units consumed. In our project we have considered to generate bill for every 10 units and send the message to Service provider and user.

![LCD Display with RTC and Rate](image3)

**Figure 5.8: LCD Display with RTC and Rate for units consumed.**
The figure 5.9 shows the message received by customer includes meter reading, total amount and last date to pay the bill.

The Figure 5.11 shows the message sent by the service provider if the bill is not paid on time and if once bill is paid the connection can be done and sent message ON. The figure below shows the sample implementation which includes all the components specified previously. For the purpose of demonstration we also included a Bulb to show the power cut and reconnection after paying bill.
6. Conclusion

The development of GSM based automated energy meter reading overcome the drawbacks of conventional system. GSM based AMR have low cost since less man required saves time by sending the message. It not only solves the problem of manual meter reading but also provide additional feature such as power disconnect, power connect, power cut alert. With this system the service provider can collect the bill any time with a single message. The data collection and manipulation task becomes fast and easier. Any modification can be made to the code in less time. Changes in rate or unit calculation can be done very effectively. This technology mitigates labor cost, collection time, energy theft, avoids late payment. Adding to this it increases data security, improved customer service, reduced revenue losses. This project is not only sending the data but also it does provide power disconnect/connect feature, power cut intimation feature.

References


