An efficient "3 phase 4 channel AC energy meter" with automatic load control and automated billing using GSM

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Abstract: Energy meter reading tedious process. Now a day energy meter reader goes to every premise and takes the reading manually then issues the bill. In manually reading human error possible and not provide reliable meter reading. To avoid this difficult task Automatic Energy Meter Reading (AMR) system is introduced. AMR is the technology that automatically collecting consumption and status of data from energy metering device and transferring the data to Electricity Board (EB) office by using Wireless Sensor Networks (WSN). After verifying customer"s serial number bill will be issued then data has been stored into database. The proposed system automatically disconnect meter either load crosses concern limit or payment periods exists. It also does not provide electricity tampering and provide accurate meter reading.

Index Terms: AMR, WSN, Electricity.

1. Introduction

2. Electricity is the driving force behind the development of any country. With the rapid increase in residential, commercial, and industrial consumers of electricity throughout the world, it has now become imperative for utilities companies to devise better, non-intrusive, environmentally-safe techniques of gauging utilities 'consumption so that correct bills can be generated and invoiced. Traditionally, the electricity meters are installed on consumer's premises and the consumption information is collected by meter-readers on their fortnightly or monthly visits to the premises. This method of gauging electricity consumption has the following disadvantages: (i) Sometimes the meters are installed inside people's homes and, if the consumer is not at home, the meter-reader cannot record the fortnightly or monthly consumption and then the utilities 'company has to resort to considering the average bill-amount of the previous months as an indicator of the likely consumption for the current month. This results in burden for both consumer and the electricity supply company. May be the consumer has not utilized similar amount of electricity in the current month as in the previous months for reasons such as, holidaying elsewhere or being in the hospital, etc. during the month, and sending him a bill for a larger amount based on his history of electricity consumption may result in his/her financial hardship. This method of billing is also not suitable for the electricity supply company because it gives inaccurate account of the overall electricity consumption in the consumer's area and may ultimately result in errors in future planning by the company. (ii) Hiring of a number of meter readers by utilities' companies and providing means of transportation to them is an expensive burden on the companies' budgets.

Moreover, these visitors of the may use vehicles to reach the consumers' premises, generate pollution in the air which has negative impact on the environment and the greenhouse effect. (iii) Dissatisfaction of some customers who may consider meter-readers' entrance to their homes as some sort of invasion of their privacy. This is especially applicable in villages, where during the day most men are outside of their homes earning a living and only women are at doing the housework. (iv)The meter readers may make some mistake in reading the consumed unit which will lead to false billing due to human error. The SMS has extended their service to content providers to deliver a wide variety of services to mobile phone users. SMS is one of the convenient mean of communication especially for reminder, notification, and a short note when the mobile phone user is not expect to answer or respond immediately. With the advancement and booming of ICT and internet technology makes online information system applications such as e-commerce are systems using Power Line Carrier (PLC) communications , Bluetooth and ZigBee were developed to address the above mention problems, but the above mentioned AMR are either short in operating distant and still require some intervention of human operators or prone to error and reliability issue due to noise and poor power quality in the transmission line, more importantly the above mentioned method does not allow control. With the rapid development of Global System Mobile (GSM) infrastructure and Information Communication Technology (ICT) in the past two decades has made wireless automatic meter reading system more reliable and possible. The GSM Power Meter Reading and Control (GPMC) System takes advantage of the available GSM infrastructure nationwide coverage in the country and the Short Messaging System (SMS) cell broadcasting feature to request and retrieve individual houses and building power consumption meter reading back to the

energy provider wirelessly and the control system will monitor the power of the appliances which consumes more power than its predefined limit. If the power increases to the predefined limit the control system will control the power by means of different techniques for different types of loads like resistive and inductive load so as to reduce un necessary power consumption of appliances and to save the energy at the same time the energy provider can connect or disconnect the power supply to the home is there is an irregularity in the payment of the electricity consumed bill with the help of the same GSM modem.

3. Network communication technology which enables energy Provider Company to read the meter reading regularly without the person visiting each house by using GSM communication technology. AMR system is very useful for remote area or small villages which are not connected by any means of transport such as an island or remote precinct. This GSM based data collection system can be very swift, accurate and efficient. The theft is the major drawback in our country because of theft more than lakes of money loss per state in our country. So our project deal with effective external tempering detection by using theft control system based on GSM. Current energy meter is used to measure the total power consumption for house or industrial purpose. This recorded reading is transmitted to the electricity board. For transmitting the reading of energy meter GSM module is used. To avoid theft, in between transformer and energy meter we propose the system in which load loss in between transformer and energy meter is detected and it will send massage to the service provider through gsm .The informative system will be helpful for the electricity board to monitor the entire supply and the correct billing accordingly without any mishap. This model reduces the manual manipulation work and theft control. GSM system also give the information of total load used, power disconnect regularly in particular interval through SMS.

1.1 Necessity

Traditionally, the electricity meters are installed on consumer's premises and the consumption information is collected by meter-readers on their fortnightly or monthly visits to the premises. This method of gauging electricity consumption has the following disadvantages: (i) Sometimes the meters are installed inside people's homes and, if the consumer is not at home, the meter-reader cannot record the fortnightly or monthly consumption and then the utilities 'company has to resort to considering the average bill-amount of the previous months as an indicator of the likely consumption for the current month. This results in burden for both consumer and the electricity supply company. May be the consumer has not utilized similar amount of electricity in the current month as in the previous months for reasons such as, holidaying elsewhere or being in the hospital, etc. during the month, and sending him a bill for a larger amount based on his history of electricity consumption may result in his/her financial hardship. This method of billing is also not suitable for the electricity supply company because it gives inaccurate account of the overall electricity consumption in the consumer's area and may ultimately result in errors in future planning by the company. (ii) Hiring of a number of meter readers by utilities' companies and providing means of transportation to them is an expensive burden on the companies' budgets. Moreover, these visitors of the may use vehicles to reach the consumers' premises, generate pollution in the air which has negative impact on the

environment and the greenhouse effect. (iii) Dissatisfaction of some customers who may consider meter-readers' entrance to their homes as some sort of invasion of their privacy.

The system designed reduces the efforts of manual data collection of energy meter. Also, data which is received at service provider side is easy to manipulate for bill generation and other such tasks. With this system we can collect the reading as well as control the supply to the user. With addition of software at service provider side, the customer can be informed of current meter reading, bill for current cycle, status of the line and other parameters to the customer with either message or a phone call.

Objectives

*   To design a circuit this continuously monitors the meter reading and sends the message to the user and electricity department.
*   To design a mechanism that will monitors and controls the power of appliances from both ends.
*   An LED Display with a speaker which will report the latest update to the customer regarding tariffs and if there is any sudden power cut. The GSM modem will report to the service provider modem on daily basis and at the end of month analysis of energy consumed is done tariffs and vats are included and bill are send to the consumers inform of mail SMS and hardcopy in the billing address provided by consumers.

System Development

*   Systems development is the process of defining, designing, testing, and implementing a new application or program or Project. It could include the internal development of customized systems, the creation of database systems, or the acquisition of third party developed software. Written standards and procedures must guide all information systems processing functions. The organization's management must define and implement standards and adopt an appropriate system development life cycle methodology governing the process of developing, acquiring, implementing, and maintaining computerized information systems and related technology.

PROPOSED WORK

*   To implement this system, an ARM controller or an PLC based board is used. module, 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 = 1600 pulses). These pulses are fed to ARM 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. The system also contains a relay circuit and an LCD display which is interfaced with the modem and the control circuit as shown in figure 1
*   Now, when the service provider sends a message to read the energy meter data, GSM modem, which is connected through UART interface, interrupts ARM. 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. At the end of the month the total unit consumed is detected, tariffs are included and sent to the consumers in form of SMS, email, and hardcopy of bill to the address of the user. 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. For this purpose, the supply goes further to home/office through a relay circuit, which is again controlled by ARM system or the PLC. The service provider can now inform the customer regarding the current bill or status using the customer's registered phone number by either a message The system will also contain a display system with a speaker which will report latest information to the consumers.
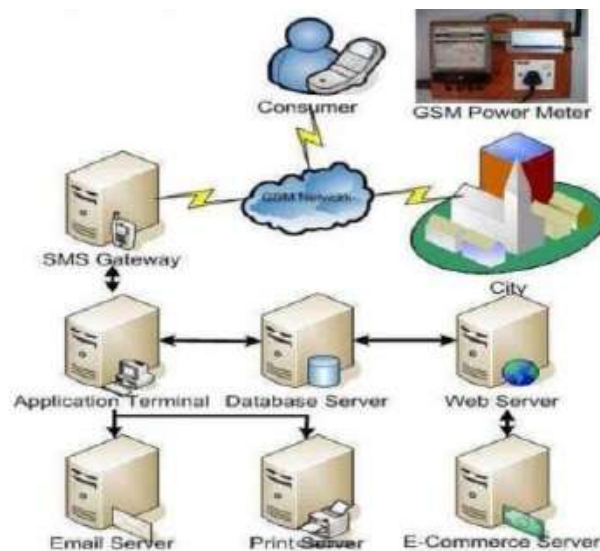
SYSTEM OVERVIEW

- The complete system over view for the system shown in the fig.2 The complete system is made up of GSM power meter (GPM) in every consumer unit and SMS gateway, application terminal data base server email server printer server and e- server installed at the distributed site the system is working In conjunction with GSM network to working In conjunction with GSM network to retrieve power meter reading using SMS. The GPM is a single Phase digital KWh which utilizes the GSM network to send the power usage reading back to the energy provider wirelessly once in a day through SMS gateway .The consumer can also check the latest reading of the energy meter in form of SMS when demanded by the users. .A sim card with the unique service no is required for the GPM to receive and reply it's to the energy provider the special service no. sim card is work similar with the mobile phone no: except it is not meant for voice service. The sim card is also used to identify and retrieve the customer details from the data base server for billing purpose. The above figure fig:2 shows the structure of the system in the service providers end. At the end of the month the total unit consumed is detected, tariffs are included and sent to the consumers in form of SMS, email, and hardcopy of bill to the address of the user. The same above meter can also be used to control the load . if the consumer wants tho control the load from the far end the can do it with the help the above GSM modem. The distributes can also control the load from the far end with the help of the same GSM modem if the consumer fails to pay the money on time .All the load control is made possible with the help of relay connecter to the meter .this system will also have an LCD display and an speaker interfaced with the modem with the help of ARM controller or the PLC that will display the important message regarding un scheduled or emergency power cut or information regarding tariff to the consumer.

Figure 2: proposed system

HARDWARE IMPLEMENTATION

A large part of the project involved choosing the appropriate hardware components to take the meter reading from the meter and send it to user and to server remotely and to control the power consumption and provide a wireless link. The initial idea was to search for an all-in-one solution that would have all the components integrated, allowing for the smallest size possible. Initially it was thought that a simple circuit could be built and attached to a microprocessor to control the power. But the cost of the circuit with microprocessor is very high. It was decided that designing a simple circuit, with the help of the microcontroller and would provide accurate power controlling and the measurement of meter reading. The following sections describe the research process as well as the implementation of these integrated circuits. Hardware implementation was done in Eagle 6.0 which is having the facility of PCB layout print. It can also be designed with PLC when being used in industrial automation purposes still work is in progress in this field so that proper interfacing can be obtained with maximum efficiency and less cost.

- **Microcontroller unit**

Microcontroller unit is used for controlling of complete AMR system. The AT89S52 is a low-power,
high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable flash memory. The AT89S52 provides 256 bytes of on-chip RAM 8K bytes of flash Memory, 32 I/O lines, watchdog timer, two data pointers, three 16-bit timer/counters a full duplex serial port, on-chip oscillator, and clock circuitry.

- **Energy measuring module**

Energy measuring module continuously measuring the instantaneous voltage and current and finding the
product of these to give instantaneous electrical power. It is spout the power in the form of pulses and also give the information of power on and off status. This data are display on to the Liquid crystal display.

Real time clock

In this DS1307 serial real time clock is used for giving the information of date and time of power cut. DS 1307 have 56 bytes RAM. Address and data are transferred serially by 2-wire, bi-directional bus. The clock/calendar provides seconds,

minutes, hours, day, date, month, and year information. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery supply.

• **Relay section**

Relay circuits are interfaced with the energy meter and microcontroller. Relays allow one circuit to switch a second circuit which can be completely separate from the first. Relay circuit are used for switching the consumer's main consumption line between cut-off and power supply mode. It is proved to be very helpful feature for energy provider company, who can remotely switch into cut off mode from power on mode of any consumer due to nonpayment of electricity bills / has large outstanding dues. it can reconnect the power supply after payment of dues.

• **Liquid crystal display**

A Liquid crystal display are interfaced to microcontroller unit that are used to display the meter reading, date time, power factor, power status, total load used etc.

• **Data storage unit**

AT24C04 is electrically erasable programmable read only memory is used for the data stored in its 4KB Memory. EEPROM interfaced with the microcontroller by using 2 wire serial interfaces. If power cut off the content of RAM must be stored in EEROM, and when power will be back the energy meter will be start from its previous state [1].

• **Temper detection unit**

Today energy theft is a serious problem due to energy theft heavy revenue losses are incurred by country. A tempering unit used for stop of this energy theft that sent the alert to energy provider company when

tempering occurs. If any person tries to tempering (such as current reversal or CT reverse tampers, partial earth fault condition, bypassing meter, magnetic interference, phase or neutral wire swapped, external tempers etc.) with energy meter the tempering unit will be activated and as SMS alert send central server of the energy provider company.

• **GSM modem**

Quad-band intelligent GSM/GPRS modem suitable for long duration data transmission. To implement AMR system a GSM modem is connected to a microcontroller which would transmits data from a meter to cell phone and also receive commend from cell phone to energy meter. The modem will send unit or pulses (power consumption) on a regular interval or on a request. AT commands set which stands for attention terminal are used by energy meter to communicate with the GSM Modem.

• **Total load calculation**

AMR also give the information of total load used in a house on request at any time. Total load used in any

house can be calculated by observed or record N number of pulse in T time that is described by equation number 1.

$$\text{Total load used} = \frac{K_h * N * 3600}{T}$$

Where
Kh =Meter constant
N=Number of pulse
T = Total pulse time of N pulses

Energy meter also sends a SMS alert to the energy provider company and customers if any persons used more than specify limit of load. The energy provider company can disconnect the power of respective customer. So customers manage their

house power consumption. Microcontroller has a program of matching of this code to power re-connect code. If this code is matches then power reconnect to respective meter. Power cut feature perform by using interrupt signal.

SOFTWARE IMPLEMENTATION

According to the hardware circuit design features, meter reading terminal program flowchart was introduced as shown in figure3.and figure .4 First the system initializes each module, and then reads the meter reading regularly and stores them. When the receiving the command, meter send the current status along with the energy consumption.
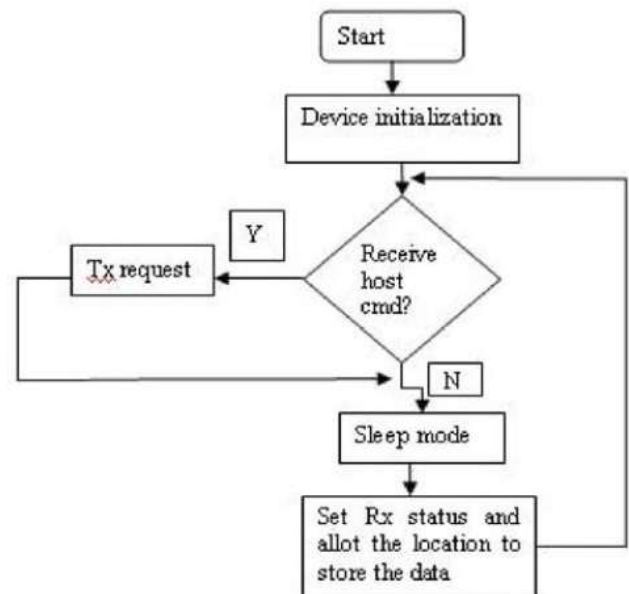

Fig 4 : Server side program flow

I. CONCLUSION

A complete working prototype of this system is being done to demonstrate an automatic power meter reading using the GSM network. The system takes the advantage of the existing GSM infrastructure that have virtually full coverage of all housing and building area across the country which lead to low infrastructure Implementations cost, simple and easy installation of GSM power meter at consumer site as GSM .Power meter is no difference from Existing analogue or digital meter installation the complete E billing system help in easy billing and delivering of the bill in form of SMS, email and printed hardcopy the system is effective reliable and efficient wireless automatic power meter reading with automatic load control. Thus it reduces the operation cost and human operator meter reading, making the system error free with the help of the GSM modem, the only drawback with the system is that it way sometimes leads to slow delivery of message to the distribution side GSM modem.

References

1. S.Arun,Dr.Sidappa "Design and Implementation of Automatic Meter Reading System Using GSM, ZIGBEE through GPRS." International Journal of Advanced Research in Computer Science and Software Engineering Research Paper.Volume 2, Issue 5, May
2. Bharat Kulkarni "GSM Based Automatic Meter Reading System Using ARM Controller"

International Journal of Emerging Technology and Advanced Engineering Website:, Volume 2, Issue 5, May 2012)

3. "Mr.Rahul Ganesh Sarangle,Prof.Dr.Uday Pandit Khot, Prof. Jayen Modi "Gsm Based Power Meter Reading And Control System" Mr.Rahul Ganesh Sarangle, Prof.Dr.Uday Pandit Khot ,Prof. Jayen Modi .International Journal of Engineering Research and Applications (IJERA) 4, June- July 2012.

4. Li Quan-Xi, Li Gang "Design of remote automatic meter reading system based on ZigBee and GPRS"Proceedings of the Third International Symposium on Computer Science and Computational Technology(ISCSCT '10) 14-15,August 2010,

5. Tariq Jamil, , "Design and Implementation of a Wireless Automatic Meter Reading System" WCE 2008, July 2 - 4, 2008, London, U.K IAENG Proceedings of the World Congress on Engineering 2008 Vol I. , July 2 - 4, 2008, London

6. B. S. Koay, S. S. Cheah, Y. H. Sng, P. H. J. Chong, P. Shum, Y. C. Tong, X.Y. Wang, Y.X. Zuo and H. W. Kuek, "Design and Implementation of Bluetooth Energy Meter" ICICS-PCM-2003,15-18 December 2003

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