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Development of a Low-Power, Low-Cost Electric Energy Meter Reader with Prepaid Scratch Card Billing System

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ABSTRACT- The proposed system aims to develop a low-power, cost-effective electric energy meter reader comprising measurement and communication modules. The measurement module employs current and potential transformers to gauge line current and voltage, facilitating wattage and energy measurement. Outputs from these transformers undergo conversion, rectification, filtering, attenuation, and analog-to-digital conversion. Energy consumption data is transmitted to both the power supplier and consumer via SMS at predefined intervals, with the system also detecting and notifying the power company of meter tampering.

Current electricity billing systems are prone to errors and time inefficiencies, stemming from electro-mechanical meter inaccuracies, human errors in recording readings, and processing bills. Postpaid systems lack consumer control over usage, leading to power wastage. Embracing a prepaid system has demonstrated significant reductions in electricity usage in several countries. Additionally, prepaid systems mitigate human errors in meter reading and bill processing. Wireless meters are suitable for residential and industrial applications, with technology advancements facilitating fast, secure, and accurate data exchange. The integration of prepaid scratch card billing for electricity is presented as a solution, leveraging advancements in wireless communication technologies like the internet and GSM. This system not only addresses billing inefficiencies but also encourages responsible electricity usage by consumers.

KEY WORDS: GSM Modem, Microcontroller, Server, and Wireless Meter.

I. INDRDUCTION:

The next generation Automatic Meter Reading whose goal is to help collect the meter measurement automatically and possibly send commands to the meters was using new possibility explore and wireless communication propose a wide proliferation.. Automation ranges from Connecting to a meter through an RS-232 interface for transmitting the meter measurements all the way from the meter to the utility company via GSM network.

1.1 History of Meters

Meters previously, and today in a couple of nations, were electromechanical gadgets with poor exactness and absence of configurability. Burglary discovery was additionally a test. Such meters are constrained to giving the measure of vitality utilization on location. With the advancement of nation's economy and the change of national power, the force necessity is still continually expanding because of utilization of ill-advised force administration frameworks and the routine vitality metering framework. Over the previous years, metering gadgets have experienced much change, and are relied upon to end up considerably more refined, offering more administrations.

Present improvements in this heading appear to give opportunities in actualizing vitality proficient metering. Advances that are more exact and precise, mistake free, and so forth. The execution of WAMRS gives numerous key components as contrasted and the simple utility meter perusing with labor. Some of these elements are recorded beneath,Higher speed.

- Improved load profile.
- Automatic billing invoice.
- Real time energy cost.
- Load management.
- Alarm warning.
- Remote power switches on/off.
- Tamper detection.
- Bundling with water and gas.

This present a two path correspondence between the power organization and the heap by sending in a great deal of force parameters and control sign to achieve the objective of burden administration and force interest control. Utilizing WAMRS on conveyance computerization can supply numerous capacities, for example, productive meter-perusing, appropriation, force checking and control, load administration and time-of-utilization rate. With fast development of versatile correspondence system, future application administration will steadily focus on

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information transmission administration. GSM has been created maturely and has numerous pragmatic applications at present. It has numerous points of interest, for example, more steady system with powerful components, covers for all intents and purposes all parts of the world, support and security of information transmission. It fulfills the need of rate for information transmission required for programmed meter perusing framework.

1.2 Messaging over GSM Network

Worldwide System for Mobile Communications (GSM) is the world's most mainstream standard for versatile telephony frameworks. GSM is utilized by more than 1.5 billion individuals crosswise over more than 212 nations and domains. GSM additionally spearheaded minimal effort usage of the short message administration (SMS) which permits gatherings to trade delay-tolerant short instant messages. The fame and wide scope of cell systems have pulled in specialists to consider the utilization of SMS administration. However there are sure flawed issues seeing GSM system, for example, its versatility, dependability and security, particularly under high load. Zerfos et al. [7] have investigated genuine information taken from a genuine GSM system in India. SMS conveyance achievement rate was observed to be 94.9%; 73.2% of the effectively conveyed messages range to the destination inside of 10 seconds; around 5% of them require over 90 minutes. Utilizing SMS for Automatic Electricity Meter perusing administration will doubtlessly build the stream of messages colossally. GSM utilizes a few cryptographic calculations for security. The advancement of UMTS presents a discretionary Universal Subscriber Identity Module (USIM), which utilizes a more drawn out verification key to give more noteworthy security, and commonly validating the system and the client. The paper comprises of taking after areas: Section II portrays the proposed framework structural engineering. The framework incorporates a 32-bit ARM microchip to manage power information handling and hand-off control, which transmits the force utilization values intermittently, by means of a current GSM system to an expert station. Area III and IV depicts the equipment structural planning and programming independently of WAMRS. Area V finishes up the paper.

II. AIM &SCOPE OF THE PRESENT INVESTIGATION

The proposed system focuses on development of low power and low cost electric energy meter reader. The system consists of two modules, measurement and communication module. The measurement module measures the line current and voltage in order to measure wattage and finally energy. Current transformer (CT) senses the line current while the potential transformer (PT) measures the line voltage. The outputs, obtained from CT and PT, are current to voltage converted, rectified, filtered, attenuated and analog to digital converted. The energy is summation of the power used over a known period of time. The amount of energy is transmitted to Power supplier as well as consumer via SMS (Short Messaging Service) at predefined intervals. The system also notifies Power Company in event of meter tampering.

2.1 EXISTING SYSTEM

Electricity is one of the basic necessities in today's world. It is the most convenient and valuable form of energy. It is extremely important to efficiently provide electricity to a large populace. One of important steps in proper transmission and usage of electricity is its metering. Lately, most of the countries, whether developed or developing, have turned to digital meters for energy data logging.

From the early days till today meter reading for electricity consumption and billing is done by human operators from houses to houses. This therefore requires a very large number of human operators and long working hours to acquire complete data reading and billing in a particular area. However, there may be cases where human operators miss to bill few houses in an area or restricted and slowed down by bad weather condition, transportation problems, etc. Moreover human operators are very much likely to make mistake while billing or reading a meter and sometimes the house's electric power meter may be placed in a location where it is not easily accessible. Again printed billing has the tendency of being lost in the mail box or being never delivered. Day by day due to the increasing number of residential housings and commercial buildings, more human operators and longer working hours is needed to complete the meter reading task which eventually increases the energy

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provider operation costs for meter reading. To achieve efficient meter reading, reduce billing error and operation costs, an Automatic Electric Meter reading system can be introduced with every energy meter in an area. It is an effective means of data collection that allow substantial saving through the reduction of meter re-read, greater data accuracy, frequent reading, improved billing and customer service, more energy profiles and consumption trends updates and better deployment of human resource. This process in very time consuming and since manual intervention is required it also increases the error in billing procedure. So, there is obvious need for automation in this area which will reduce the time delay and cost incurred in the current procedure

Prior Art

Major developments and projects in the field of remote metering are in progress, involving various research and development programs such as PLCs, application of the system on large databases, utilization of the necessary communication links, and others. Above system is inflated that's it is not castoff in India as consider Indian frugality.

III. IMPLEMENTATION

The system consists of wireless meter and the server which is shown in fig 1. The wireless meter placed in homes, company and the buildings which have exchange the information using the GSM network through SMS. Both the prepaid and post paid system implemented using this architecture.

A. Wireless Meter

The metering module consists of a Microcontroller, metering IC, LCD i.e. liquid crystal display, EEPROM, Relay, GSM module and Keypad.

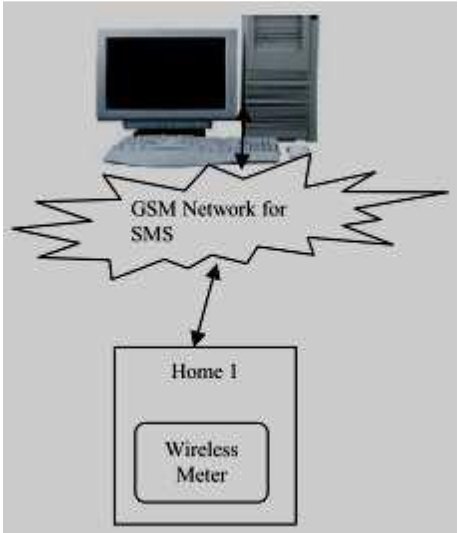

Fig 1 Wireless Electricity Meter

B. Microcontroller Unit

PIC microcontroller is used as main unit. The PIC is an 8 bit Reduced Instruction set computer (RISC) Microcontroller. It is one of the most popular microcontrollers for its high performance and low cost. It has three 8 bit ports, one 6 bit and one three bit port so total 33 I/O lines. Fig 2 shows block diagram of wireless meter. It has 8 KB of program memory and 368 data memory. The program inside the microcontroller contain the protocol for accessing different hardware peripheral such as LCD,EEPROM, Relay, Metering IC, GSM Module. And applications contain the billing calculation and send the SMS.

C. Display Unit

16x2 Character LCD is interfaced with microcontroller using 4 wire modes. The meter reading i.e. KWh, total KWh, cost KWh, last billing date (Post paid scheme) and remaining KWh in prepaid scheme etc.

Electrical Erasable Read only Memory (EEPROM) When the power fail occurs, the all reading is stored in EEPROM so that when power is back on, the meter can start from its last state. An I2C EPROM (AT24C64) of 8KB size is used.

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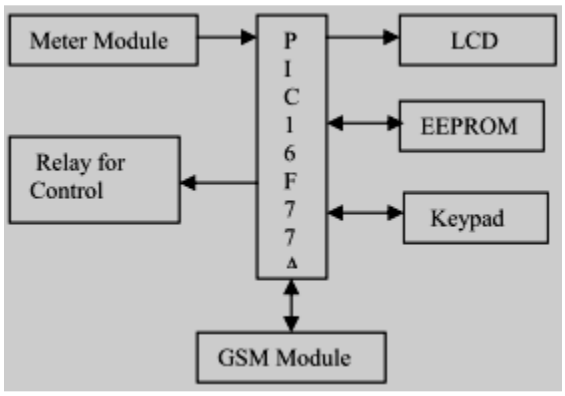

Fig. 2 Block Diagram of Wireless Meter

D. Metering Module

The metering module (ADE 7757) is used. The ADE 7757 is mixed signal single phase metering IC. It supplies average real power information on the low frequency outputs F1 and F2. These outputs may directly drive the electromechanical counter or interface with MCU. The frequency output CF is connected to a microcontroller pin. This will count the number of pulses in given time. The average power proportional to the average frequency is given by

Average frequency = Average power = Counter/Time

The energy consumed during the integration period is given by Energy = Average Power x Time = (counter/ time) x time The ADE 7757 calculates the product of two voltage signals (on channel V1 and V2) and then low- pass filters this product to exact real power information.

This real power information is then converted to a frequency. The frequency information is output on F1 and F2 in the form of active low pulses. The result is an output frequency that is proportional to the average real power. [3]

E. Relay Unit

A relay is used for connecting and disconnecting power supply to the costumer s load. The microcontroller sends signals to the relay input signal pins to control the relay contacts

F. GSM Modem

A GSM modem is interfaced with the microcontroller serial port for sending and receiving SMS. Using AT command Protocol, [2] microcontroller send the different commands to the modem. AT-commands which stand for ATTENTION TERMINAL are used by processing unit to communicate with the GSM Modem. This whole operation is based on the instructions that are passed by processing unit.

This modem and the processing unit are linked by means of RS-232 communication protocol [4]. This operates under the following configuration,

- Baud Rate = 9600
- Parity Bit = None
- Byte Size = 8
- Stop Bit =1

Some of the main and frequently used AT-Commands are given below as also used in,

- AT (Attention Command)
- AT+CMGL (List message)
- AT+CMGF (Selecting messaging mode)
- AT+CMGS (Send message)
- AT +CMGR (Read message)
- AT+CMGD (Delete message)

G. Keypad

A 3x4 keypad is integrated with meter module. Use full in prepaid mode. The key available on this keypad start from 0-9 and one enter key

II. CENTRAL SERVER

Server mainly consist of GSM Hardware unit and several software module which shown in fig 3.

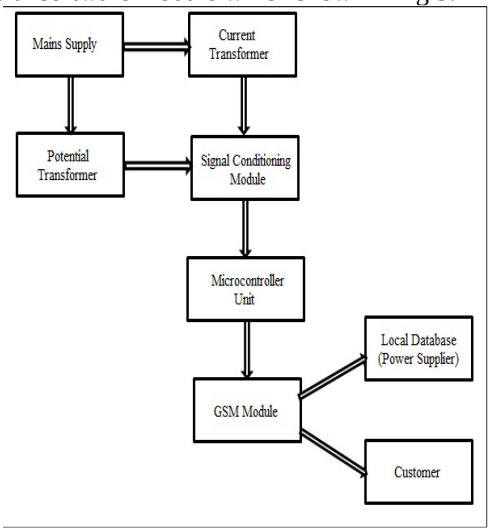

Fig 3 Block Diagram Serve

It consists of GSM module which used for sending and receiving the SMS using AT command [2]. To interface modem with server the MCU is used. Communication is done using the serial protocol. Server's Serial port (RS 232) and 8051 with RS232 module used between them.

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A. Server Software

Our system the central server is built on windows XP operating system with VB programming Language.

The software composed several module which shown in fig 3.The data communication module communicate to 8051 microcontroller through serial communication. Microcontroller 8051 is communicating to GSM through AT Commands.

When server wants collect information from particular remote location meter, it send request SMS message to particular meter and wait for data from GSM module. After the remote meter receives the Request SMS massage, it makes a data frame consisting of the meter's information and sends it to the server by SMS. The server then gets the SMS data from the GSM modem and stores the information in the Database. Fig 4 shows the flow chart of post paid billing system.

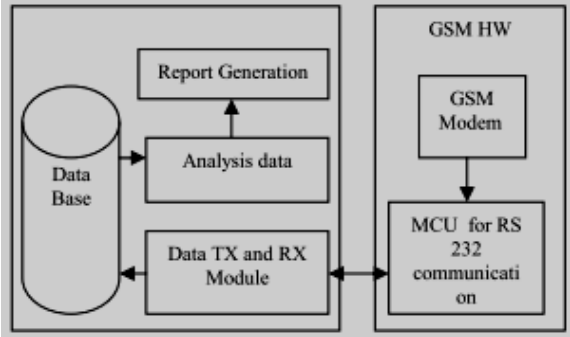

Fig. 4 Post paid Billing System

The data collection can be done at any time or periodically such as monthly basis. The Monitoring & Analysis Module gets data from the Database and calculates the overall energy consumption of the meter. Server operator can send Disconnection SMS massage to the wireless meter to disconnect the meters relay contacts and thus stop the customer to consume further energy. Pre-paid scratch-card based billing scheme can also be implemented using the SMS based technique.

The electric supplier will produce scratch-cards. Customers will buy scratch-cards and send the SMS through keypad included in Wireless meter to the central server consisting of the customer's meter ID and the scratch-card's secret pin number. When the central server receives the SMS, it checks the validity of the pin number from the database and meter ID. If the meter ID is valid and the pin number is also valid and still unused, then the server sends an SMS to the customer's meter which contains the information of how much balance will be recharged in the meter. The meter receives the SMS, decode it and recharge the balance. Fig 5 shows prepaid billing system.

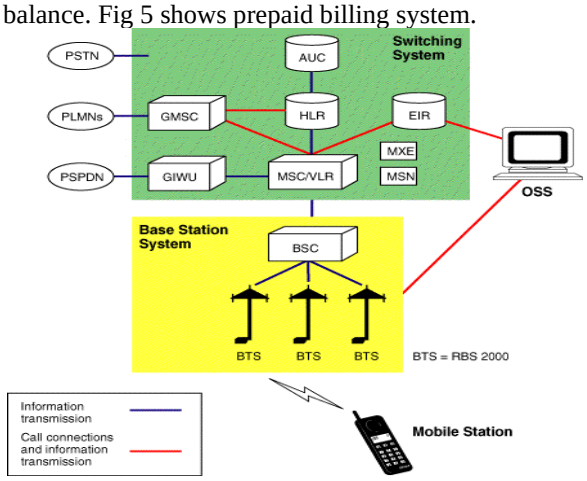

Fig5 Prepaid Billing Systems

IV. CONCLUSION

In conclusion, the development of a low-power, low-cost electric energy meter reader with a prepaid scratch card billing system presents a promising solution to address the inefficiencies and limitations of traditional postpaid electricity billing systems. This innovative system integrates measurement and communication modules to accurately measure energy consumption, transmit data to both the power supplier and consumer via SMS, and detect meter tampering.

The existing postpaid billing systems are prone to errors and time inefficiencies, leading to inaccuracies in billing and lack of consumer control over electricity usage. By implementing a prepaid system, these issues can be mitigated, as demonstrated by its success in reducing electricity usage in various countries. Furthermore, wireless meters equipped with GSM technology offer a convenient and reliable means of data exchange, facilitating real-time communication between the utility provider and consumers.

The references provided offer valuable insights into the design, implementation, and benefits of similar systems, demonstrating the feasibility and effectiveness of the proposed solution. Overall, the development of a low-power, low-cost electric energy meter reader with a prepaid scratch card billing system represents a significant step towards promoting

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responsible electricity usage and improving the efficiency of energy management..

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