

# DESIGN OF EMBEDDED BASED AUTOMATED METER READING SYSTEM FOR REAL TIME PROCESSING

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**Abstract**— A new embedded technology based approach for automated energy meter reading system is proposed which enables the meter readings to be updated onto the web server automatically on a regular interval basis and sends bills to customers each month. It provides a facility of recharging the energy meters remotely. Customers can pay bills of postpaid meters and can recharge the prepaid meters by sending a message to the service provider. The meter readings are sent to nearby located central station (gateway) using RF link and from there to web server using GSM. It also provides the facility of electricity tamper detection. The wireless controlling of meter reading system is mainly done using ARM 7 microcontroller. Embedded C is used for ARM coding and web server is designed using HTML. Database is created using MySQL.

**Keywords**— Automated energy meter reading system, ARM 7 based gateway, Electricity tamper detection, Web server.

## I. INTRODUCTION

India is advancing towards the path of the digital smart country. Now most of the population in India are the smart users, they use online methods of shopping, billing and payments. But still there are people who do not know how to access internet, how to open a website and make payments online. So, there is a need of the design which is applicable to each and every category of people in India even to those who are not the smart users. This paper deals with the advance concept of e-metering (electronic-metering) which has gone through rapidly as a solution for the above problem and also it is reliable and efficient Automatic Meter Reading (AMR) system. So, this paper presents the design of an AMR system which comprises of simple and low cost wireless GSM energy meter and a web interface associated with it for automating billing and managing the collected data globally. The proposed system replaces the conventional method of meter reading and enables server providers to access the energy meters remotely.

Paper [4] deals with the method in which the

electricity meter readings transmits to the service provider remotely using GSM. Bharat Kulkarni [5] proposed the design which automatically reads the meter readings using ARM microcontroller and sends the reading to the server via SMS. It means there is no need of manual labour for the data collection from different houses. S.Arun and Dr.Naidu [15] designed a wireless automatic meter reading system (WAMRS) for commercial and industrial use based on wireless communication incorporating GSM and Zigbee to facilitate bill generation at the server end and informing customer via SMS, email. In the research paper [3], an improved solution for metering is provided using energy chip. This designed energy meter calculates the total average power from the single phase voltages and currents input and give data logic output equivalent to the average power. This system also provides the facility of electrical energy billing and data management system. In paper [2] the concept of e-metering for AMR system using GSM is proposed. Also a software solution is facilitate so that the customers can access the webpage and pay the bill from anywhere without visiting to the billing office. The total monthly power usage and due bill is sent back to the customer after processing data via SMS. The paper [9] focussed on the problem of electricity tampering and gave a solution for minimising this tampering using smart meter. Smart metering is a new concept which is used for calculating power usage consumption and also helps in reducing and controlling power monthly consumption by informing the consumer about their usage on per hour basis so that customer can only use the electricity which is actually needed. Also there is an alarm system facility in the smart meters for the detection of electricity tampering with the meter or in between lines. Paper [10] proposed a GSM Automatic Meter Power Reading system (GAMPR) for prepaid energy meters and paper [14] proposed a model for post-paid energy meters based on ARM 7 using GSM and Zigbee and was also helpful in tampering. In paper [1], an automatic wireless meter reading system using Zigbee is proposed. The readings are automatically sent to service provider and bill is generated

automatically and is send to customer via SMS. The customer can pay the bill using the keypad provided with EB. So many efforts have been made to improve the conventional method of meter reading system in order to make the system automatic, cost effective and highly efficient.

The organization of the paper is as follows: in section II the overview of system model is given. Section III and Section IV describes the methodology and proposed algorithms. Experimental results and analysis of proposed system are given in section V. And finally section VI concludes this paper.

## II. OVERVIEW

Many efforts have been made and papers have been published proposing the different and improved designs of the automatic meter reading system and still the research is going on continuously. So, a new system is proposed which is very efficient, errorless, high coverage and cost effective. The system can monitor the meter readings regularly without the person visiting each house every time. The readings are sent to the centralised located ARM microcontroller based station through RF link. This central station collects readings from all the houses of the same premises on regular basis. A GSM based wireless communication module is incorporated with ARM to have remote access over the usage of electricity. There is a PC with a GSM receiver at the web server end, which contains the database acts as the billing point which generates the bill at end of the month.

The key features of the proposed system are-

- i. Automatic cost effective wireless system.
- ii. Applicable to both prepaid and post-paid meters.
- iii. Activation & deactivation controlling from server.
- iv. Bill distribution and payment via SMS.
- v. Detection of door tampering.

## III. METHODOLOGY

The system model consists of three different units: home communicable unit, central controlling unit (gateway) and web server. The working of each unit is described in detail below.

### 1. HARDWARE IMPLEMENTATION

#### A. Home Communicable Unit

This unit consists of the energy meter of the house of customer and power supply. 8051 microcontroller, non-volatile EEPROM, LCD segment and RF module are incorporated with the energy meter. The meter readings are shown on the LCD screen and stored in EEPROM simultaneously. The

readings are sent to the centrally located unit (gateway) through RF link from where it is send to server. There is also a provision of button with the meter for the detection of door tampering. The button is pressed in case of normal state and when tampering occurs with the meter, the pressed button released and sends an alarming signal to the server via gateway. This controlling is done by 8051 which is coded using Embedded C. Relay is provided for power cut when supply voltage exceeds threshold voltage.

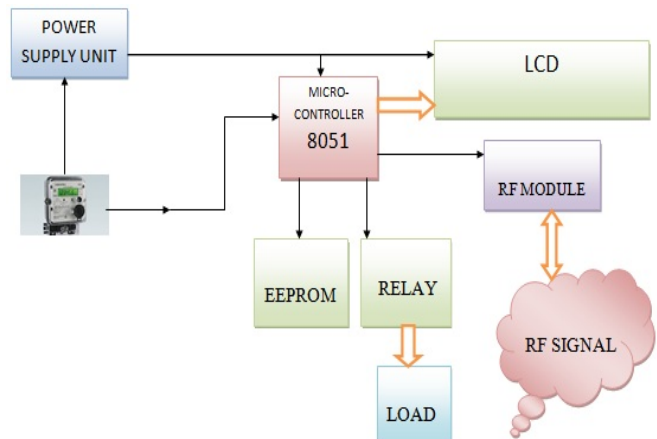


Fig.1 Home Communicable Unit

#### B. Central Controlling Unit (Gateway)

This unit consists of an ARM7 microcontroller, RF module, power supply, LCD segment, EEPROM and a GSM module. The meter readings sent from all the home communicable units of the same premise get collected here and are sent to server simultaneously through GSM via SMS and are stored in EEPROM simultaneously. LCD screen is used to display meter readings. ARM7 is very fast in processing so it is used and the complete controlling is done by ARM7 which is coded using Embedded C.

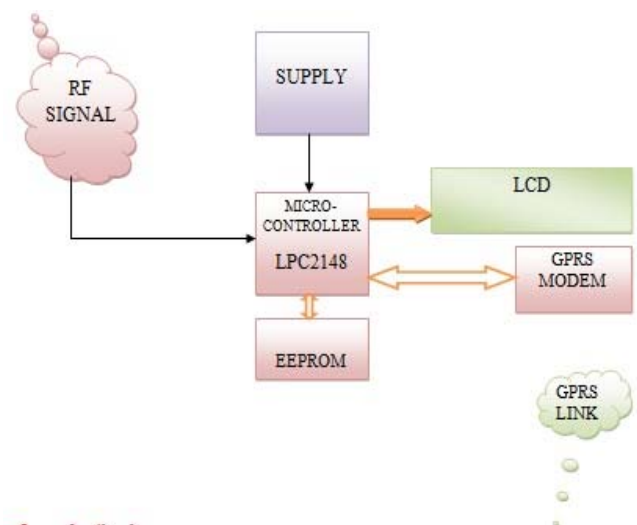


Fig.2 Central Controlling Unit (Gateway)

## 2. SOFTWARE IMPLEMENTATION

### A. Web Server

The web server is developed in order to control the whole system remotely. All the customer details like name of the customer, address, contact numbers, unique meter identification number and type of meter whether prepaid or post-paid, etc. are stored in the form of database at server end of the service provider. The meter readings are sent to server every 3 min through GSM via SMS and get updated in database. The meter status shows “Healthy” when the communication between meter and server is proper and readings are received by server properly. When the meter readings exceed allowed data usage or in case of door tampering, the meter status changes to “Alarm” from “Healthy” The activation or deactivation of meter connections can be controlled from the server end remotely without visiting to customer house. The activation and deactivation is informed to customer via SMS. The bill is generated at the beginning of every month and it is sent to customer mobile number via SMS. The customer can recharge their meters by an amount sending a SMS to the server. The web server is developed using HTML and database is created using MySQL.

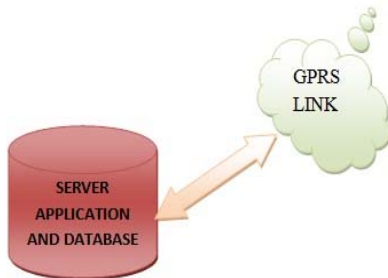


Fig.3 Web Server  
IV. ALGORITHM

### A. Flow Chart For home Communicable Unit

The energy meter is incorporated with 8051 microcontroller which processes the input currents and voltages into numerical value and sends it to the gateway using RF link. The flow chart for the home communication unit is defined as the meter starts, 8051 unit initializes the serial communication for data transmission and LCD initializes simultaneously. 8051 checks for the last stored value in EEPROM and then display the serial number and meter reading on the LCD. Then it will check whether the data is received by the RF module or not. If data received then the value is sent to the gateway in the form of frames using RF link and the same value is stored in EEPROM for future use.

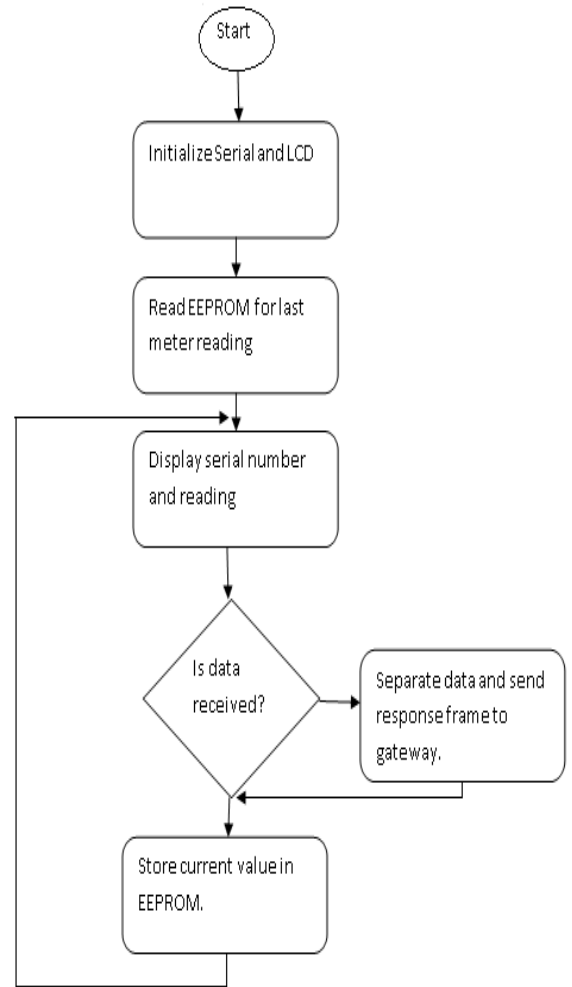


Fig.4 Flow chart for home communicable unit

### B. Flow Chart For Gateway

The gateway is based on the ARM microcontroller which processes the received data from the home units. First it initialises the GSM for message transmission and LCD for displaying numerical values. Timers initialise for the periodic message. Serial port initialises for RF communication and transmissions starts. Now a request is send to server to install for the first time through GSM and wait for response. If response received, it will send next frame to server and store this value simultaneously. Now LCD displays the status of GSM, door of meter and other connected devices at gateway. The point A displays the door status. The gateway asks the home meter units to send its status and meter readings once in every 3 min. Then gateway sends a SMS requesting server to update database with new status. If acknowledge is received from server, the status frame is send to the server from gateway via SMS and database gets updates with new data. Again it checks for the status of connected devices and this process will be continued forever.

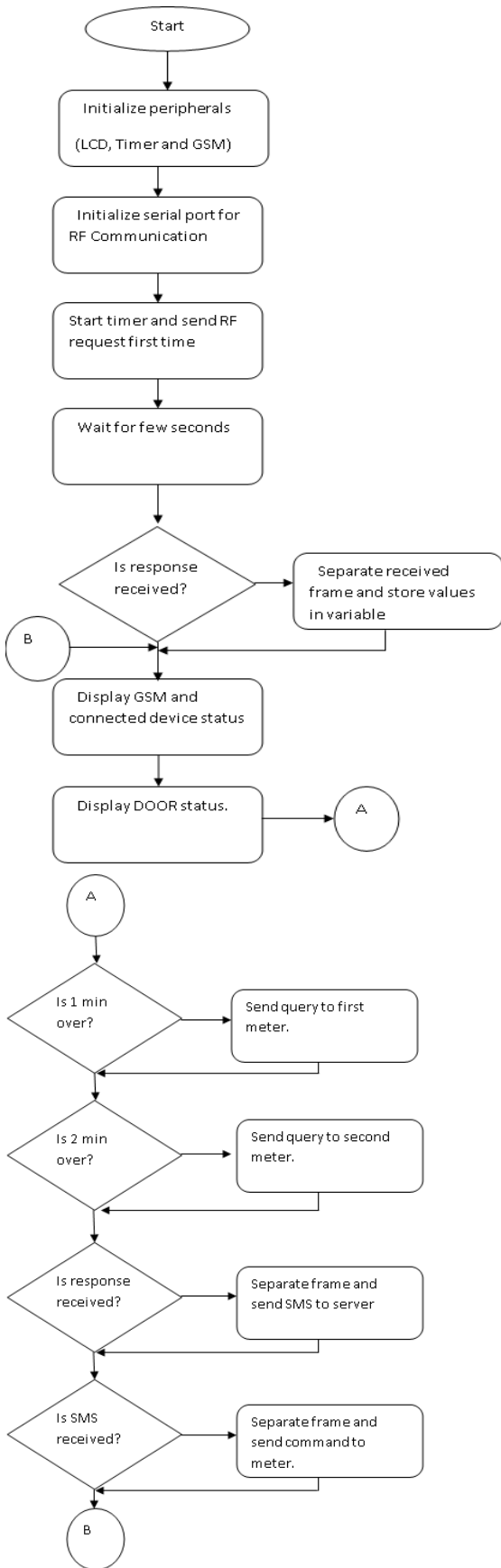


Fig.5 Flow chart for gateway

### C. Communication Protocol

The communication protocol to setup RF link from gateway to meter and the command and request frame to and from sender and receiver is defined below.

SENDER	DESTINATION ID	COMMAND/REQUEST	Data

Sender: 0x01 Gateway  
0x02 Meter1  
0x03 Meter2

Destination ID: 12345 Meter1  
12340 Meter2

Command: 0x01 when gateway sends ON/OFF Command to meter

Request: 0x02 when gateway request for meter reading

### V. RESULT AND ANALYSIS

The proposed system is developed and implemented giving proper results. All peripherals are attached according to the proposed system and the model is working properly. The pictures of all different communicable units of the system model are shown below.



Fig.6 Home communicable unit

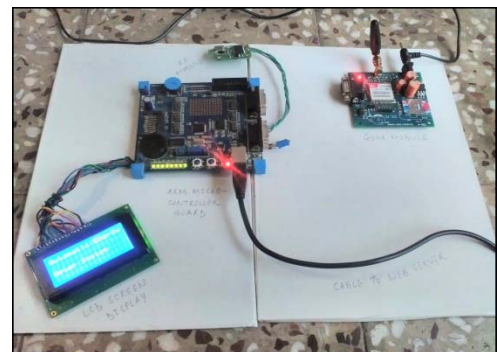


Fig.7 Central hub (Gateway)



Fig.8 Web server



Fig.12 Sending bills via SMS

Customer ID	Name	Address	Contact No	Zone	Connection Type
12340	NAYAN GUPTA	Plot 98 Ge	9619688923	EAST	Post-Paid
12341	RAHUL SINHA	Plot 88 Ge	9619688923	EAST	Post-Paid
12342	SHRUTI GOUR	1/2 Bhawar	9619688923	EAST	Post-Paid
12344	RANJEET G	2/3 LIG	9619688923	WEST	Post-Paid
12345	PIYUSH G	94 Vasudev	9926020488	EAST	Post-Paid
12350	VISHAKHA G	72 Sch 78	9926020488	WEST	Pre-Paid

Fig.9 Customer information database at server

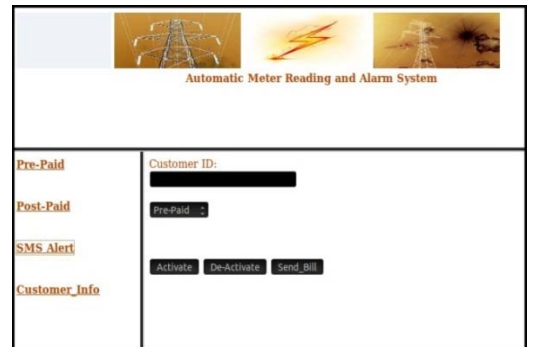


Fig.13 Activation or deactivation control of meter connections from server

Customer ID	Last Recharge(Rs)	Recharge Time	Allowed Usage	Reading	Time	Meter Status
12350	300.000000		90.000000	53.299999	15/10/11,13:35:48	HEALTHY

Fig.10 Showing meter status "Healthy" in case of proper communication between meter and server.

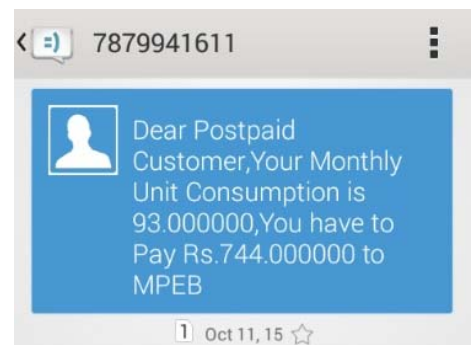


Fig. 14 SMS received by postpaid meter users

Customer ID	Reading	Time Stamp	Status	Jan	Feb	Mar	Apr
12345	200.500000	15/10/11,15:20:01	ALARM	50.000000	100.000000	130.000000	155.000000

Fig.11 Showing "Alarm" condition in case of bill dues or door tampering.

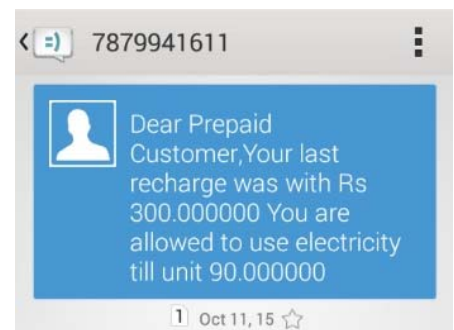


Fig.15 SMS received by prepaid meter users



## VI. CONCLUSION

The world is leading towards technology advancement, so the proposed real time based embedded system which works on wireless communication is highly efficient because every process from taking meter readings to sending it to the service provider, updating the data in database, generating bills, sending bills to the customer via SMS and recharging any type of meter either prepaid meters or postpaid meters, everything is automated and manual labor free which minimizes the errors up to very extinct. ARM7 microcontroller is used which has very high speed and processing ability so the overall system is very fast. The provision of gateway facilitates the system to be applicable to the very longer distances. The GSM module which is a universally accepted standard for its cost effectiveness is incorporated with the gateways. Incorporating GSM module with gateways reduces more cost rather than incorporating GSM with each home meter unit. The automatic bill generation at the beginning of each month and informing customers about their generated bills via SMS is one of the key features of this system and the provision of paying the electricity bill by sending a SMS is quite easy for them as recharging their energy meters is just like recharging their mobile phones. The most common problem of power tampering can also be detected using this system model.

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