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Automated Meter Reading Infrastructure with Virtual Energy Meter and Theft Detection

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Abstract: In this research paper the proposed method is a two way communication between electricity board and consumers. It focuses on the measurement of energy consumption, providing data for the system software and a system for payment at your place. In this system the energy is measured in units and the data is fed to a remote server using a smart energy meter, and a software solution is provided to detect any illegal activities and to control the power supply. The data is send to server by using same communication method; the consumer can pay the bill at home by using a mobile application or through internet. The android app is virtual energy meter. It helps the user to view his energy meter, get notification from office etc... The meter reading, billing, notifying, disconnection and reconnection can be viewed and controlled from office without visiting the place. In the case of broken transmission line due to adverse weather condition, the authorities get notified immediately and can take corrective measures. A single phase energy meter has been implemented using ARDUINO microcontroller and communication part has been implemented using GPRS communication.

Keywords: AMI, GPRS, Arduino, Android, Virtual Energy Meter, Theft Detection.

I. INTRODUCTION

Use of electricity is going on increasing day by day, thus the demand for it is also increasing. Electricity has become an unavoidable component of our life, but in the present scenario conservation of this form of energy is not in proper manner. Even though AMR's have introduced, due to its least accuracy and inefficiency of these AMR's the old method of metering is still in practice. The traditional electro-mechanical meter which is widely used today for collection of meter readings is also inefficient, because a meter reader has to physically be on site to take the reading. The human error can open an opportunity for corruption done by the human meter reader. So the problem which arises in the billing system can become inaccurate and inefficient. The availability of wireless communication media has made the exchange of information fast, secured and accurate. Wireless meter reading puts more control into the hands of both utilities and consumers by giving them more detailed information about power consumption. This allows utilities to better regulate supply. The traditional method of metering gives no option for detection of illegal or unauthorized use of electricity and also electricity tapping cannot be found out. In the work presented here, a technique has been developed to read electricity meter readings from a remote server automatically using the GPRS for cellular phones. The meters send the meter readings like voltage, current to a central server. The central server then stores the information in database for analysis. As there is no human intervention in the entire process, there is no chance of human error and corruption. In the extremely bad weather conditions like heavy snow, rain, storm, etc. the system will not hamper on collecting data. The metering method also introduces a user friendly android app, where the consumers can see the present meter reading and also pay their bills through app.

II. RELATED WORK

A. Electro-Mechanical Meters:

The electromechanical induction meter operates by counting the revolutions of an aluminium disc which is made to rotate at a speed proportional to the power. The number of revolutions is thus proportional to the energy usage.

B. Prepayment Meters:

Prepayment meter are mainly used for a rented accommodation. This is mainly used in such cases that the retailers believe that the customer may for whatever reason not pay the bill. This requires the customer to make advance payment before electricity can be used. If the available credit is exhausted then the supply of electricity is cut off by a relay.

C. Low Cost Electricity Meter Reading System Using GSM:

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. The complete monthly usage and due bill is messaged back to the customer after processing these data.

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D. Live energy meter reading and billing system through GPRS:

This method is an automatic meter reading technique via GPRS. The energy meter uploads the reading periodically to a central public server through GPRS. This automatic meter reading system consists of client-server architecture where the web browser is the client and the server functions are shared between a web-server, a communication server and a database server. The readings of meter is sent to the server along with the necessary details of consumer, where the server takes this information and do certain calculations and comparisons server to calculate the total consumption of electricity of the end user and generates the electricity bill automatically at the end of every month. This statistics and information can be viewed through web portal or an android mobile connected to the internet.

There are many existing system in today's market but the issues were:

- Highly Person dependent.
- Human errors cannot be avoided.
- Accessibility of meters in rural/ Agricultural zones.
- Energy Audits performed based on bill collection which is highly inaccurate.
- Billing done mainly on estimated/ monthly average basis
- Inability to monitor and control discrete loads
- Billing cycle requires excessive time.

Meter data used only for billing, cannot help in analysis like demand analysis, energy audit, pinpointing losses, etc.

III. PROPOSED SYSTEM

Since GPRS is cost effective compared to SMS, monitoring of energy meters at lower cost is made possible. Daily consumption reports are generated which can be monitored through Android application and/or web portal. Also, android users can pay their electric bills from their android application. Non-android users can monitor and pay their bills online. The system is more reliable and accurate reading values are collected from energy meters. Live readings of the energy meter can be viewed through Android application. Also, the readings can be viewed online. The human intensive work is avoided and all the values are maintained in the central server. The communication medium is secure and tampering of energy meters can be identified easily. If an error occurs in the system, the value in the central server will not be updated. Once the value updated crosses the threshold time, the server can determine that something is wrong in the system and can report the engineers in EB. Thus, identification of error becomes easier. Since the values are stored in the central database; the reports are made accessible from anywhere in the world.

A. Advantages of the Proposed System

The users can be aware of their electricity consumption. The human work of collecting readings by visiting every home at the end of every month can be avoided by generating Electricity bills automatically. Theft of electricity can be avoided by tamper proof energy meters. The errors in the system can be identified quickly. The proposed methodology is an AMR system which communicates efficiently over GPRS network on real time basis. This methodology have an authorized system software which is linked to the database server, from where the power consumption of users and other important notifications are available and also an android app & server for users, from where the meter readings & cost of consumed power can be known, and also bills can be paid.

IV. BLOCK DIAGRAM

The block diagram of the system is given in Fig .1 (a), 1 (b),1 (c).Normally the generated power from main station is transmitted to substation over long distance transmitting network after feeding it to a step up transformer, from the substation using a substation transformer which may be step down or step up, the power is delivered to consumers in houses and industries.

The proposed system is implemented with the substation transformer, which monitors the various parameters of transformer, such an output current and output voltage etc. and sends this information to the system software. Similarly a system monitors the current in every supply lines and sends this information to the software. Each consumer will be having the designed GPRS enabled smart energy meters which sends the real time reading to the system software.

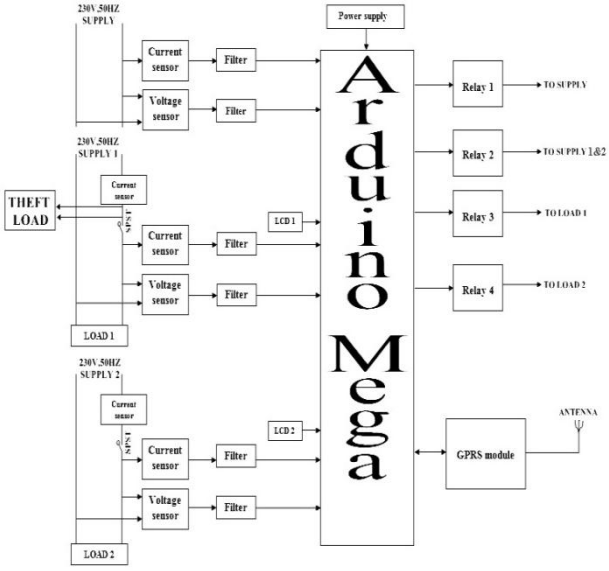

Fig.1 (a) Distribution System

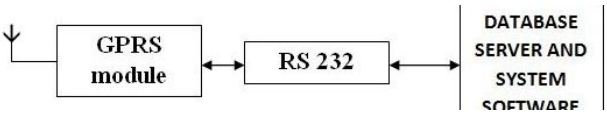

Fig.1 (b) Office Section

Fig.1(c) Consumer Section

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V. HARDWARE IMPLEMENTATION

A single phase energy meter has been implemented using ARDUINO microcontroller (AT mega 2560) and communication part has been implemented using GPRS communication. The transformer module has been implemented using current sensor and voltage sensor and interfaced it with ARDUINO microcontroller. Similarly the relay module also implemented and interfaced with micro controller. In order to demonstrate the energy consumption of different users the prototype has been made with two identical smart meter sections.

All the sections were initially simulated using Proteus Design Suite Version 8.0. Then all the modules are integrated with ARDUINO Micro controller Board and tested the functionality.

The following fig 2(a) and (b) shows the snapshot of the hardware implementation of the proposed system.

Fig. 2(a) Hardware Implementation

Fig. 2(b) Hardware Implementation

VI. SOFTWARE IMPLEMENTATION

The system's software was developed using the following software tools.

- ARDUINO IDE Version 1.6.0 - to programme the microcontroller
- C-Sharp (visual Studio 2010) - to develop the software for office section to calculate the energy used by each user, to detect theft happened in the system and for comparison purpose.
- Dot NET (visual Studio 2010) -to create a web Page for the user to design a virtual energy meter using their laptops or personal computers.
- Eclipse JUNO –Android app to create virtual energy meter for user side.

A. Flow Chart for System Software

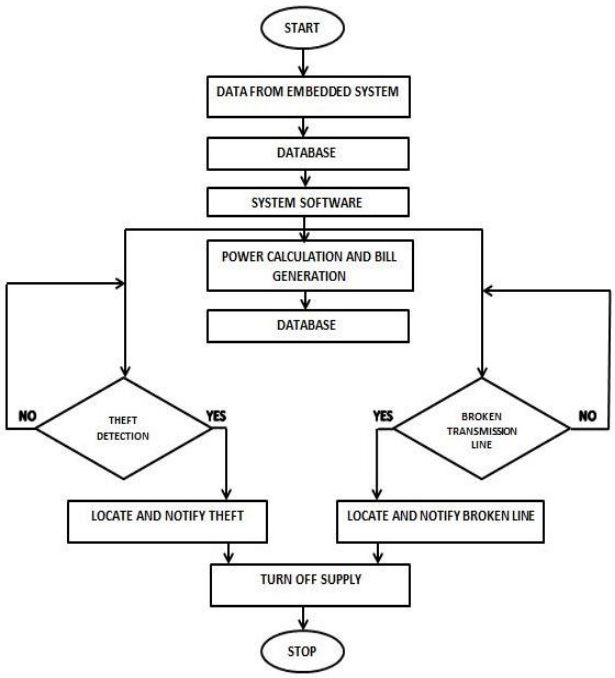

Fig. 3 System Software

The system software will be having database of each consumers and the transformers, various comparisons are done by the software and it notifies when any tapping takes place or when illegal activates are done in any of the designed system. The system software gives every data to server where any user can login by the provided name and password through an android app or through internet, and here the user can see the live meter reading, corresponding cost and also user will be able to pay bill through this. In the proposed method a system is implemented with the substation transformer, which monitors the various parameters of transformer, such an o/p current o/p voltage etc. and sends this information directly to the database in the system software. Similarly each consumer will be having the designed GPRS enabled smart energy meters which send the real time reading to the system software. The system software will be having database of each consumers and the transformers, various comparisons are done by the software and it notifies when any tapping

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Database is continuously updated with the readings from distribution transformer, pole system and smart meters. The system software refers these readings from the database for further computations. This software calculates the power units consumed by the latter sections. The bill is generated for the users. This system software is communicating with the database server on real time basis.
Theft detection: Along with calculating power, the software checks for any illegal activity. On the basis of a number of comparisons the software has provision to detect theft. The software will locate the theft location and then alerts the users by notifying through android app. It also disconnects the power to the theft load. This will help the authority to block further theft and take necessary action.
Broken transmission line: There are cases of broken transmission lines due to various reasons. This can prove to be very hazardous. If a line is broken, the current and voltage to the load will be zero. The software monitors for such cases. It detects broken transmission line and cut power to the line to ensure safety. This will enable the electricity board to reach the correct location and avoid possibilities of hazards.

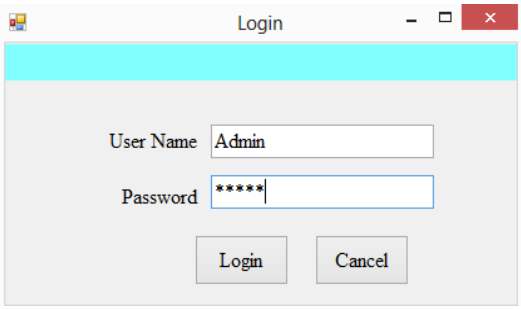

Fig. 4(a) System Software Login

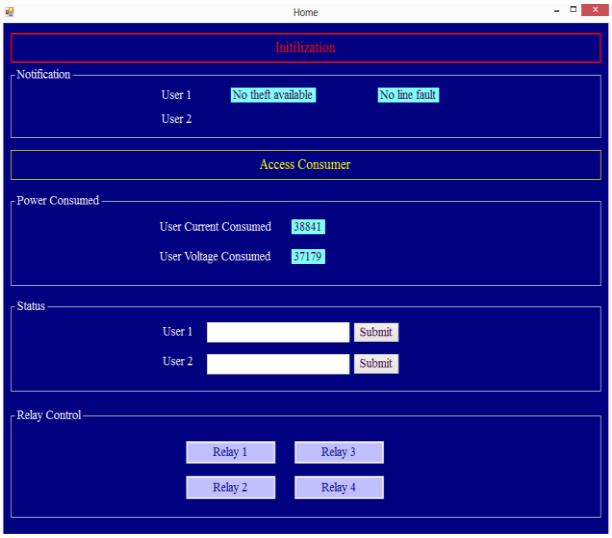

Fig. 4(b) System Software Main Page

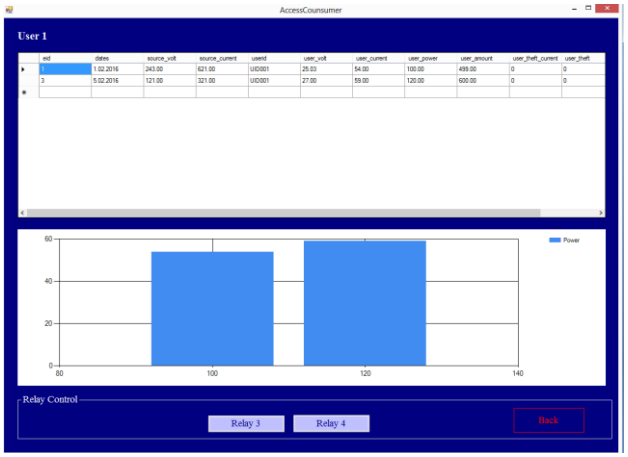

Fig. 4(c) Consumer Statistics

B. Flow Chart for Consumer Section

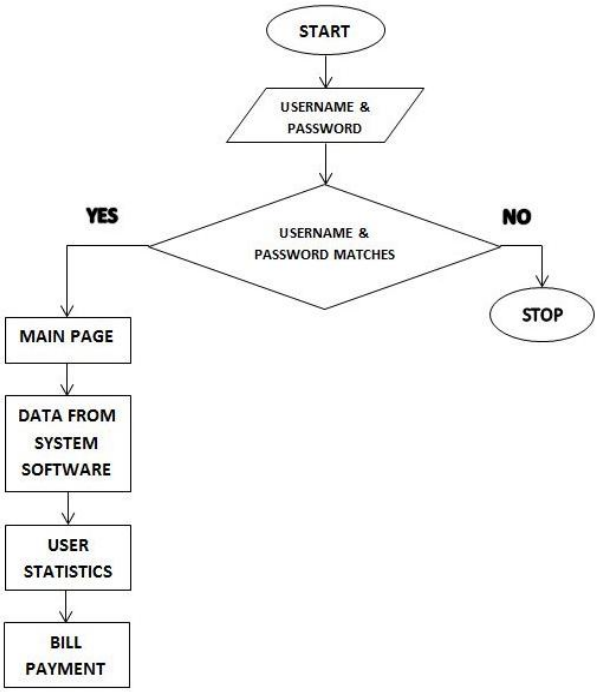

Fig. 5 Android App and Web Page

The consumer section allows only authorised users to login. Every consumer is provided with login id and password. The app/web page checks for the validity of user in the server database i.e., it checks if the user id and password matches with the values in database. The application provides only three attempts for login after which the page will be blocked and the user will have approach the electricity board for unblocking. The user will then have to provide verification documents to get access to the page.
If it is a valid user, the app/web page will open to the main page. The main page is virtual energy meter, it displays the energy meter reading on real time basis. The consumer can view his/her meter reading along with cost of consumption. He/she can monitor his electricity consumption and also pay his bills through theapp/web page. Electricity board can communicate with the consumer by giving notifications to the app.

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The following figure shows the screen shot of the web page created for user login, main page and for billing purpose.

Fig. 6(a) Web Page Login

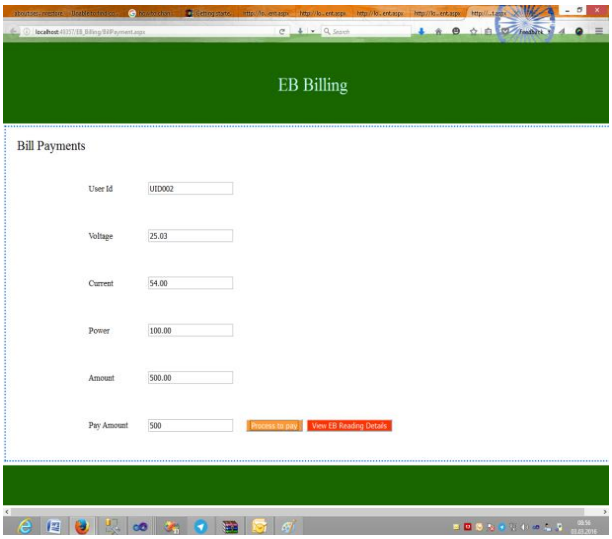

Fig. 6(b) Main Page

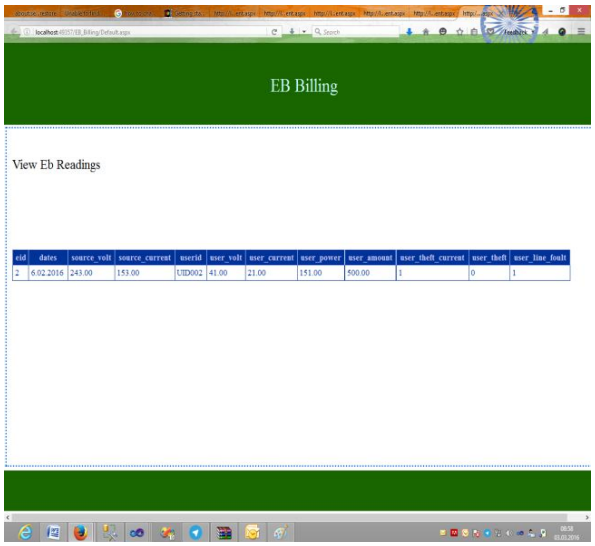

Fig. 6(c) Consumer Consumption

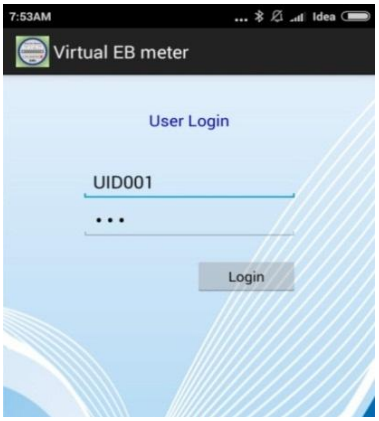

Fig 7(a) Android App User Login Page

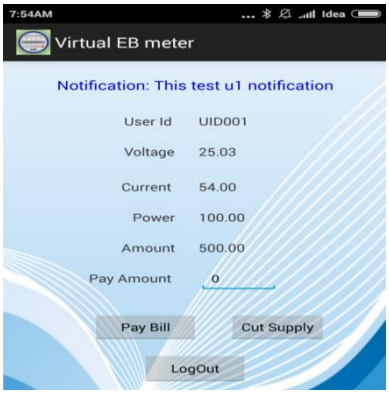

Fig.7(b)Main Page

Fig.7(c) Consumption Statisticis

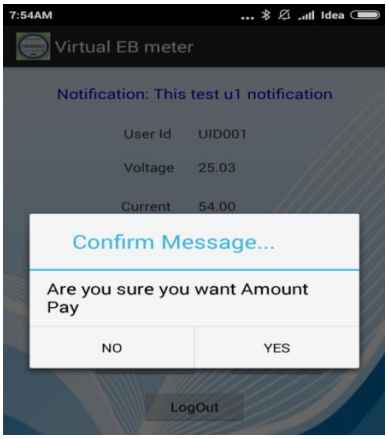

Fig.7(d) Payment Page

The above figure shows the screen shot of the virtual energy meter created using android application created for user login, main page and for billing purpose.

VII. RESULTS

An efficient automated energy meter reading infrastructure was developed and implemented in this paper and it helps the user to view his energy meter, get notification from office, etc... The meter reading, billing, notifying, disconnection and reconnection can be viewed and controlled from office without visiting the place. In the case of broken transmission line due to adverse weather condition, the authorities get notified immediately and can take corrective measures.

VII. CONCLUSION

A smart system like this can help sustain energy and also plausibly suppress the foul techniques of steeling power from the power lines. The generation and linkage of electric power can be switched ON or OFF using simple techniques of recharge. It shows a much more convenient way to develop the power system and it is consumer friendly. This system is user friendly and cost effective and can produce a large interest for the electricity supply departments for its advantages. Developments such as these provide faster payments and also reliability towards the service.

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