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A Survey on RFID Based Prepaid Energy Meter and Home Automation

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Abstract: World is looking towards automation and we achieve a step towards it by using radio frequency identification (RFID) based prepaid energy meter and home automation system with an android application running at subscriber's mobile station. The energy meter is credited through RFID technology and the automation of different appliances are controlled by the subscriber via an android mobile application. The subscribers may check their current credit, consumed units, current load and they can manage appliances remotely. A load management system is introduced, when load exceeds a certain defined level then appliances are automatically shut down.Fire sensor alerts the subscriber via GSM whenever a fire accident occurs. An automatic theft detection mechanism has also been set in place for the system.

Keywords: ***Android application, home automation, load management, prepaid energy meter, Radio Frequency Identification (RFID).***

I. INTRODUCTION

Electricity plays a vital role in growth of our country. Even though power production corporations focusing highly on generation, transmission and distribution, they are meeting power loss due to illegal consumption of electrical power from the transmission lines by the consumers. Power theft has become a great challenge to the electricity board. The dailies report says that Electricity Board suffers a total loss of 8 % in revenue due to power theft every year, which has to be controlled. This survey paper identifies the power theft and indicates it to the Electricity board through GSM network. It also deals about the remote monitoring of an energy meter in the proposed system. In case of Industries, the industrialists have to monitor and control the usage of electrical energy level. The main objective is to prevent energy usage beyond the maximum allotted energy by the power supplier, by preventing from over load usage. Energy consumption is audited by using current transformer connected series to the load.

RFID is a contactless wireless technology which uses radio waves for the automatic remote identification of different objects; we can differentiate between RFID systems according to the operating ranges of 0-1 cm for close coupling, 0-1m for remote-coupling, and greater than 1m for long-range systems. RFID technology allows the transmission of data through a small portable tag; an RFID reader reads the data from this tag and consequently processed as per the requirement of the given application. There are two major categories of RFID tags, either active or passive.

II. EXISTING SYSTEMS

F. Wang et al. [1] presented a paper on which the equipment of electricity defense energy meter is designed, which adopts Atmega128 as the control core and with low power consumption and high accuracy. It is showed that this system can not only accurate measurement of electrical energy but also to accurately determine the occurrence of electricity stealing and time of stealing is also recorded, which brings great convince to the power system.

L. X. chun et al. [2] proposed the design scheme of a three-phase multi-purpose standard electrical energy meter, The experiment results indicates that the tested model compiles with national standards of 0.02 standard electrical energy meter and has already been put into application. due to modular structure designing, simple combination of different modules can produce series products of three-phase standard electrical energy meter.

B. S. Koay et al. [3] proposed a method in which he explained about a trend of an energy meter(Bluetooth technology).A wireless digital energy meter will definitely offer greater convenience to the meter reading task. Bluetooth technology is chosen as a possible wireless solution to this issue. we present the design and implementation issues of a Bluetooth-Enabled Energy Meter. The Energy Reader can collect the energy consumption reading from the Energy Meter wirelessly based on Bluetooth. Two methods, which can retrieve the meter reading with little human intervention, are proposed and implemented in the targeted applications. They are AMR (Automatic Meter Reading) and the APM (Automatic Polling Mechanism).

V. V. Das [4] proposed a new network communication system for energy meter reading by integrating communication technology and software system along with existing meters. The communication system is connected with electricity regional/sub-regional

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office which will rather act as a base station. Base office can verify the energy meters performance by checking the day to day consumption of energy. This helped to avoid any tampering or break down of energy meter.

S. Maitra [5] proposed a method to Measure the energy consumed by a consumer and to pay the bill with the help of embedded system. According to this the consumer will purchase a cash-card of amount depending on consumption of energy and after the full consumption, the consumer will purchase a cash-card of amount depending on the energy consumption. Increases convenience, decreases man power, reduces risk of theft of cash, increase reliability, safety and securing, reduces the cost of bill management system etc.,

Islam, Md Manirul et al. [6] proposed a new energy meter i.e., Electronic Energy Meter with Remote Monitoring and Billing capability, Going to the billing office, stand in long line and submitting the bills is a boring job and time consuming also. This can be avoided by remote monitoring of electronic energy meter and prepaid billing system by the use of cash card. It can play a vital role in load forecasting, complex tarrif rate setup, cash card bill payment, system protection and power stealing defense. This system is more reliable, accurate and cost effective.

Chandel et al. [7] propose a paper which states the causes of non-technical losses of electricity and methods to stop it. Power theft through Energy Meter tampering and manipulation with the meter reading is one of the major causes of revenue losses. Replacement of old Electromechanical meters by Electronic energy meters with anti-tamper features has helped utilities to find out the meter tampering attempts but still there is a long way to go as people are finding new ways to tamper meters.

Kamal Ramadan et al. [8] presents a new idea of designing a prepaid energy meters that has the ability of being connected to a unified centre (Energy Company). The process of connecting the meters to a unified centre can facilitate the security, control and maintenance purposes. The data are transmitted over this network using Power Line Communication (PLC) technology. A special device is used to inject the data to the network and captures them from the network; this device is the power line communication modem. The designed network makes the energy company able to access any prepaid energy meter in the unified area and control the measurements of this meter; and as a result, stealing of electricity can be prevented. Also company can communicate with the consumer by sending text messages such as a serial number for recharging the energy or alarm the consumer before the whole amount of electricity is totally consumed. Moreover, this network offers the ability of controlling the supply of energy such as switch “On” or “Off” of the electricity supply.

M. Anas et al. [9] Smart meter is introduced to minimize electricity theft, because of its high security, best efficiency, and excellent resistance towards many of theft ideas in electromechanical meters.

N.B. Dev Choudhury et al. [10] proposed GPRS Enabled Smart Energy Meter that provides a bidirectional communication between customer and utility. This meter can take real time voltage, current, and power factor readings. The meter calculate the energy consumed and is stored in cloud using GPRS. Graphical programming of LabVIEW is used to develop the In Home Display (IHD). The IHD functions as home energy management system successfully displaying the energy demand curve, harmonic content, load schedule, and current price of energy usage. a hypothetical Time Of Use (TOU) pricing is developed and analyze the results. Also, a methodology of intelligent scheduling of load appliances in correspondence to TOU have been developed.

Arote et al. [11] proposed a system that presents a total electronic three phase four wire energy meter: In this view all measurements taken in digital design. Controller is used for controlling all functions of meter. Proposed algorithm for power calculation reduces hardware requirement as power factor is calculated in algorithm which eliminates the need of zero crossing detector circuit.

In existing systems, either an electronic energy meter or an electro-mechanical meter is fixed in the premise for measuring the energy usage. This method of electricity billing involves a person from the distribution unit reading the number of units of electricity consumed in the energy meter, conveying this information to the distribution unit and then preparing the bill according to the units consumed for a fixed amount of time. Still accuracy cannot be guaranteed as there can be errors in human reading. Even though digital meters are being replacing conventional electromechanical meters and provide much accurate readings, still the problem of deliberately making a false reading can exist. Despite this, the task of billing for every consumer is a time consuming job for the distribution grid. Also the consumer can deliberately consume more amount of power than required and still refrain from paying the bill and nothing can be done to severe the electric power supply. To eliminate all these problems, the most convenient method is making the whole system prepaid similar to a mobile phone recharge or a DTH recharge. Many systems built on various platforms have been proposed by different research groups all over the world for Prepaid Energy Meter.

For wireless meter reading Bluetooth technology can be chosen [3]. But its range is very short. The communication system used in taking reading from energy meter is complex [4].Even though embedded energy meter measure the energy consumed by a consumer and to pay the bill [5], it is still postpaid.

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III. PROPOSED SYSTEM

Based on the earlier studies, we proposed a most effective and efficient method to reduce human resources and thefting of electricity. The proposed prepaid energy metering and home automation system mainly depends on a central microcontroller, RFID module, electromechanical energy meter, EPS8266, thing speak software, GSM modem and an Android application as depicted in Fig. 1. Microcontroller is the central module of this work, it stores the information of instantaneous energy, units credited, units remaining, tariff, current load and all relevant information is stored and updated in the microcontroller.

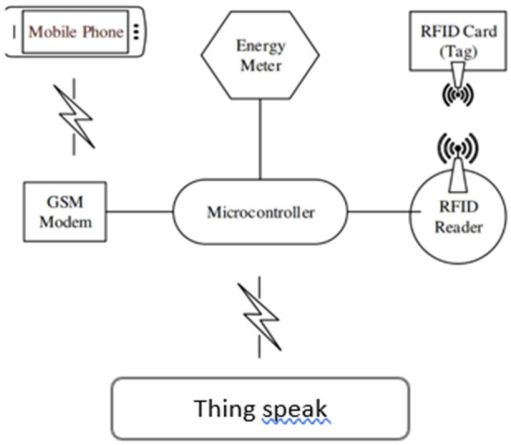

Fig 3.1 Overview of the proposed system

A RFID smart card (tag), is used to credit the units into the microcontroller through a RFID reader attached to the microcontroller. The energy consumed by the utilities is calculated in the microcontroller and the units for the consumed energy are automatically deducted.

In this work, PIC16F877A Microcontroller has been used. A certain limit is set for the loads in terms of watts. If this limit is reached, a warning Short Message Service (SMS) is sent to the user and authorities. Relays are implemented to turn on or off the appliances through android application, control signal is sent to the microcontroller and it acts according to the received command. Relays also turn off the loads if the prepaid credit balance goes down to zero.

RFID technology does not call for physical contact between the tag and reader, information onto the tag is written through a RFID controller/programmer module. Once the tag is in the magnetic field of the reader, it collects information from valid tag only and rejects the invalid ones.

The objective of implementing a prepaid system is achieved through an algorithm illustrated in Fig The fundamental idea was to develop an algorithm which allows the subscriber to be connected to the electricity network as long as they have a credit or prepaid units and the electricity is detached if the remaining credit goes down to zero. However, the subscriber is informed, through a SMS alert, about the remaining low credit. A minimum threshold (e.g. 25 units) is set, once credit is less than 25 units, a SMS alert is sent after every 5 minutes. If the subscriber fails to credit the meter, all the appliances are disconnected via relays.

IV. CONCLUSION

In this paper, a new economical prepaid energy metering system using RFID technology has been presented along with a survey on it. An android application was developed to remotely monitor the energy consumption and to control the appliances through home automation.

This prepaid energy metering is highly effective because it eliminates manual meter readings, equips users to be updated about their electricity consumption and remaining prepaid units though a remote application running on their mobile phones. It also delivers effective load management and theft detection mechanisms to make it more versatile for the practical deployments. Large scale implementation of this system will reduces power theft, false meter reading and may be valuable if integrated within future smart grid systems.

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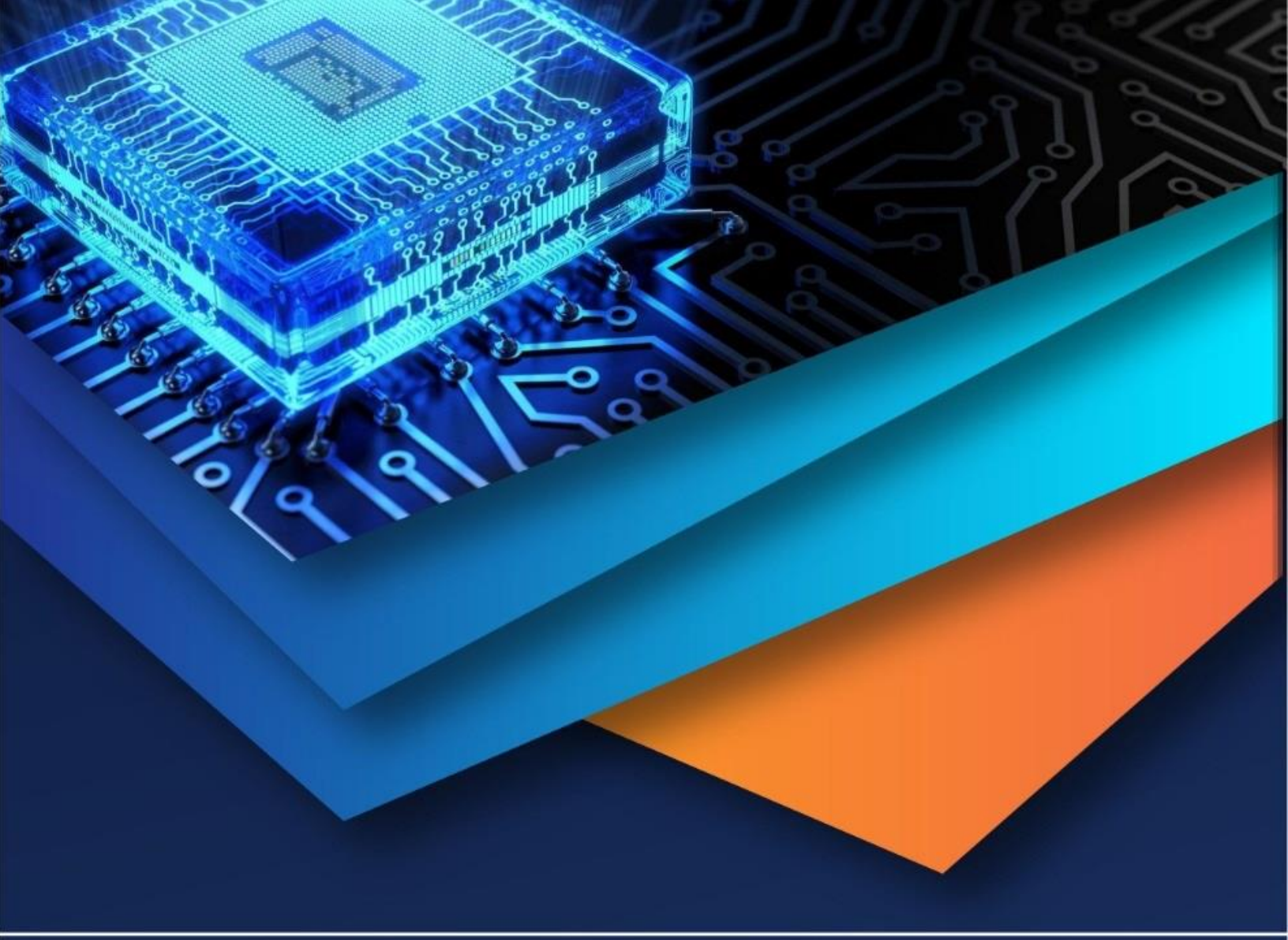

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