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A Smart Android Based Prepaid Energy Metering System to Control Unauthorized Electricity Usage Design by Using ARM

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Abstract: **unauthorized Electricity control is emerged as a serious problem in power sectors especially in the developing countries. A huge amount of revenue is lost due to electricity usage in illegal way. In some countries this is so severe that governments are incurring losses instead of revenue. In some cases government has to provide subsidies to the power sector to maintain a reasonable price of electricity. The financial loss results in shortage of funds for investments to expand the existing power capacity and as a result governments are failing to satisfy the ever increasing demand of electricity. In some cases this problem has become so extreme that the affected power systems are near bankrupt. Power theft is a concerned issue even in the most efficient power systems like in USA and moderately efficient system like in Malaysia. However, in developing and under developed countries the practice of power theft is so common that it is often kept out of discussion. Electricity theft includes tampering meters to show a low meter reading, stealing electricity bypassing a meter, billing irregularities and unpaid bills .Billing irregularities comprise inaccurate meter reading taken by bribed service man and intentional fixing of the bill by office staffs in exchange of illicit payments from the consumer. Different nontechnical and technical methods were proposed in the past to detect electricity pilfering. Nontechnical methods may include inspection of the customers with suspicious load profile. Although periodic inspection can substantially reduce theft, such measure requires large manpower and huge labor. Such effort also fails in most cases due to the dishonesty of the staffs. Some of the technical ways to detect pilferage are use of central observer meter at secondary terminals of distribution transformer, harmonic generator, genetic support vector machines, extreme learning machine, power line impedance technique. However, these technical approaches can be effectively implemented only if proper communication is ensured between the central control station and the appropriate test points. Recently, prepaid energy meters based on GSM network has been proposed . These meters incorporate the facility of prepaid metering system and remote load control.**

This prepaid metering system can be further matured to address the problem of electricity theft. In this paper, we have proposed a GSM based prepaid energy metering system which deals with different aspects of electricity theft. The proposed system prevents irregularities of billing, reluctance of consumers to pay bills in time, meter tampering and bypassing.

Keywords: **Android OS, ARM, Smart energy meters, GSM network.**

PROPOSED PREPAID METERING SYSTEM

In the proposed system the power utility maintains a server and each consumer is provided an energy meter. The server and prepaid meters use GSM modem and GSM module respectively to communicate with each other using the GSM network. Fig. 1 shows an overview of the proposed prepaid metering system. The energy meter consists of a microcontroller (ATmega 32), energy measuring chip (ADE7751), GSM module (Simens A62 mobile phone in our work), MAX232, current transformers, potential transformers, LCD display and a relay.

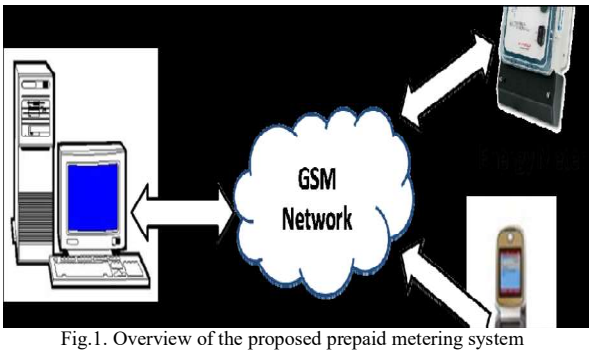

Fig.1. Overview of the proposed prepaid metering system

The energy metering chip produces pulses proportional to the energy consumed using the outputs of current and potential transformers. The microcontroller calculates the energy consumption by counting the output pulses of the energy metering chip on an interrupt basis. The microcontroller uses AT command set to communicate with the GSM module (mobile phone). A battery backup is also available in the energy meter.

The backup is required to detect electricity theft. demonstrates the prototype of the energy meter. The C programming language and the MATLAB software have been used to program the microcontroller and to implement the server, respectively. The recharging process in the proposed metering system is similar to that of recharging balance in a mobile phone.

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The user has to buy a scratch card and scratch it to uncover the secret pin number of the corresponding energy unit he has bought. For example, if a user wants to buy 100 units (KWh), he has to pay for the 100 units and obtain a scratch card which holds the secret pin number of the corresponding 100 units. The user has to send the pin number to the server through SMS. The server then checks whether the pin number is valid or not. If the pin number is valid, the server then extracts the information of energy-unit from the pin number (in this case 100 units) and sends it to the meter of the user through GSM network.

The household meter then receives the corresponding unit and is activated. As the user consumes energy, the corresponding units are deducted from the total balance and the remaining units are displayed using LCD. After the consumption of the allocated energy, the meter automatically disconnects the load from the main power line using the relay until the user recharges again. Thus the system avoids the irregularities associated with traditional billing system and ensures revenue collection.

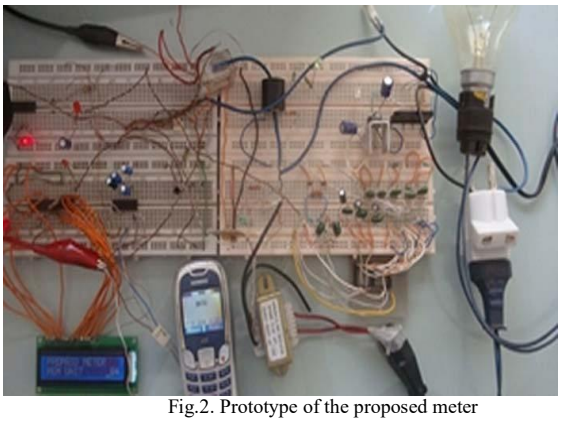

Fig.2. Prototype of the proposed meter

GSM MODEM (900/1800 MHZ): Seimen's GSM/GPRS Smart Modem is a multi-functional, ready to use, rugged unit that can be embedded or plugged into any application. The Smart Modem can be controlled and customized to various levels by using the standard AT commands. The modem is fully type-approved, it can speed up the operational time with full range of Voice, Data, Fax and Short Messages (Point to Point and Cell Broadcast), the modem also supports GPRS (Class 2*) for spontaneous data transfer.

Vital role of GSM modem in 'Remote billing of energy meter/water meter using GSM modem is as follows:

a) User GSM modem will transmit the consumption amount to office MODEM.
b) Office MODEM will receive the data sent by the user MODEM.
c) Instead of IR we are using GSM because in IR lots of disturbance will be there when distance is more.

A. MAX232 IC:

The MAX232 is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits, so that devices works on TTL Logic can share the data with devices connected through Serial port (DB9 Connector).

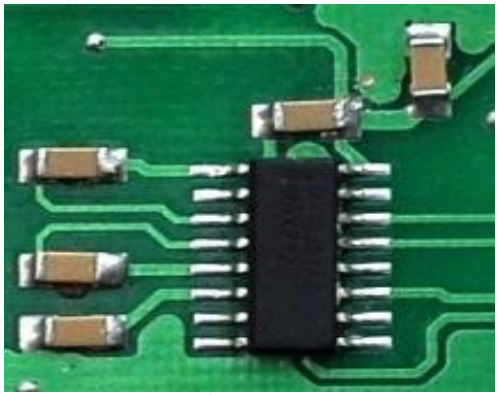

Fig.3.MAX232 IC

RTC – DS1307:

This is used to maintain the current time in off line processing. The DS1307 Serial Real-Time Clock is a low power; full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially via a 2-wire, bi-directional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator. The DS1307 has a built-in power sense circuit that detects power failures and automatically switches to the battery

SIM (Subscriber Identity Module) Card Slot:

This onboard SIM card slot provide User functionality of insert a SIM (GSM only) card of any service provider. Process of inserting and locking SIM card into SIM card slot is given in this manual. While inserting in and removing out SIM card from SIM card slot, User needs to take precaution that power supply should be OFF so that after making Power supply ON it will be easy to reinitialize with SIM for this module.

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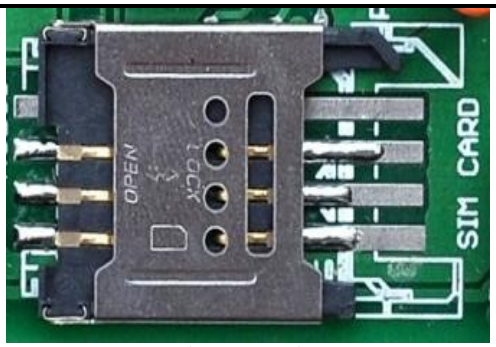

Fig. 4.: SIM Slot

Light-emitting diodes are used in applications as diverse as replacements for aviation lighting, automotive lighting (particularly brake lamps, turn signals and indicators) as well as in traffic signals. The compact size, the possibility of narrow bandwidth, switching speed, and extreme reliability of LEDs has allowed new text and video displays and sensors to be developed, while their high switching rates are also useful in advanced communications technology. Infrared LEDs are also used in the remote control units of many commercial products including televisions, DVD players, and other domestic appliances.

BLOCK DIAGRAM

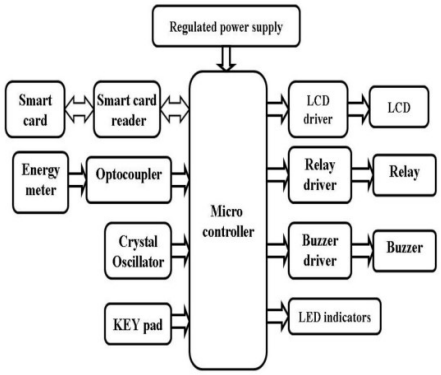

Fig.5. Block diagram of Smart card metering system

The project consists of a microcontroller, energy meter, relay, buzzer, LCD, Keypad and LED indicators. The microcontrollers internal non-volatile memory is used to store the electricity consumed. The nonvolatile memory inside the Smartcard is used to store the prepaid amount. When the recharged units become zero on power consumption, the microcontroller put off all the loads connected to it by giving an audible beep sound. User has to recharge the same Smartcard for further usage of electricity.

- The meter consists of a microcontroller, a current feedback section consisting of a current
- Transformer, a signal conditioning circuit &adc.
- A prepaid smart card containing a serial number & amount has to be inserted into the meter.
- This project uses regulated 5v, 500ma power supply. 7805 and 7812 three terminal voltage regulators are used for voltage regulation.
- Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12v step down transformer.
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- Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/12v step down transformer.

WORKING PROCEDURE

The recharging process in the proposed metering system is similar to that of recharging balance in a mobile phone. The user has to buy a scratch card and scratch it to uncover the secret pin number of the corresponding energy unit he has bought. For example, if a user wants to buy 100 units (KWh), he has to pay for the 100 units and obtain a scratch card which holds the secret pin number of the corresponding 100 units. The user has to send the pin number to the server through SMS. The server then checks whether the pin number is valid or not. If the pin number is valid, the server then extracts the information of energy-unit from the pin number (in this case 100 units) and sends it to the meter of the user through GSM network.

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Technical Challenges

The existing electricity system in Sri Lanka does not support both demand side management and decentralized power generation, since much of the transmission and distribution infrastructure we have today, is more than 50 years old. This aging grid infrastructure is a huge barrier to deploy smart meters in Sri Lanka, since it doesn't support handling large amount of data. Therefore the existing system must be upgraded, as well as a communication infrastructure also must be in place to support successful deployment of smart meters.

Protection

A popular method to bypass conventional meter is shorting the phase line as shown in Fig. 3. If only one current transformer is used and connected in the phase line, then the

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energy measured by the meter be zero. Another method of bypassing is to disconnect the neutral line as depicted in fig .In this case the potential measured by the potential transformer will be zero and no energy consumptions will be registered by the meter. To prevent these by passing's, two current transformers are used separately in the phase and neutral line in our proposed system. The output voltages of CT1 and CT2 are provided to the ADC inputs of the microcontroller. If the phase line is shorted or the neutral line is disconnected then there will be difference between the output voltages of CT1 and CT2. The microcontroller compares the voltages of CT1 and CT2 and if any significant difference is found, it disconnects the load immediately using the relay. In such events the energy meter warns the server of the corresponding bypassing through SMS. Upon receiving SMS, the server blocks the energy meter and informs the authority. The authority can take legal action against the consumer.

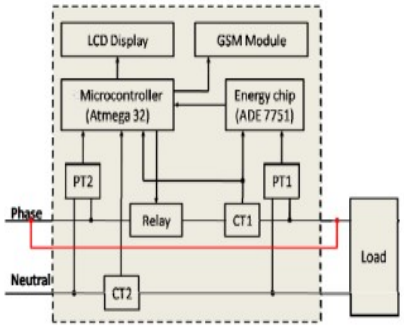

Fig.6. shorting the phase line.

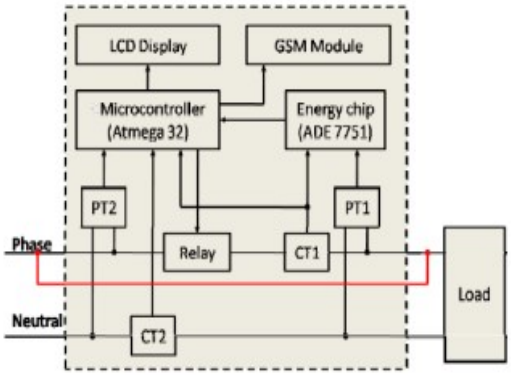

Fig.7. Disconnecting the neutral line

PROTECTION AGAINST WHOLE METER BYPASSING

In extreme cases the whole meter can be bypassed as shown in Fig. 5. As a result the meter will detect no energy consumption. To prevent this kind of theft, our proposed energy meter takes several steps. The output of PT2 is converted to 5V dc and is given to the interrupt pin of the microcontroller. When the whole meter is bypassed PT2 detects no voltage and an interrupt is sent to the microcontroller. The energy meter then requests the power status of the area, where the meter is located, to the server. If the server confirms that the power supply is available in that area, then the meter immediately disconnects the load and informs the server of the electricity theft. During the whole operation backup from a rechargeable battery is available.

CONCLUSION

In this paper, we have proposed a prepaid energy meter which takes advantage of the GSM network that has virtually access to every household and area across different countries. The GSM communication not only implements the idea of prepaid consumption of electricity but also facilitates the utilities to control energy theft using our smart energy meter. In this system, the information of electricity theft is directly reported to the central authority. Therefore, utilities can take immediate legal action against the accused consumer and hence control electricity theft to a great extent. The proposed meter is thus highly useful for power utilities for reducing electricity pilfering and ensuring revenue collection. We are sending bills through post, instead of this, we can add a printer in every house and if we give print command from the server, it will print the bill and the user can get the bill over there only.

REFERENCES

[1]. The official Bluetooth website from Bluetoot SIG: http://www.bluetooth.com
[2]. J.Mander and D. Picopoulos, "Bluetooth Piconet Applications," pp. 1 25.
[3]. R. Piyare and M. Tazil, "Bluetooth Based Home Automation System using Cell Phone," in Consumer Electronics, 2011, pp. 192-195.
[4]. Kailash Pati Dutta, Pankaj Rai and Vineet Shekher, "Microcontroller Based Voice Activated Wireless Automation System:, VSRD-IJEECE", Vol. 2(8), 2012, 642-649
[5]. Baris Yuksekkaya, A.Alper Kayalar, M. Bilgehan Tosun, M.Kaan Ozcan, and Ali Ziya Alkar, "A GSM, Internet and Speech Controlled Wireless Internet Home Automation System", IEEE Transactions on Consumer Electronics, Vol. 52, No. 3, AUGUST 2006
[6]. N.Sriskanthan and Tan Karande, "Bluetooth Based Home Automation Systems," Journal of Microprocessors and Microsystems, 2002, Vol. 26, pp. 281-289
[7]. Kwang Yeol Lee & Jae Weon Choi, "Remote-Controlled Home Automation System via Bluetooth Home Network" in SICE Annual Conference in Fukui, 2003, Vol. 3, pp. 2824-2829
[8]. Wijetunge S.P., Wijetunge U.S., Peiris G.R.V, Aluthgedara C.S. & Samarasinghe A.T.L.K., "Design and Implementation of a Bluetooth based General Purpose Controlling Module", in IEEE, 2008, pp. 206-211
[9]. Sandeep Kumar & Mohammed A Qadeer, "Universal Digital Device Automation and Control", in IEEE, 2009, pp. 490-494
[10]. Hiroshi Kanma, Noboru Wakabayashi, Ritsuko Kanazawa & Hirimichi Ito, "Home Appliance Control System over Bluetooth with a Cellular Phone", in IEEE, 2003, pp. 1049-1053