Smart Prepaid Energy Meter using GSM and Arduino

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ABSTRACT

The aim of paper is to propose a different method for measuring and billing of the energy consumed rather the conventional method. Here a new procedure is followed based on ATmega 328P microcontroller for controlling and detecting energy consumed. It is possible to recharge the electricity balance through this system jus by sending an SMS. It also continuously reads the energy meter readings and automatically sends some updates like low-balance alert, zero-balance alert, recharge alert when necessary to the registered number through GSM modem. Illegal usage of power is detected and alert message is sent to the authorities immediately

KEYWORDS -; smart meters; Arduino; energy meter; GSM

INTRODUCTION

In a world where everything is automated, the automation of the energy payments is much needed. The world is being digitized and it is important that we should be able to move along with trends and changes. Energy is the most common and most important resource and the need for it use it in a controlled manner is crucial where the resources for it are scarce. So, using Prepaid Energy meters helps us to avoid the wastage of power consumed in our daily lives. Moreover, it is also important to protect the revenue of the government from the loss occurs due to the illegal usage of power. Hence, there is a definite need for us to use an advanced energy meters, which can both monitor the consumption and theft.

EXISTING SYSTEM

The energy meters used now-a-days are modified version of the older system, the digital meters doesn't have a prepaid system, where the power to be consumed is estimated prior to its usage and recharged, similar to that of a prepaid talk time for a mobile. Moreover to it, there is no proper equipment which can detect the illegal power usage, using power without actually paying for it. However, in some energy meters an LED is provide which blinks whenever someone tries to open the energy meter box, but this can be stopped using a button which is provided at it backside, which doesn't guarantee security.

PROPOSED SYSTEM

Smart Prepaid Energy meter using Arduino and GSM can provide the solution to problems discussed. This project helps in not only automating but also for controlled managing of the energy consumed, which results in efficient usage of power. GSM modem is helpful for the message alerts and notifications needed for these purposes. The different components used are controlled by ATmega 328P microcontroller in Fig 1.

Illegal usage of power, in other words power theft, is a loss to the government's revenue. This problem, up to some extent, can be solved with this project. Whenever power theft is detected, the system notifies the authorities.

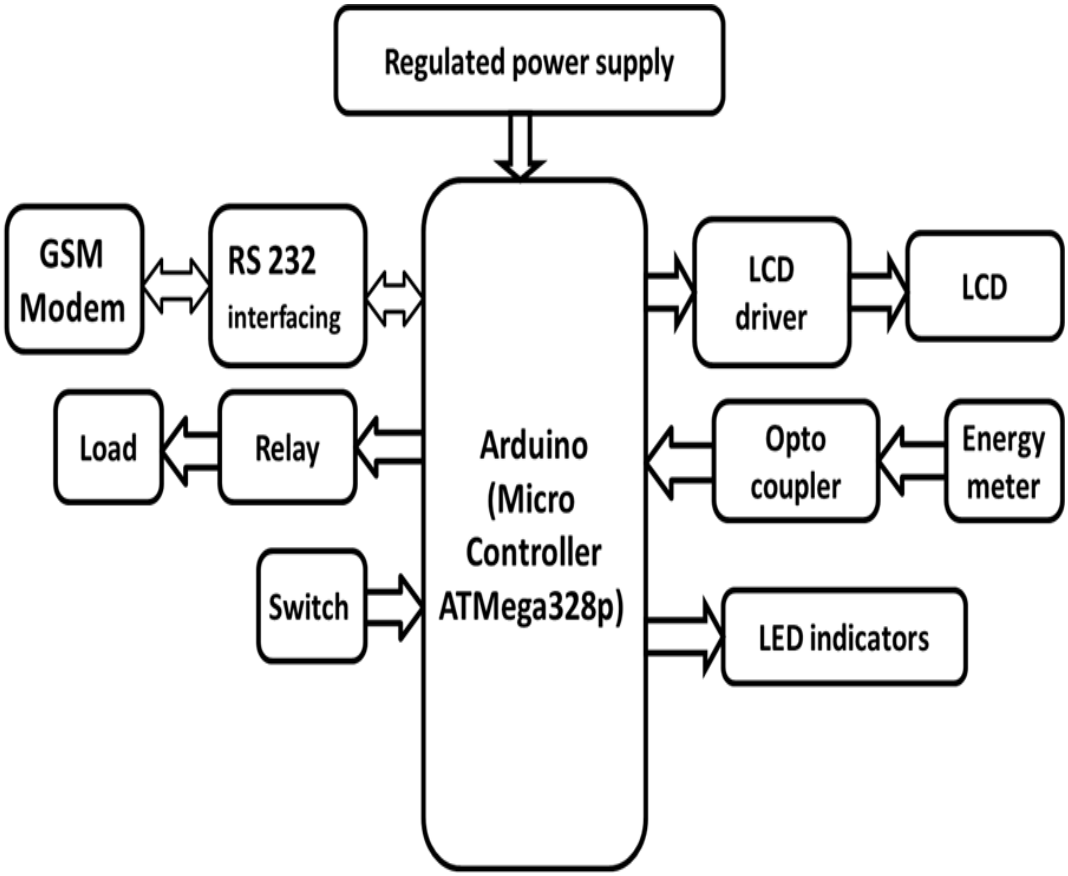

Fig 1. Block diagram of prepaid energy meter with power theft detection and control

A. Analysis of Hardware Components:

1. Regulated Power Supply:

The microcontroller and the circuit associated with it requires 5V supply where as the relay used requires 12V supply for its operation. Usage of two separate power supplies for arduino and relay will increase the size and cost of the project. Hence, a single 12V adapter is connected to the mains, which produces 12V output usable for the relay and then this voltage is passed through a LM7805 voltage regulator resulting in a 5V DC output usable for the arduino and the associated circuitry. The adaptor works as a filter and rectifier. Load is connected across 220V AC supply.

2. Microcontroller:

Microcontroller is a programmable device which consists of a processor RAM, ROM, I/O ports, and a timer all on a single chip. ATmega 328P microcontroller is used in this project. It is highly reliable and virtually low cost. The software used to program the ATmega 328P to do specific tasks is Arduino IDE. It has a total of 28 pins out of which 23 are multi-functional. The device operates between 1.8-5.5 volts

3. GSM Modem:

GSM in this project is used for the communication between the device and the user. We used SIM800L module. This module supports quad-band GSM/GPRS network, available for GPRS and SMS message data remote transmission. The SIM800L communicates with microcontroller via UART port, supports command including 3GPP TS 27.007, 27.005 and SIMCOM enhanced AT Commands. SIM800L is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. After connecting power module boots up, searches for cellular network and logins automatically. On board LED displays connection state (no network coverage-fast blinking, logged in-slow blinking).

4. Energy Meters:

In this project Digital Energy Meters. These meters have microprocessors which are used to calculate phase angle between voltage and current, so that it also measures and indicates reactive power. It is programmed in such a way that it calculates energy according to the tariff and other parameters like power factor, maximum demand, etc. and stores them in EEPROM. It also contains real time clock (RTC) for calculating time for power integration, maximum demand calculations and also time and date stamps for particular parameters.

5. Optocoupler:

An Optocoupler is an electronic device that interconnects two separate electrical circuits by means of a light sensitive optical interface. It acts to break ground loops used in eliminating common-mode noise, especially for systems working at the higher operating voltages. Here we are using PC817 Optocoupler.

6. Relay:

A relay is an electrically operated switch. In this project relay is used to control the power to the energy meter. The relays are controlled using a low-power signal. All relays contain a sensing unit, the electric coil, which is powered by AC or DC current. When the applied current or voltage exceeds a threshold value, the coil activates the armature, which operates either to close the open contacts or to open the closed contacts. When a power is supplied to the coil, it generates a magnetic force that actuates the switch mechanism. The magnetic force is, in effect, relaying the action from one circuit to another. The first circuit is called the control circuit; the second is called the load circuit.

B. Working:

The 230V AC power supply is given to operate the loads. A 20V adapter is used to provide 5V to the Arduino board and from here it is interfaced with relay, GSM and LCD. The transmitter and receiver pins of GSM are connected to the receiver (Rx 0) and transmitter (Tx 1) pins of Arduino board. The optocoupler is given to the 8 pin of Arduino Uno and the other end is given to the energy meter. The relay is connected to the 12 pin of the Arduino board and to the energy meter as well as the load. The load in turn is connected to the energy meter. The LCD 6 pins i.e. RS, Rw, E, D0-D2 are given to the 2, 3, 4,5,6,7 pins and the switch is connected to the 13 pin of the Arduino board. Here we are representing the switch outside of the energy meter just to represent the power theft in real life as shown in Fig 2.

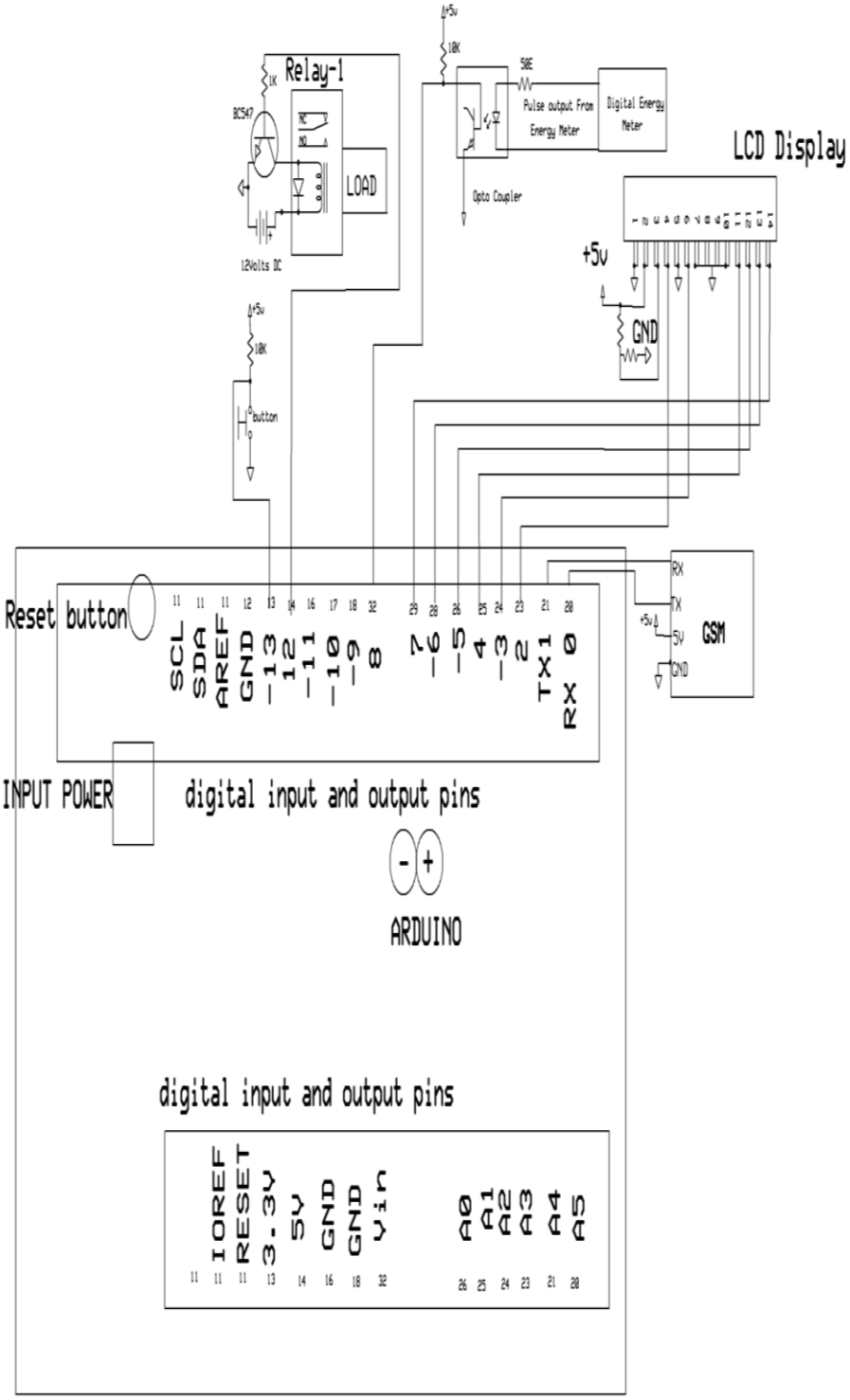

Fig 2. Circuit diagram of prepaid energy meter.

FLOWCHART:

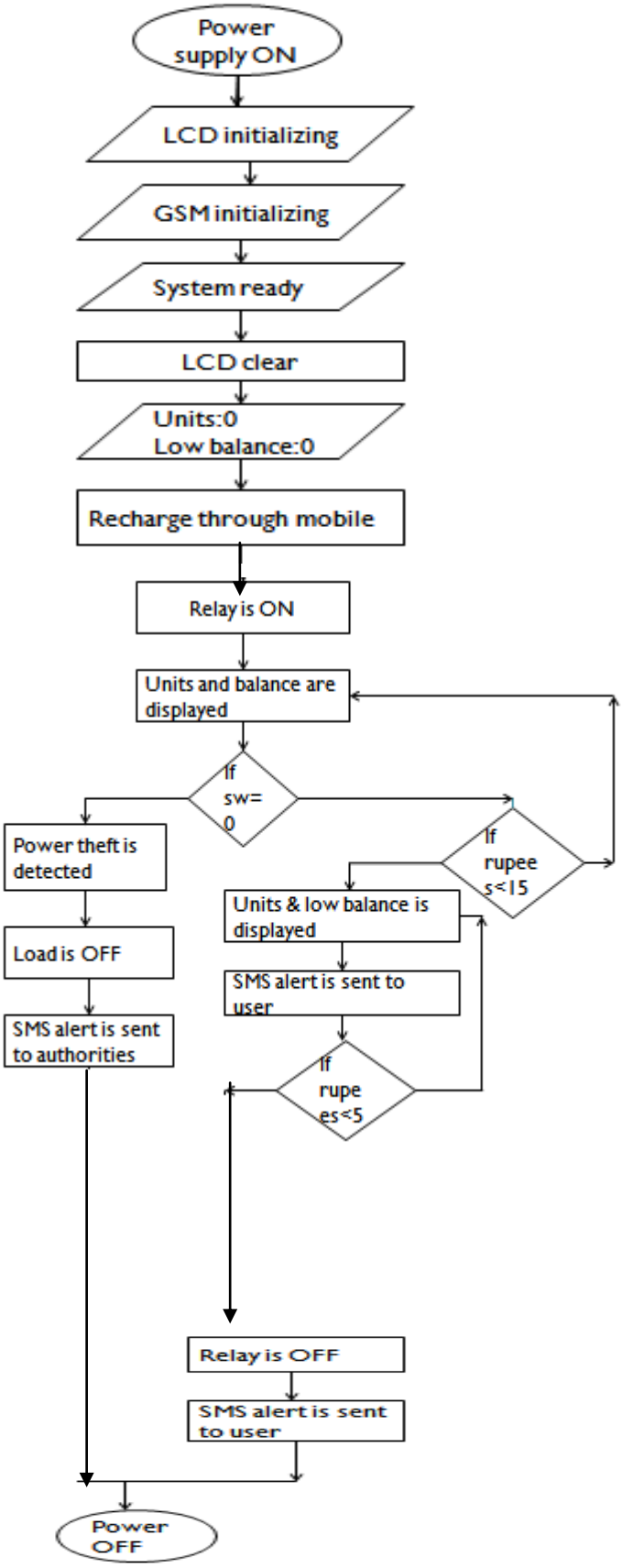

Fig 3. Flow chart

ALGORITHM:

Step1: Switch ON the power supply.

Step2: Initialize the LCD and GSM and display System Ready message.

Step3: Clear LCD and display units and balance.

Step4: Recharge through mobile so that Relay is turned ON.

Step5: Display the new units and balance available.

Step6: If switch is ON go to step11 else go to step 7.

Step7: If rupees<15, go to step 8 else go to step 5.

Step8: Send the SMS alert and display the same in LCD.

Step 9: If rupees<5, go to step 10 else go to step 7.

Step10: Turn OFF the Relay, send alert message and go to step 13.

Step11: Turn OFF the load.

Step12: Send the SMS alert to the authorities and go to step 13.

Step 13: Turn OFF the power.

RESULTS

When the supply is provided to meter, initially LCD gets initialized. Text SMS is sent to consumer as “System Ready”. The meter can be recharged by messaging from the any number to the GSM modem that is fixed with meter and user will get message that the energy meter has been recharged by some amount shown in Fig 4. The consumer can recharge the meter according to his requirement. If the consumer wants to know the left out balance in meter then it can be checked in LCD display of Meter. If the switch is ON, it indicates the power theft.

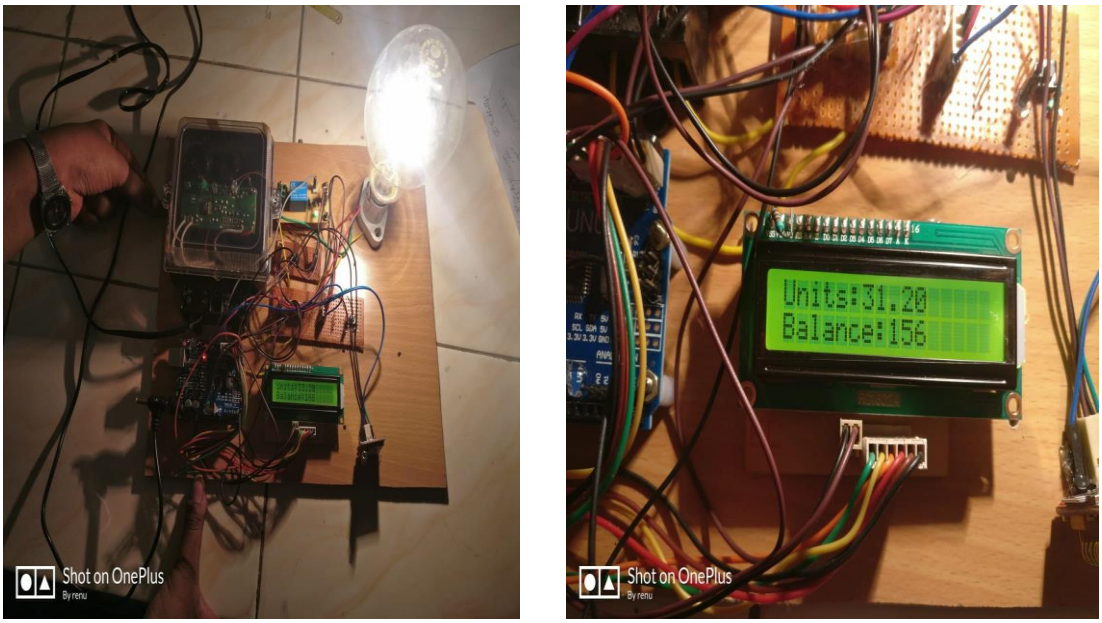

Fig 4.Recharge is done and the balance & units goes on decreasing as the load consumes energy

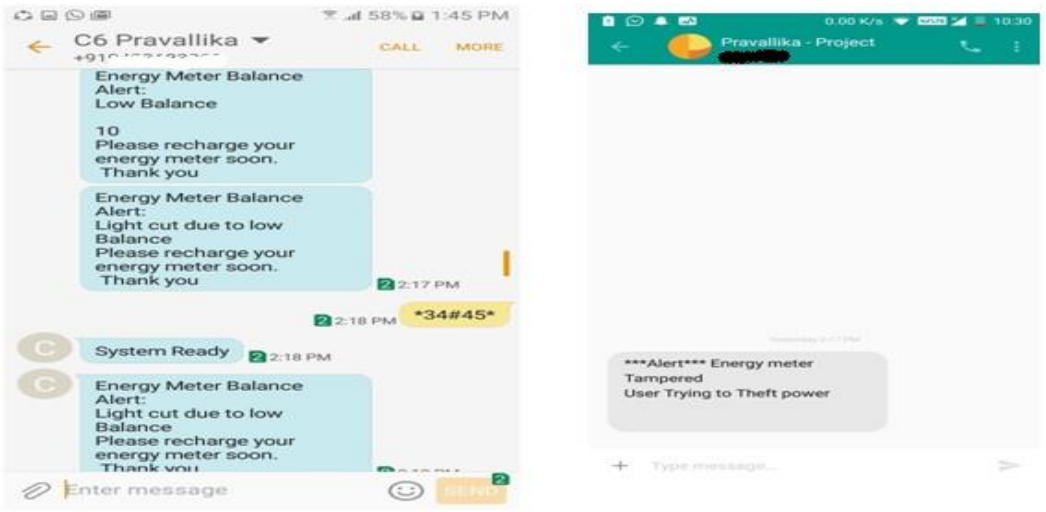

Fig 5. The message alerts to the user mobile when there is low balance and no balance

CONCLUSION

Prepaid energy meter with power theft detection is easy to install and beneficial for both energy provider and consumer. This project reduces the manual efforts and human errors, by monitoring all the parameters and functioning of the connections. Also by implementing this system we can control the usage of electricity on consumer side to avoid wastage of power. An attempt is made in this work to develop a system, which when interfaced with static electronic energy meter is avoided where in complexity of the circuit is reduced and cost also gets reduced of the meter. This system avoids electricity theft to large extent and makes the energy meter tamper proof. This meter increases the revenue of the Government by detecting the unauthorized tampering in the power lines.

REFERENCES

[1] Smart energy metering and power theft control using Arduino & GSM Automated Smart Metering ; (IEEE-2017)

[2] Hashmi, M.U., & Jayesh, G.P. (2015). Anti-theft Energy Metering for Smart Electrical Distribution System. International Conference on Industrial Instrumentation and Control(ICIC) ,May 28-30

[3] Ganurkar, S., & Gour, P. (2014). Prepaid Energy Meter for Billing System Using Microcontroller and Recharge Card. International Journal Of Core Engineering & Management (IJCEM) 1, Issue 1, April.

[4] Pradeep Mittall 2015, Wireless Electricity billing system, International Research Journal of Engineering and Technology (IRJET) Volume: 02,pp.21-34.

[5] J.L.Parra and E.A.S.Calderon 2013, Use of shunts detecting equipment for the identification of illegal power outlets, International Journal of Innovative research in science, engineering and technology, pp. 1–4.