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Smart Energy Meter using Arduino UNO

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Abstract*: *Electricity theft is a common practice in developing countries which cannot be controlled by the governments due to lack of technology. Emerging trends such as Automatic Meter Reading (AMR) eliminate the need of person visiting each house but these advancement further increases Non-Technical losses (NTL) because of no regular inspection at the residence. However traditional meter reading by human operator is inefficient to meet the future residential development needs. This paper proposes a new system based on Arduino microcontroller to protect the energy meter from meter tampering. The proposed system reduces the thefts as it automatically cut off the power whenever the balance in the customer's account reaches to zero. The paper proposes prepaid energy meter that utilizes LDR sensor, GSM, Relay and 16*2 LCD display. SMS automatically send to utility server through Global System for Mobile (GSM) network when these measures detected. In this paper a novel method is proposed to solve the problem with AMR systems without affecting its major advantage of remote monitoring. Integrating this new feature into smart meters provides a robust metering solution.

Keywords: AMR (Automatic Meter Reading), NTL (Non-Technical losses), LDR sensor, GSM, Relay, LCD.

I. INTRODUCTION

In the past recent years there are various anti-power theft methods are introduced by the governments to avoid the theft in electricity. A possible action can be regularly visiting the consumer's metering installations to check them in order to find out any problem. This should be done by specialized and well-trained teams. However, these visits are expensive if carried out for the whole set of consumers of the utility. More often the governments are not taking any action to prevent these losses from happening because it requires huge amount of investments in terms of labors as well as monitoring equipment. Low cost techniques without need of human intervention are the need of an hour. In many developing countries, NTL due to electricity theft account to about 10-40% of their total generation capacity. The proposed system utilize Arduino UNO microcontroller. The energy meter is installed in the homes or offices. The electricity fee per unit is set to 2 rupees in this project. On the application of the power supply initially reset the microcontroller. The process started by registering the mobile number of the user with the help of GSM. If the account linked to the registered mobile number doesn't have enough money then the recharging of account is done with the help of GSM. The AC load is connected that can be controlled with the help of relay. The tampering of the meter is detected by the sending high signal to the controller. The 16*2 LCD continuously displays the processing information.

II. LITERATURE SURVEY

In [1] the paper provides smart energy metering with AMR systems without affecting its major advantage of remote monitoring. Integrating this new feature into smart meters provides a robust metering solution. Electricity theft is a common practice in developing countries which cannot be controlled by the governments due to lack of technology. Emerging trends such as Automatic Meter Reading (AMR) eliminate the need of person visiting each house but this advancement further increase Non-Technical loss (NTL) because of no regular inspection at the residence. However traditional meter reading by human operator is inefficient to meet the future residential development needs. This paper proposes a new system based on ARM-Cortex M3 processor to protect the energy meter from phase line bypassing, neutral line disconnection, whole meter bypassing and meter tampering. A SMS automatically send to utility server through Global System for Mobile (GSM) network when these measures detected. In this paper a novel method is proposed to solve the problem.

In[2] this paper explains Every management system is trying to make automatic, portable and remote control. This work presents a novel smart energy meter for an automatic and superior metering and billing system. The integration of the Arduino and GSM Short Message Service (SMS) provide the meter reading system with some automatic functions that are predefined. Firstly, we have simulated the project in PROTEUS 8.0 then successfully implemented on the circuit board in laboratory. The proposed energy meter system can incorporate with embedded controller and GSM modem to transmit the data like consumed energy in kWh, generated

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bill, security services (line Cut/On) over GSM mobile network such as data can be then fed and integrated into existing energy management systems located at power companies or organizations to provide the services among the customers without man-power. Our implemented project is able to provide all required services remotely for metering and billing with high fidelity.

In [3] this paper explains Power utilities in different countries especially in the developing ones are incurring huge losses due to electricity theft. This paper proposes a prepaid energy metering system to control electricity theft. In this system a smart energy meter is installed in every consumer unit and a server is maintained at the service provider side. Both the meter and the server are equipped with GSM module which facilitates bidirectional communication between the two ends using the existing GSM infrastructure. Consumers can easily recharge their energy meter by sending a PIN number hidden in a scratch card to the server using SMS. This paper presents some measures to control meter bypassing and tampering. The bidirectional GSM communication using SMS ensures the effectiveness of these measures. Pilferage of electricity can be substantially reduced by incorporating the proposed measures along with the prepaid metering scheme. Legal actions against dishonest consumers can also be taken in this system.

III. PROPOSED DESIGN METHODOLOGY

A. *Block Diagram*

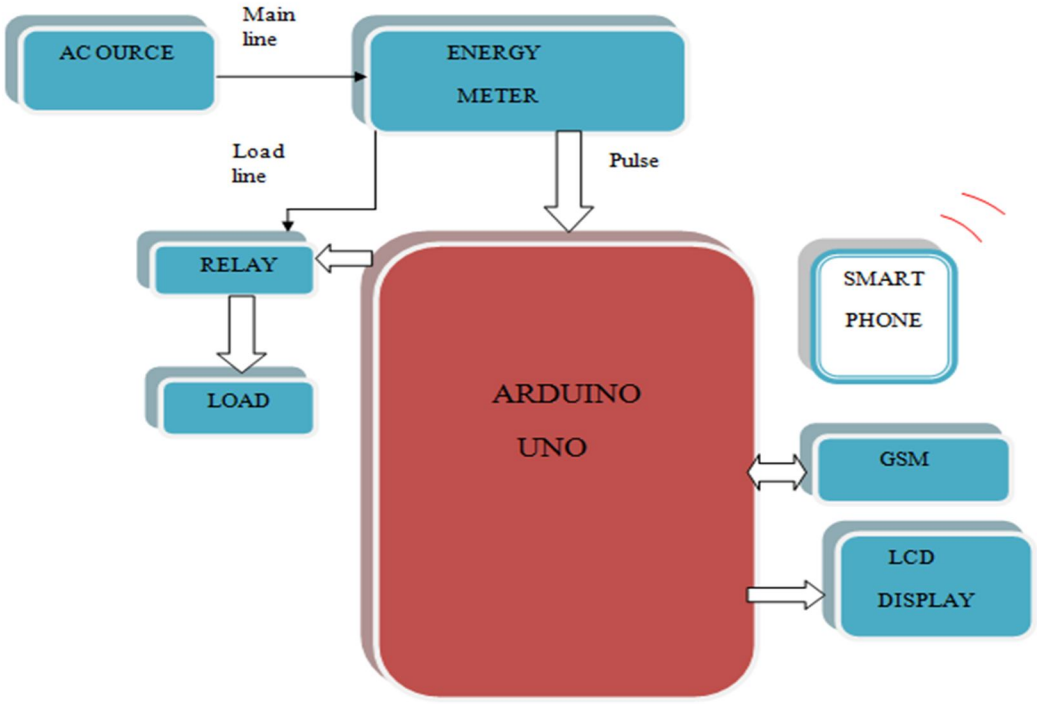


Fig. 1 Block diagram of proposed method

IV. HARDWARE IMPLEMENTATION

A. *Components Required*

1) *Arduino UNO:* Microcontroller board consists of ATmega328 microcontroller. It has six inputs which are analog, fourteen (14) digital I/O pins; operating frequency is 16 MHz, ICSP header, USB connector, power jack & RESET key. To power ON this board it is either connected with an adapter or with PC through an USB.
2) *GSM:* GSM module is used to establish communication between a computer and a GSM system. GSM stands for Global System for Mobile Communication. GSM supports transmission of both audio and video signals.
3) *LCD:* LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. Liquid crystal display technology works by blocking light. Specifically, an LCD is made of two pieces of polarized glass (also called substrate) that contain a liquid crystal material between them. A backlight creates light that passes through the first substrate. At the same time, electrical currents cause the liquid crystal molecules to align to allow varying levels of light to pass through to the second substrate and create the colours.

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4) *Energy Meter:* The meter which is used for measuring the energy utilises by the electric load is known as the energy meter. The energy is the total power consumed and utilised by the load at a particular interval of time. It is used in domestic and industrial AC circuit for measuring the power consumption.
5) *LDR Sensor:* An LDR is a component that has a (variable) resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits.
6) *Relay:* Relays are switches that open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit. As relay diagrams show, when a relay contact is normally open (NO), there is an open contact when the relay is not energized.
7) *GSM:* The SIM800A Quad-Band GSM/GPRS Module with RS232 Interface is a complete Quad-band GSM/GPRS solution in an LGA (Land grid array) type which can be embedded in the customer applications. SIM800A support Quad-band 850/900/1800/1900 MHz, it can transmit Voice, SMS and data information.

V. EXPERIMENTAL SETUP AND RESULTS

The proposed system utilize Arduino UNO microcontroller. The energy meter is installed in the homes or offices. The electricity fee per unit is set to 2 rupees in this project. On the application of the power supply initially reset the microcontroller. The process started by registering the mobile number of the user with the help of GSM. If the account linked to the registered mobile number doesn't have enough money then the recharging of account is done with the help of GSM. The AC load is connected that can be controlled with the help of relay. The tampering of the meter is detected by the sending high signal to the controller. The 16*2 LCD continuously displays the processing information. The experimental setup of the proposed system is shown in the figure 2.

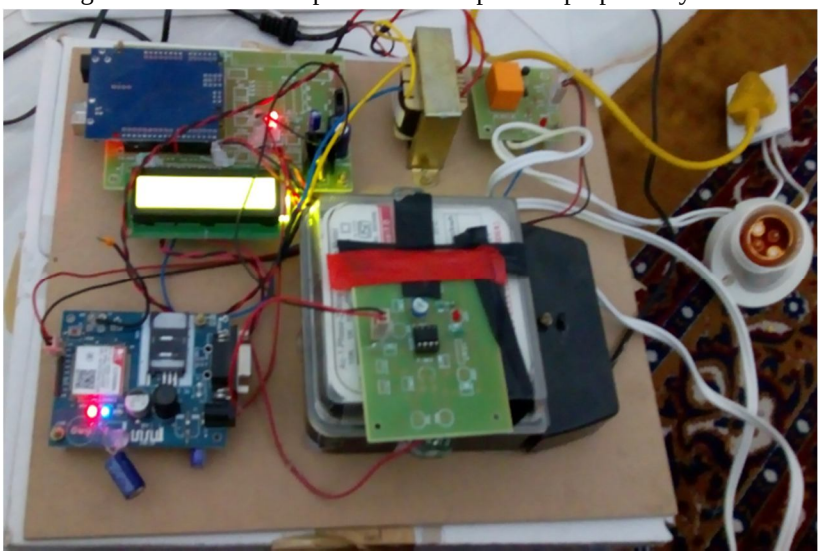


Fig. 2 Experimental setup of the system

Figure 3 and figure 4 provides the LCD display of welcome message and SMS sending information by GSM to register the customer's mobile number.



Fig. 3 Welcome message



Fig. 4 LCD display of registering mobile number

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The figure 5 provides the information regarding the low balance in terms of U: 006 and A: 000.

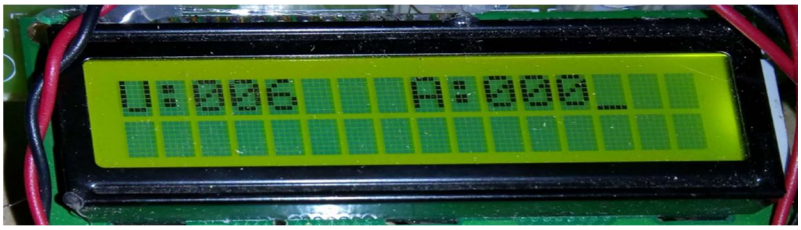


Fig. 5 LCD display zero balance

The following figure 6 provides the SMS's sended and received by the customer. The SMS consists of processes like registration of mobile number, recharging of electricity bill account of the customer and tampering alert SMS sent to the customer's mobile number.



Fig. 6 SMS sent and received by the customer

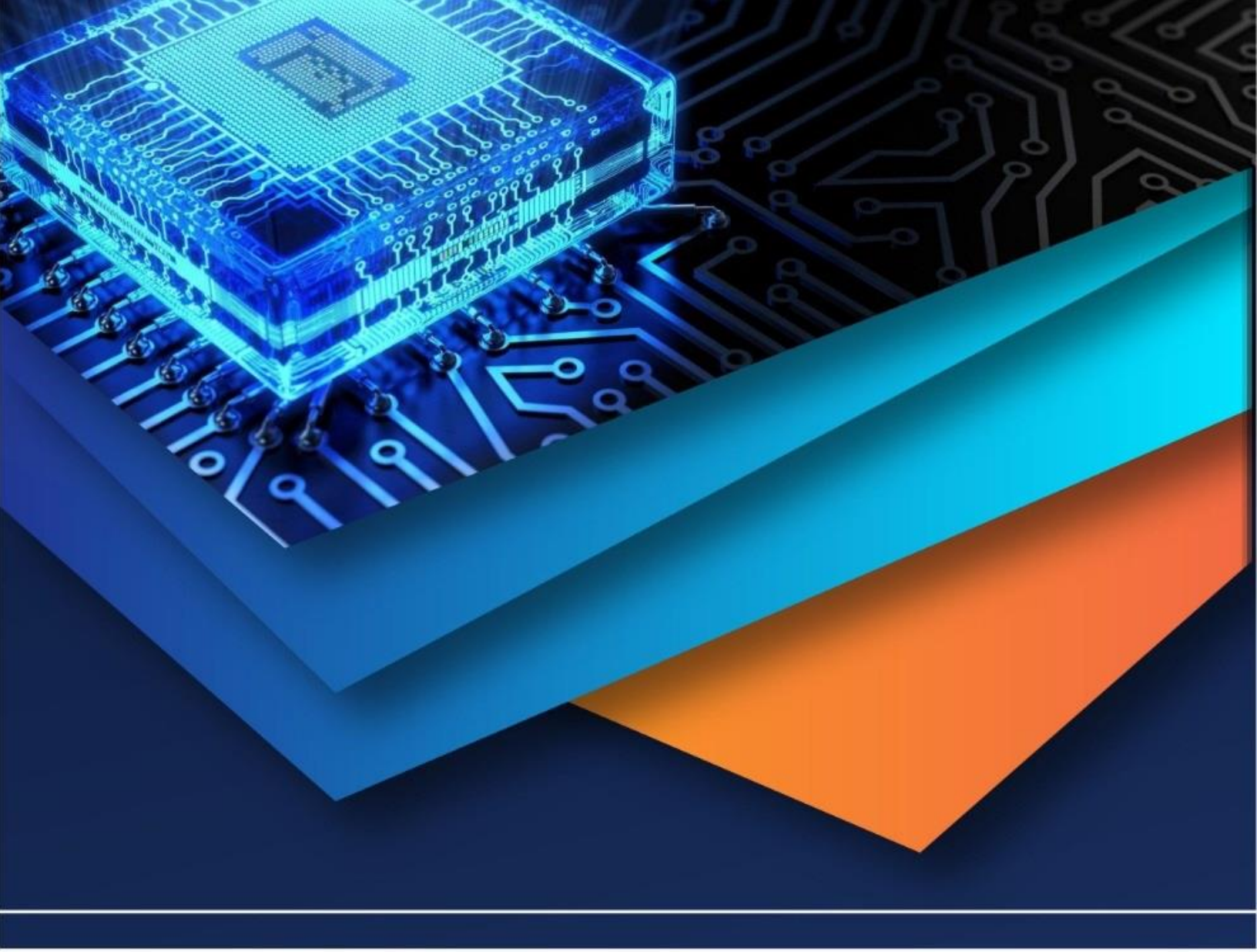
VI. CONCLUSION

This paper is intended to present an overview of prepaid energy meter which can control the usage of electricity on consumer said to avoid wastage of power. Prepaid energy meter is a concept to minimise the electricity theft with a cost efficient manner. The users are not bound to pay excesses amount of money, users have to pay according to their requirement. Prepaid energy meter is more reliable and user friendly. This prepaid remote energy meter proves to be a boon in the power sector. The system is also capable of detecting the tampering of meter by the customer's.

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