

Prepaid Electricity Meter with Theft Detection

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Abstract - Arduino based Prepaid Electricity Meter is a system which makes the billing of electricity consumption by a user prepaid. The primary application of this project is to calculate the energy consumption based on the number of pulses generated in the electricity meter, and subsequent deduction of money from the balance amount. This makes the user aware of the consumption of electricity but also reduces human effort of door to door billing, as the system would send timely and appropriate messages to the registered user in case of low balance in the system. The system is designed to make it tamper proof and in case of any external human intervention, it would report the Electricity Board about the same and switch off the power supply. An auto detection system for electricity theft has been employed which allows to tackle the menace of electricity theft faced by electricity boards to make sure that no un-authorized usage of electricity takes place. Tamper proofing of the system makes sure that there is no intentional tampering of the electricity meter to alter or stop the billing of electricity consumption.

Key Words: Arduino , Theft detection, Tamper proof, Prepaid electricity meter

1. INTRODUCTION

In today's world electricity has become an indispensable part of our everyday life. It is a major driving factor for advances in technology. In a developing country like India with such a large population who wants access to electricity, the metering of electricity usage at household level proves to be a manpower extensive task where a representative from the electricity company goes door to door and takes readings from meters installed at homes and gives bills to subscribers which is to be paid. Also, electricity theft is quite common which further strains the already burdened electricity grid in our country. It is a menace in terms of revenue for the electricity boards/companies.

1.1 Block Diagram

The block diagram representation of the project is shown in figure 1. It simplifies the system into various blocks for better visualization and interpretation. It describes the various blocks of the system and shows which components receive output from the Arduino and which ones provide an input to the Arduino. Some work as sensors and other as actuators

A five Volt power supply provides power to the system. The current and the LDR(Light Dependent Resistor) sensors provide an input after sensing the flow of current and the LED pulses to the Arduino. The LCD module receives inputs

from the Arduino for displaying customary messages to the user and for sending SMS alerts in case of electricity theft and system tampering. The GSM module interfaced to the Arduino is responsible for sending alerts. A single phase 220V electricity meter counts the units being consumed by the load. A SPDT relay is used to trigger the load ON or OFF.

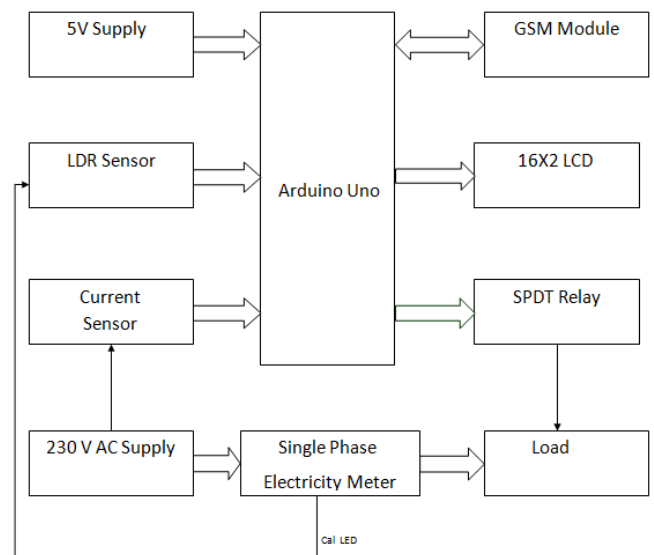


Fig 1 : Block Diagram of Prepaid electricity meter

A brief description of each block of the project is as follows :-

1. Arduino Uno:- This is the board used in the project and it is the heart of the project where microcontroller is ATMEGA 328. It is responsible for sending commands to the GSM module ,for sending SMS alerts to the user and also to the 16x2 LCD module to display proper messages to the user. It also receives input from the LDR sensor and the current sensor. The LDR input is used to compute the electricity consumption by the load. The input from current sensor is used to detect the theft of electricity. It also drives a relay switch to switch ON and OFF the load.
2. GSM Module:- It is responsible for sending SMS alerts to the user as well to the electricity company and it allows the user to recharge the electricity meter by sending a simple SMS.
3. 16X2 LCD :-The 16X2 Liquid Crystal Display is employed to display proper messages on its screen .This is used to print additional information like units remaining, welcome text for the user whenever the system is turned ON, theft detection message etc. It is employed to make the system more users friendly.

4. LDR sensor: The Light Dependent Resistor sensor is used to detect the pulse output from the single phase electricity meter. It is placed very close to the LED and covered. It senses the blinking of the LED and provides the subsequent detection to the Arduino for unit consumption calculation.
5. Electricity Meter:- Single phase 220 V electricity meter which is used in homes for metering of electricity is used as the meter in the project.
6. ACS712 Current Sensor:- This sensor detects the flow of current through the load side of the electricity meter and generates a signal proportional to that of current. This sensor is used to detect the theft of electricity by the user.
7. SPDT Relay:- A Single Pole Double Throw or SPDT relay is used to switch ON/OFF the load which is connected to the electricity meter in case of Zero balance in the system. It is also triggered in case of tampering with the meter. It also gets triggered whenever theft of electricity is detected by the system.

2. ALGORITHM

- Step 1: Initialise balance=1,count=0,units=0
- Step 2: Check if (tampering) == yes goto step 3 else goto step 4.
- Step 3: Send "Tampering detected" text message to the electricity board. Trigger relay to turn off load. int subsequent message on LCD.
- Step 4: Check if (balance>1),if yes GoTo step 5 else goto Step 9 .
- Step 5: Turn on the system, intimate the subscriber regarding the same.
- Step 6: Compute the number of units remaining and update the balance.
- Step 7: Check (if balance less than or equal to 5), if yes goto step 8.
- Step 8: Send message to the subscriber regarding low System balance. Print "Low Balance" message on LCD.
- Step 9: Check (theft),if yes, GoTo step 10 else GoTo step 11
- Step 10: Intimate the electricity board by sending message "Theft is Detected".
- Step 11: Open live terminal to receive message in the GSM module.
- Step 12: Check for message, if message is received GoTo step 13 else goto step 11.
- Step 13: Read message from memory and extract.

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Step 14: Check, if (message received ==#).If yes, Update the system balance as balance =balance+10.

Step 15: Send message to user about recharge success and goto step 2.

3. IMPLEMENTATION OF PREPAID SYSTEM FOR

Electricity Metering

The project presents a robust system which allows the consumer to use electricity by making payments in a prepaid manner, just like the recharge of a mobile SIM is carried out. The user can recharge his/her system account by sending a simple SMS to the system. This SMS recharges the User's account. The system also sends alerts to the user in case of low balance in the system to remind the user to recharge. The system cuts off the power supply when the balance of the system falls to zero based upon calculation of the amount of electricity being consumed by the load. The implementation is shown in Fig. 2.

The load connected to the load side of the electricity meter is a bulb of 200 Watts. The SPDT relay is connected to the load on one side and is provided input from the Arduino for the triggering of the load. The single phase electricity meter is connected to 220 Volts 50 Hz AC supply. The LDR sensor is employed such that it receives maximum intensity of light when the Calibration LED blinks.

The frequency of the blinking of the Cal.LED depends on the load connected to the load end of the meter. Higher loads correspond to increased frequency of LED blinks and vice versa is true for small value of loads connected. The LDR detects this blinking and the units consumed by the load are calculated.

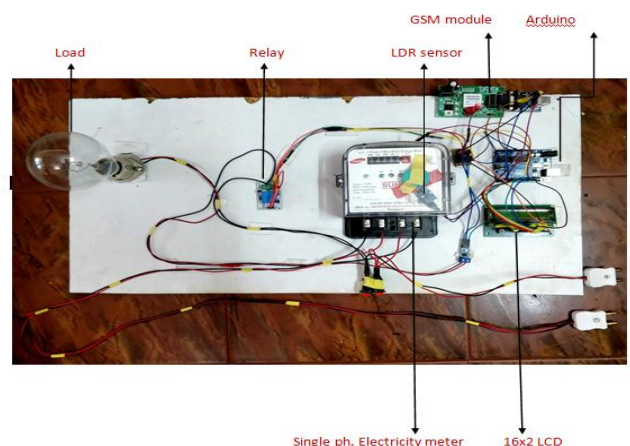


Fig.2 : Prepaid Electricity meter system

4. RESULTS AND DISCUSSION

The system switches the power supply ON only if the balance in the system is greater than or equal to 1 Rupees. The

system calculates the amount of power consumed by the load connected and deducts the subsequently from the balance amount. The system sends alerts to the user as shown in Fig.3 when:

1. The system balance is Re. 1 to remind the user to recharge.
2. When balance falls to 0 informing that power is cut off.
3. The system is recharged by the user.



Fig. 3 : SMS alerts received by user on the registered Number

The user can recharge the system simply by sending a SMS to the system (#-recharges the system for rupees 10).The system receives the message through the GSM module. After

the message is received it is decoded by the Arduino based upon the code and recharges the system and sends alert to user that recharge of Rs 10 is done as shown in Fig.4 (considering # is sent by the user) and switches back the power ON by triggering the relay.

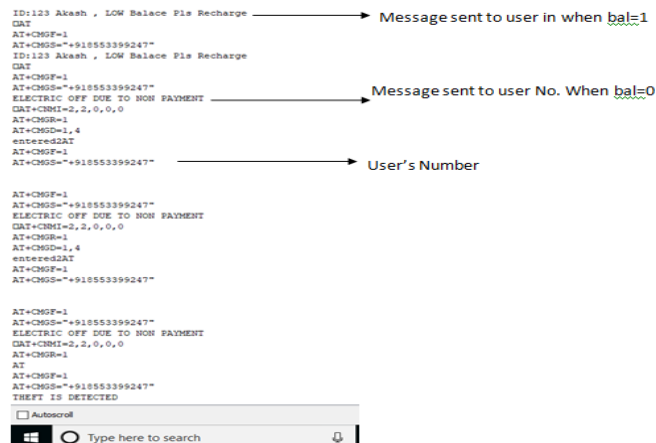


Fig.4 : Arduino Serial Monitor showing SMS Rx and Tx

The system is made tamper proof by offering a simple mechanism where the system switches OFF the power supply by triggering the relay whenever the electricity meter protective casing is lifted or someone tries to force it open. This has been done so that the practice of manipulating the readings of the meter by the users to use electricity free of cost or at a much reduced cost is checked. The system intimates the electricity board whenever a user tries to utilize electricity even after the balance in his/her account falls to zero by employing a current sensor which senses the electricity owing through the load end of the meter even after the power supply is turned OFF after the balance has become zero. This keeps unauthorized usage of electricity in check by detecting theft of electricity at the household level as shown in Fig.5



Fig.5 : Alerts received when Tampering is detected.

5. CONCLUSION

The project Prepaid electricity meter with theft detection has been implemented successfully and has applications in households especially in rural areas. This system can be adopted widely because of its low cost and also because it stops revenue leakage to the already burdened electricity boards because of electricity theft. The main advantage of this project is its low cost solution for prepaid metering of electricity usage and also stops theft of electricity at household level. The facility of tamper detection stops any intrusions by the user into the electricity meter to alter or stop the calculation of units being consumed.

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