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An Innovative Approach To Iot Based Prepaid Energy Meter

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Abstract: *The main problem of the conventional metering system is that person from utility has go to area by area and read the energy meter of every house and handover the bills. According to that reading consumer pays the bill. Then, when the customer failed to pay bills for a long period of time one person from utility has go to area by area and remove the fuse to disconnect the consumer premises from the distribution feeder. This process can be replaced by using prepaid energy meter. Many times errors like extra billing or notification from utility are given frequently even bills are paid regularly. In this paper, Microcontroller based prepaid measuring system to calculate the power consumption and GSM circuit for Short Messaging Service to the user is used.*

Key Word: *GSM, PREPAID ENERGY METER, SMART MONITORING AND CONTROL, THEFT DETECTION, ARDUINO*

I.INTRODUCTION

The existing system is a time consuming and it requires more labor and components. Electricity, one of the major requirements used for various commercial and domestic purposes plays an essential role in uplifting the life-style of people. However, the billing system is time-consuming and not user-friendly. The uninterrupted supply of electricity smoothens the daily routine. The electric measuring system operates by continuously measuring the voltage (V) and current (A) at every instant. The product of voltage and current gives the electrical power (W) at every instant, this power is consolidated with time to give the electrical energy consumed.

Today's conventional meters use kilowatt-hour as the standard unit of measurement. The billing requires readings to be read once during the period. This creates room for error as it involves human intervention [1]. The proposed metering system in this paper offers to automate this process thereby eliminating fallacies and dishonest behavior. Implemented using Arduino .microcontroller and GSM, it provides bidirectional communication between the user and meter. Ease of reading and load disconnection/re-connection are some of the traits that make this proposed metering system a better alternative to prevalent systems.

A. Literature Survey

The history and evolution of energy meter dates back to the 1880s, a little before the widespread use of electricity. The era of gas lamps also contained the energy measurement system where the amount of energy consumed per household was calculated. With the discovery and use of electricity, the Electric lamps rapidly replaced the gas lamps, proving to be brighter and more cost efficient. A new system for consumption measurement was required. DC meters measured charge in the unit ampere-hours. With time the DC meters proved to be insufficient. Then came Edison's meters classified as electrolytic and electrochemical meters. In 1889, that a Hungarian named Otto Blathy created and patented the first AC meter using kilowatt-hour as the standard unit, whose operating principle is used till date.

B. Prepaid Energy Meter

This is the proposed system. The proposed system consists of digital energy meter, an Arduino (microcontroller), GSM modem and Relay .In this method consumer pay the energy bill amount before usage of energy consumption. Prepaid method can reduce the problem for traditional billing system and also reduce the manpower for taking meter reading.

a) Advantages of Prepaid Meter

- For Utility

1) No bill production
2) No bill distribution
3) Reduce the manpower
4) Lower overhead

5) No additional action for disconnection
6) Avoid human errors

- For Consumer

1) Pay the bill as required the energy consumption
2) No billing error
3) Reduce the energy wastage
4) It shows usage unit and remaining unit

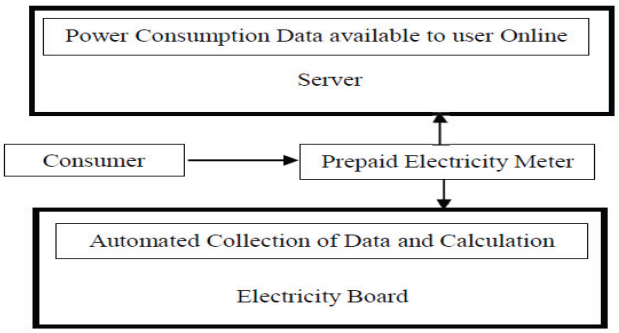

Figure 1 - Pre-Paid Method of Measuring Electricity

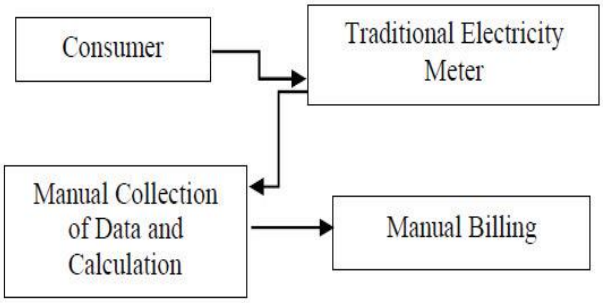

Figure 2 - Conventional Method of Electricity Measurement

II.WORKING EXPLANATION

Here we have interfaced electricity energy meter with Arduino using the pulse LED (Calibration or Cal) of electricity Energy meter. We only need to connect tis CAL LED to Arduino through an Optocoupler IC.

When we power up the system then it reads previous values of rupees stored in EEPROM and restores them into the variables then checks the available balance with the predefined value and take action according to them, like if available balance is greater than threshold value of rupees then Arduino turns On the electricity of home or office by using relay.

And if balance is less than threshold value of rupees then Arduino sends a SMS to user phone regarding low balance alert and requesting to recharge soon. And if balance is less than threshold value of rupees then Arduino turns off the electricity connection of home and sends a SMS to user's phone for 'Light Cut' alert and requesting to recharge soon. GSM module has been used to send and receive messages it acts as the communicating medium between arduino microcontroller and the mobile phone,

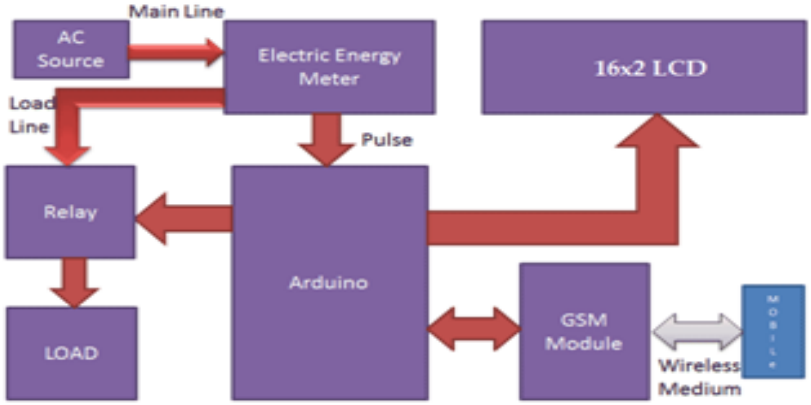

Figure 3 - Block Diagram of the Circuit

Now when we need to recharge our system, we can recharge it simply by sending a SMS to the system, through our Cellphone. Like if we want to recharge by 100 rupees then we will send "RUCode1"through SMS. System receives this message and extract recharge amount and update the balance of system. And system again turns on the electricity of the house or office.

A. Supplier Side Merit:

When the total power for a particular recharged amount is consumed without any human interaction the load (consumer) is isolated from the supply this reduces the human work and greatly reduce the money involvement.

B. Consumer Side Merit:

When half of the power for a particular recharged amount is consumed the system sends message to the consumer that 50% of power is consumed likewise the message sending process will be continuous for 90%, 95% of full power consumption.

In a conventional metering system there will be a sudden cut in supply when they don't pay bills for longer time this

leads to inconvenience to the customer. But in above messaging process the customer can monitor and conscious about the power usage. Hence no sudden cut in supply voltage as it is intimated earlier.

In a conventional energy meter there is no anti-theft alarm system but in proposed system there is an anti-theft alarm system by using a door stop switch. The main connections terminals of an energy meter are closed by an end cover .to execute a theft process the end cover needed to be removed. The door stop switch is connected in such a way that the removal of end cover will activate the door stop switch and in turn end stop switch gives signal to the arduino microcontroller. According to the sequence of code the microcontroller with the help of GSM module send theft alert message to the supplier mobile number.

C. Features Can Be Implemented Later On:

Consider the total power is consumed by the user and the supply is about to cutoff .At this time the customer can extend the validity by paying an extra penalty without interrupting the supply. This will prevent the inconvenience of the consumers due to sudden interrupt in power supply.

III.CIRCUIT DESCRIPTION

Circuit connections for this Wireless Electricity Meter Reading Project, are shown in the diagram; we have used an Arduino UNO for processing all the things used in project. A liquid crystal display is used for displaying the status of Units and remaining balance. Data pins of LCD namely RS, EN, D4, D5, D6, D7 are connected to Arduino digital pin number 7, 6, 5, 4, 3, 2. And Rx and TX pins of GSM module are directly connected to the TX and Rx pins of Arduino respectively. And GSM module is powered by using a 12 volt adaptor. A relay is used for switching electricity connection which is connected at pin 12 of Arduino though ULN2003 relay driver.

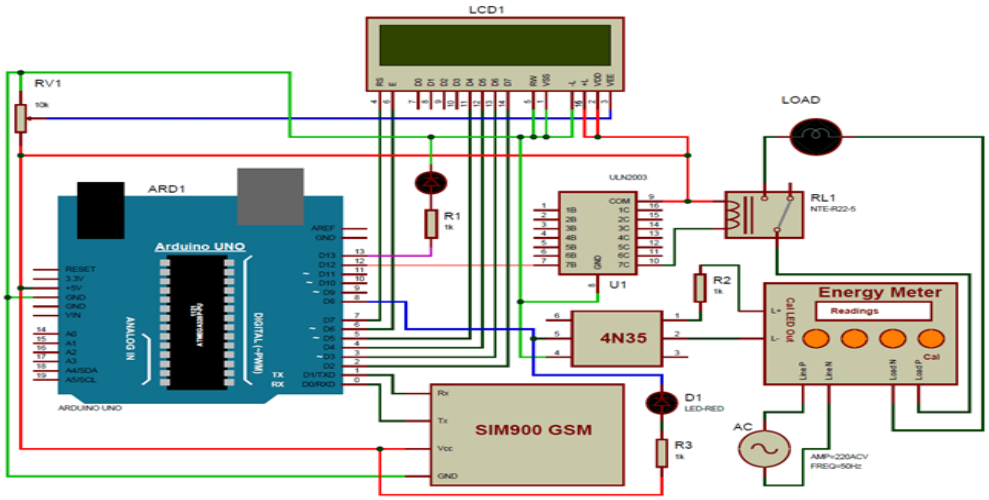

Figure 4 - Circuit Simulation in Proteus

A. How to Connect Energy Meter with Arduino

First user need to buy an Analogue Electricity Energy Meter. After it user needs to open it and find the Pulse LED or Cal LED's terminals (cathode and Anode). Now solder two wires at both the terminals and take it out from the energy meter and then close energy meter and tight the screws.

Now user needs to connect anode terminal of LED at pin number 1 of Opt coupler and cathode terminal to pin 2. Pin number four of optocoupler should be directly connected to ground. A LED and a Pull-up resistor are connected at pin number 5 of optocoupler. And same terminal should go to the Arduino pin 8 too.

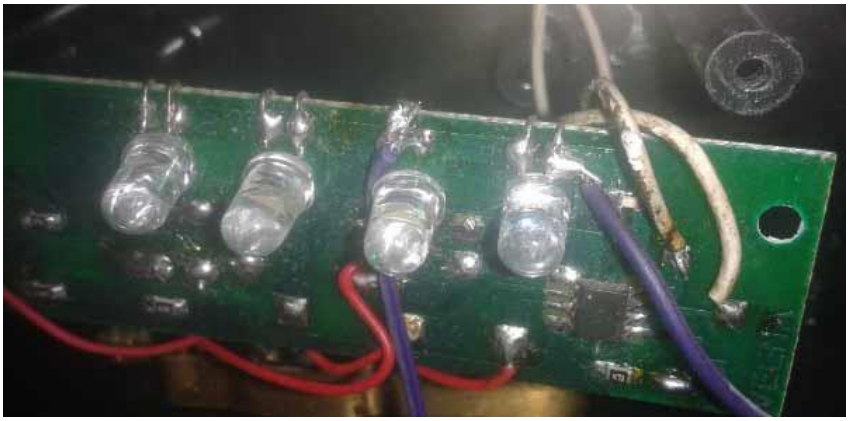

Figure 5 - Connection between Energy Meter and Arduino

Figure 6 Hardware Implementation

IV.COMPONENTS USED

This system is a new concept for electricity measuring techniques, which has the capability to reduce misuse of electricity and theft of electricity.

As soon as the credit amount is exhausted the supply disconnects until the next recharge. Modules and main parts of the system are summarized as below:

i. Arduino Uno Microcontroller
ii. Global System for Mobile Communication (GSM)
iii. Android Messaging Application
iv. Relay
v. Liquid Crystal Display (LCD)
vi. End stop switch
vii. PC817 Opto Isolator
viii. 230 V Power Supply
ix. 5 V Power Supply
x. Load

1. Arduino Uno Microcontroller

The Arduino-Uno Microcontroller which is used in the proposed system for processing the input from sensors as well as providing necessary control signals to the peripherals. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. Units.

Figure 7- Arduino UNO

2. Global System for Mobile Communication (GSM)

The GSM module plays a crucial role in the communication between devices and the GSM network. It is responsible for establishing and maintaining the communication link between the device and the network. The module also handles the encryption and decryption of data, which ensures the security of the communication. The SIM800L is a powerful and cost-effective GSM module that is widely used in a variety of applications. This quad-band GSM/GPRS module is designed to work on the four global GSM frequency bands (850/900/1800/1900MHz), making it compatible with most cellular networks around the world. The SIM800L module is a reliable and efficient solution for adding cellular connectivity to devices such as IoT devices, alarms, remote controls, and more. The SIM800L GSM module is small in size, low in power consumption and easy to integrate into any system with its UART and ADC interfaces. It also supports GPRS class 10, making it an ideal choice for applications that require internet connectivity.

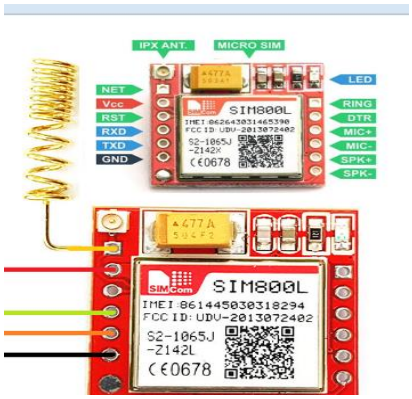

Figure 8 - GSM 800l module

I. Relay

A simple relay consists of wire coil wrapped around a soft iron core, or solenoid, an iron yoke that delivers a low reluctance path for magnetic flux, a movable iron armature and one or more sets of contacts.

The movable armature is hinged to the yoke and linked to one or more set of the moving contacts.

Figure 9 - Relay Module

II. Liquid Crystal Display (LCD)

The term LCD stands for liquid crystal display.

It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments.

The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

*Figure 10 - 16*2 LCD Display*

III. End Stop Switch

End stop switch is used to identify the power theft when the terminal box of energy meter is tried to unbox. The roller part of switch is pressed or activated mechanically by the end cover of energy meter when the cover is tried to remove the pressed roller part is released and gives feedback signal to micro controller as power theft detected.

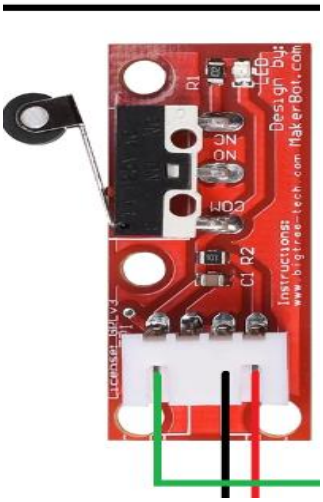

Figure 10 - End Stop Switch

IV. Pc817 Op to Isolator

An optocoupler is also called an optoisolator, photo-coupler & optical isolator is one kind of semiconductor device that allows the electrical signal to transmit between two isolated circuits through light. This component includes two parts like an LED and a photosensitive device.

PC817 IC is an optocoupler that includes a phototransistor and an IR diode. In various circuits, filters play a key role to remove the noise.

When the circuit including resistor and capacitor always eliminates the noise from the incoming signal however the resistor & value capacitor frequently depends on the inward signal.

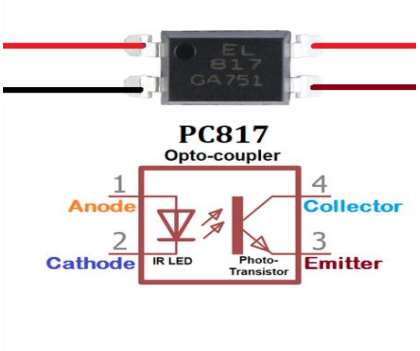

Figure 11 - opto-coupler

V.CALCULATION OF PULSES AND UNITS

Before proceeding for the calculations, first we have to keep in mind the pulse rate of energy meter. There are two pulse rates of energy meter first is 1600 imp/kwh and second is 3200 imp/kwh. So here we are using 3200 imp/kwh pulse rate energy meter.

So first we need to calculate the Pulses for 100watt, means how many times Pulse LED will blink in a minute, for the load of 100 watts.

Pulse= (Pluse_rate*watt*time)/ (1000*3600)

So pulses for 100 watt bulb in 60 seconds, with energy meter of 3200 imp/kwh pulse rate can be calculated as below:

Pulses=3200*100*60/1000*3600

Pulses = ~5.33 pulse per minute

Now we need to calculate Power factor of a single pulse, means how much electricity will be consumed in one pulse:

PF= watt/(hour*Pulse)

PF=100/60*5.33

PF=0.3125 watt in a single pulse

Units= PF*Total pulse/1000
Total pulses in an hour is around 5.33*60=320
Units = 0.3125*320/1000
Units = 0.1 per hour
If a 100 watt bulb is lighting for a day then it will consume
Units =0.1*24
Units = 2.4 Units
And suppose unit rate is at your region is 5 rupees per unit then
You have to pay for 2.4 Units Rs:
Rupees=2.4*5=12rupees

VI.CONCLUSION

This work presents design and development of android based smart electricity system using GSM. This system is a prepaid electricity measuring device which is user friendly and avoids wastage of power. The utilization of energy in better and efficient way is needed, so this pre-paid meter proves to be advantageous in the power sector. There is no control of usage from the consumer's side, this is the major drawback of the post-paid system. A lot of power is wasted by the consumer due to lack of planning of power consumption. Since the supply of power is limited, as a responsible citizen, there is a need to utilize electricity in a better and efficient way. The electricity supply board has to receive huge amounts in the form of pending bills, which leads to revenue losses and also stops the routes to modernization because of lack of funds. The billing system is minimally able to detect power theft and even when it does at the end of the month. Also, the electricity supply board is facing many problems in terms of losses and is unable to track of the changing maximum demand for consumers. The consumer is facing problems like receiving due bills for bills even after paying as well as poor reliability of electricity supply and quality even if bills are paid regularly. The android application developed is a solution for all these problems is i.e. to keep track of the consumers load on a timely basis, which will help assure accurate billing, track maximum demand, and detect online theft. These are all the features to be taken into account for designing an efficient energy billing system. The present system incorporates these features to address the problems faced by both the consumers and the electricity supply board.

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