Automatic cut out two-way energy billing system using power line communication

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--**ABSTRACT**---
There are many problems in distribution, metering and billing processes facing the power distribution utilities and the metering billing processes which are considered complex problems. In Nigeria there are two common types of meter in use. The system Automatic cut out two-way energy billing system using power line communications used for the transfer of data between consumer and utility. The aim of this project is to measure and monitor the electricity consumed by consumers in a locality and transmitting the measured reading between the consumer and electricity provider. The author reviewed other related works on the subject matter the advantages and disadvantages. The design carefully used two units which are linked together using PLC method, one is installed at the provider premises and the other at the user's premises. The block diagram of the two units are shown, the software design on how the system works is illustrated by the flow chart for the provider unit and the user unit. The construction of the hardware and the results of the testing are shown in the pictures 1, 2, 3, 4 and 5. The results shows that the system worked perfectly displaying the reading of the energy parameters and once any attempt to temper, the system automatically cut out the supply to the user
Keywords: *Automatic Meter Reading, Power Line communication, Arduino microcontroller, Electricity provider and user*

I.   INTRODUCTION

There are many problems in distribution, metering and billing processes facing the power distribution utilities and the metering and billing processes are considered complex problems. The existent classical method to retrieve energy meter data and billing is not suitable and time exhaustion where the utility staff must go to each consumer and manually take the reading of that meter then return to the electricity distribution office to issue the bill for each customer. In addition, these collected data from meters would be entered manually to the software billing system for issuing bills. These operations of retrieving data and issuing bills for the in the classical method are suffering many problems. The main problems are the non-existence of the customers sometimes at their houses which leading the meter reader to retry the process of meter reading and sometimes because of the lack of integrity and credibility of some of the meter readers, they do not retry meter reading they estimate the meter reading [1]. There are three basic types of energy meters in use, Electromechanical induction type Energy meter, Electronic Energy meters and the Smart Energy Meters [2]. In Nigeria, the common meters in use are the kilowatt-hour meters (kWA)and the pre-paid meters. The kWA electric meters are situated in houses, offices, and factories, etc. Meter readers go to the place which is generally situated inside the house and take the meter reading. Most of the time the owner gives some extra money to the meter reader person to have less meter reading. As a result, corruptions occur and actual payment is not received by the service provider. So, the provider faces a huge amount of loss in every year. Prepaid electricity is a great solution for many residents. Increasingly residents are getting tired of paying excess electricity bills. By using prepayment, customers pay for their electricity upfront, before they use it. The benefit of this is that you don't have any surprise bills at the end of the month and can budget for your electricity accordingly [3]. Automatic Meter Reading System (AMR) is the remote collection of consumption data from customers' utility like Electric meters using radio frequency, telephony, power-line or satellite communications technologies and process the data to generate the bill. The concept of Power Line Communication is used for the transfer of data between consumer and utility. Power Line Communication uses a high-power line for communication. The data is transmitted at a higher frequency than that of the transmission frequency. The main advantage of this method is that no additional transmission line is required for the transmission of data.

This project is mainly implemented for the purpose of getting a fully automatic electricity billing system. The aim of this project is to measure and monitor the electricity consumed by consumers in a locality

and transmitting the measured reading between the consumer and electricity provider. It also helps in reducing the malpractices of meter bypass by the user and damages of the meter. Using this system, the Electricity provider can access all data regarding the consumed power at each home. The system can monitor the power usage both ways for the service provider and the user.

II.   RELATED WORKS

There are some works covering similar subjects which are discussed here, the design of an automated energy meter reading system using GSM [4] by using a microcontroller based electric energy metering system using the Global System for Mobile communication (GSM) network. This system provides solution to the irregularities posed by the traditional metering technique by allowing the utility provider have access to remote monitoring capabilities, full control over consumer load, and remote power disconnection in the case of energy theft.

Automatic meter reading for electricity using power line communication [6] which they implemented the automatic meter reading using power line communication. It is being used in measuring electricity, gas, water consumption in many countries of the world since it has a lot of advantages that the old analog meters don't have. It has advantages in safety, real time measuring and time saving as well as it has a better user interface and digital data analysis. Data is sent over existing carrier that reduces the complexity and cost of system.

Electrical energy billing system based on smart meter and GSM [1] the system sends a message to the own customer mobile phone which contains the current bill, due bill, and total bill every two months to be paid. In addition, the system can print out a hard copy of the customer bill. Finally, the system has the ability of automatic power outage if the customer refrains or delays for certain time in paying the bills by means of an SMS massage

Automated EB Billing and Supply Control using Power Line Communication [7]in the present scenario power line communication (PLC) is one of the economical ways of communication of data. Even though there are new methods of wireless communication methods, practically it is very much time consuming to install such a system, and also it is highly cost consuming method. But the power lines which already exist and connect every household in a particular area is more advantageous as it does not require any new installation or erection for establishment of communication channels, and thus is not a time consuming one. One biggest advantage of this system is that it can be readily implemented, unlike the other modern methods. The power line network can also be used for creating emergency response networks. The most important feature in this system is the use of digital meters consisting of micro controllers and real time clock, thus eliminating the loss of meter data during power failure.

III.   THE PROPOSED SYSTEM

The proposed system uses the plc for transmitting data between the two units and can display the energy parameter readings at both sides simultaneously, has the ability to sense temper by the user and send signal to provider unit to alarm and disconnect the user automatically. In this way it has advantages over the systems reviewed above because it does not require another medium for communication between the units, it's also has both ends meter reading display and when temper the system disconnect the user immediately, which can just be reconnected by the provider with just a reset button.

IV.   MATERIALS AND METHOD

4.1 Architecture of the system
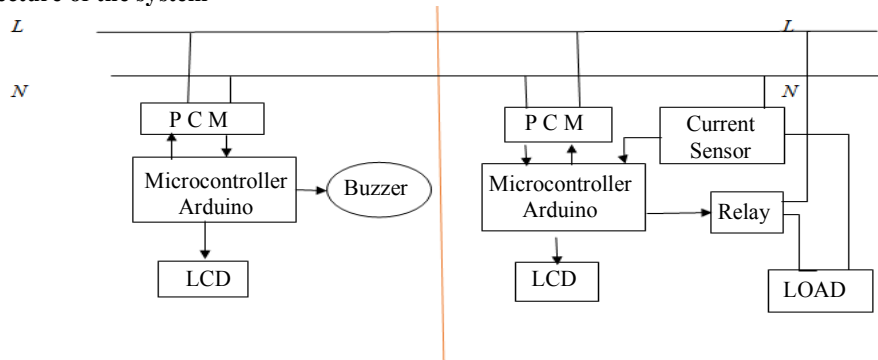
a. Block diagram of the Provider Unit   b. Block diagram of the user Unit
Figure 1 Block of the system

Automatic cut out two-way energy billing system using power line communication being describe in this work consist of two principal units whose block diagram is shown in Fig. 1. The unit at the service provider ends depicted in the block diagram as in Fig. 1a and the unit at the user end as in Fig. 1b.

The unit at the service provider consists of a power communication module (PCM) which take enveloped information demodulate or modulate a signal to the Arduino microcontroller, the signal which is transmitted to the user using the power lines and vis verse. The buzzer is used for alarm when it received tempered message and the liquid crystal display for displaying the parameters. From the user end the current sensor, sense the current between the transmission power line and the load, send it to the Arduino microcontroller. The parameters Current (I), Power (P), Energy Charge (B) and the Bill (B) will be displayed at the LCD and transmit the same to the service provider through the PCM and power lines.
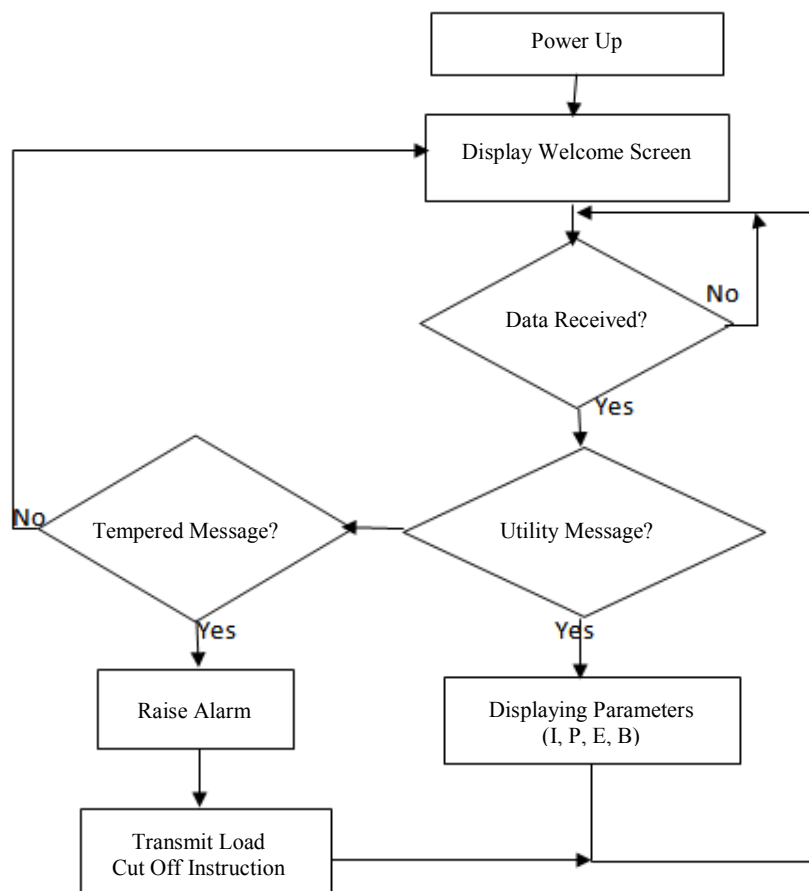
4.2 Software Design

Figure 2. Flowchart for the program of Provider unit

The PCM for the user transmits a serial code to the PCM of the service provider and vice versa when the load is turned on the LCD at the service provider display a welcome message. At the user end when the power is on to the load, the signal is sent to the LCD to display parameters.
i) When power-up, the load is turned on, then display parameters, transmit the same to the service provider, if not tempered with. Otherwise, the system transmits a tempered message to the provider, on receiving action message the system turns off the load if no message is received the system return to display parameters.
ii) At the provider the system displays welcome, if the system does not receive data it goes back, but if utility message is received then the system displays parameters if is tempered massage, the system alarm and then transmit load cut off instruction to the user system.
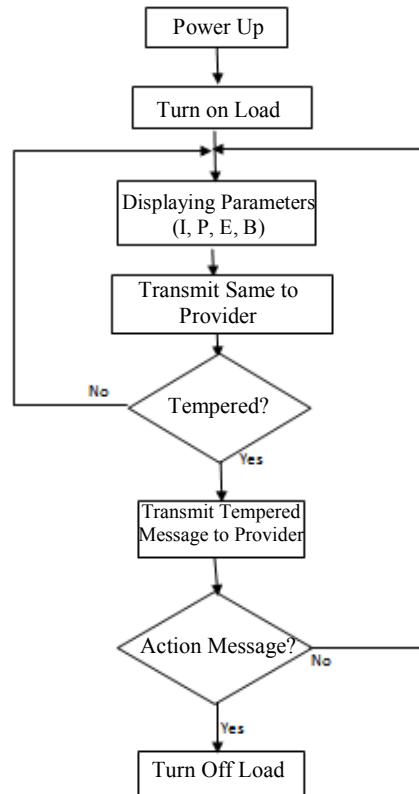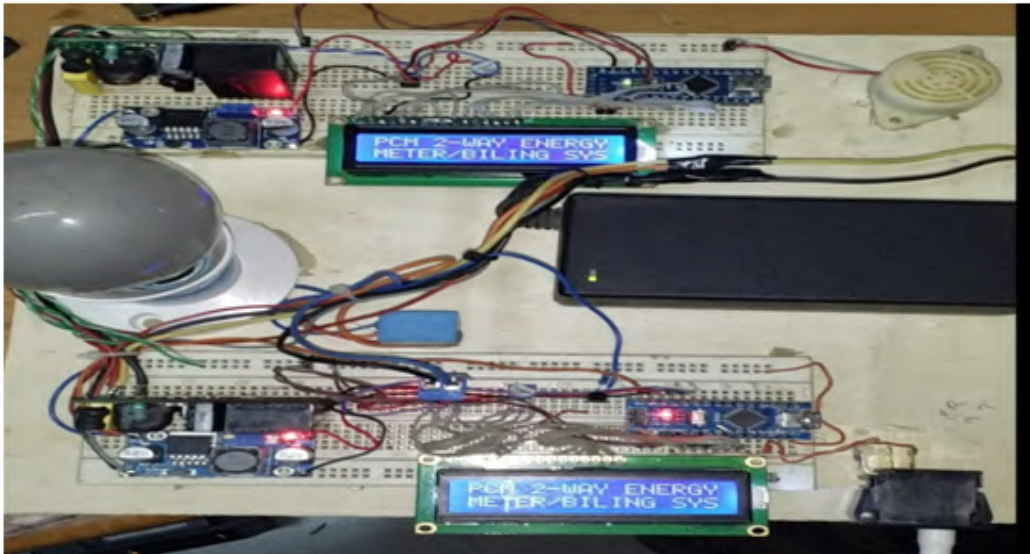
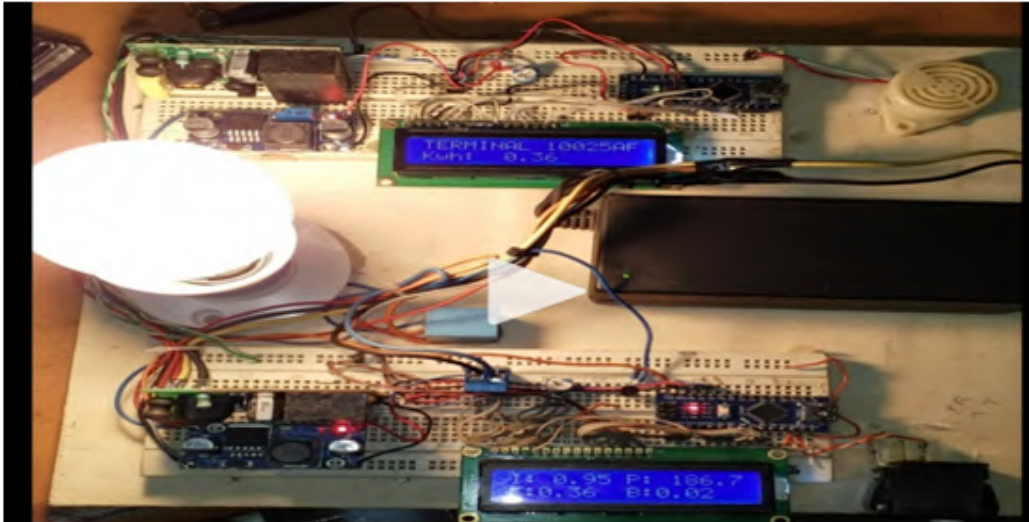**Figure 3. Flowchart for the program of User unit**

4.3 Results and discussion
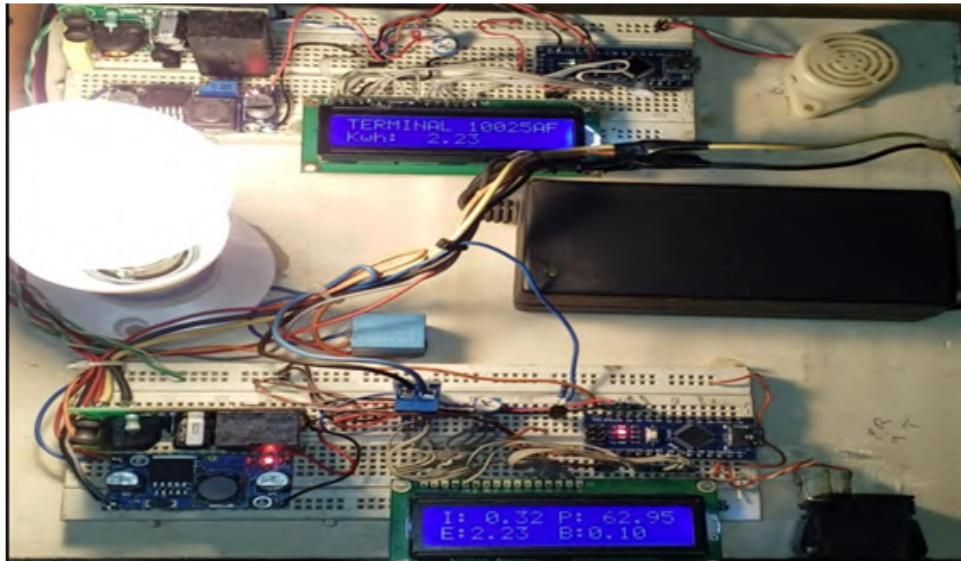
Picture 1

Pic.1 shows welcome message when power is on from the provider, both ends displayed the same message.
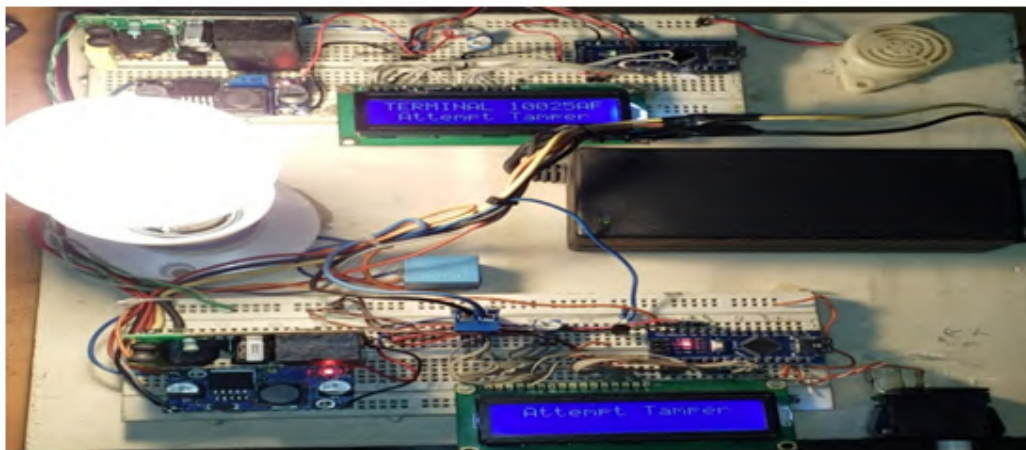
Picture 2

Picture 3

Pict.2 and 3 indicates displaying energy parameters upon receiving Utility message, the provider shows the terminal number and the energy consumed while at the user end it displays the current (I) the power (P), the energy charge (E) and the energy bill (B) which are all calculated using Arduino microcontroller through the current and voltage that is drawn from the current sensor. The calibration is in the unit of electric energy, kilowatt-hour (kWh). Equation 1 shows the mathematical expression for the product of the power consumed and the period of consumption while Equation 2 and 3 express the relationship between power, energy and time.

$P = I*V$ (1)

$E = I*V*t$ (2)

$E = P*t$ (3)

Where; E= Energy in kilowatt-hour, P= Power consumed in kilowatts, t= time in hours [5]. The cost of energy consumed is also set as appropriate.

Picture 4

Pict. 4 indicates an attempt to tamper with the system by the user, an attempt tempered message will be displayed on both the user system and the provider. The system at the provider raised alarm and shut down the supply to the terminal and the light goes off automatically as shownin Pic. 5
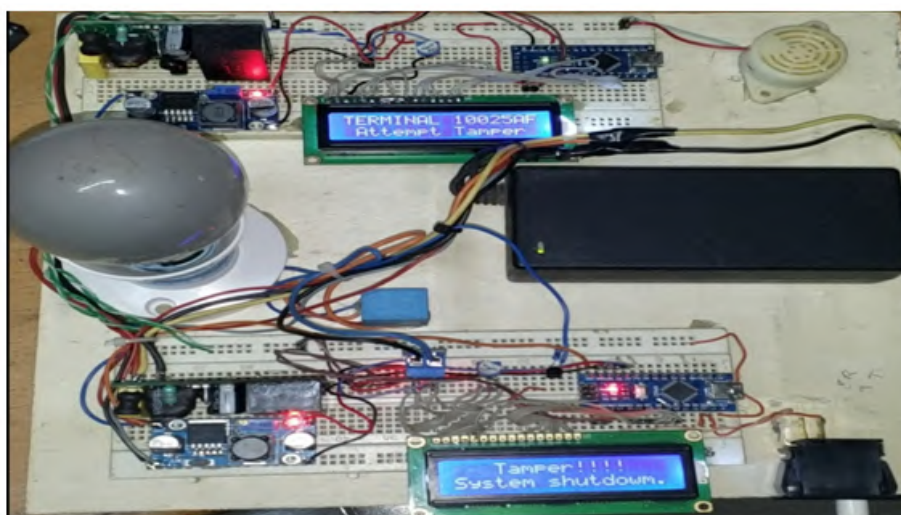
Picture 5

V.   CONCLUSION

The problem of metering and billing is one of the important issue's electricity suffers for a long time in Nigeria and causes loss of much money. The presented system is portable and flexible for practical usage because it is designed to benefit the distribution companies and the electricity consumer. The designed automatic cut out two-way energy billing system using power line communication meter is accurate and suitable for practical usages and not only as prototype device it was tested and it proved its worth and reliability. The results obtained demonstrated its accuracy, flexibility, and the usefulness of the presented system. It should be, however, noted that there are times the system gives an error message but can be reset immediately and it goes back to normal reading. Automation of the customer billing system has been achieved as the meter keeps track of the consumers load on a timely basis. This design, therefore, removes the manual reading of meters with its attached consequences of time-consuming system and bill manipulation which reduces remove generation by utilities while adding higher bills to the consumer.

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