Raspberry Pi 2 based Prepaid Electricity Billing System for Below Poverty

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Abstract— **In this paper, the Raspberry P 2 based prepaid electricity billing system for below poverty in developed. Nowadays the electricity board on behalf of Government, releases a benefits for the below Poverty peoples in India especially. The electricity board on behalf of Government has provided 100 units to poor people a month, but some of the people may consumes more than limited units (100 units) a month. The remaining units consumed by people are bourdons to the electricity board and loss of revenue. The loss is going to reduce by implementing Raspberry Pi 2 based prepaid electricity billing system. After consuming the units presented by board, the power is automatically cutoff by automated.**

Keywords— Raspberry Pi 2 Processor, GSM, Relay, Buzzer, 71M6543F Microcontroller, Current Transformer and mobile Phone.

I. INTRODUCTION

Power plays an important role in the world and also it is very important to control thefting of power. In some of the places, there is no energy meters in houses, some of the people may use power illegally as a result, the electricity board will lose revenue. Now, the Government of India has passed the mandatory rule that the energy meter must install at each house to read consumed units and paid the bill monthly. Now the electricity billing is two types, one is pre-paid and second one is post-paid mostly post paid billing process is done. Now for benefits, the electricity department we proposed and implemented the pre- paid electricity billing process that is to pay the bill before the usage of electricity power. Large companies deals with electricity board by paying the previously, that is the benefit for both (companies as well as the government) [1, 2, 3].

Now the electricity department proposed a new idea and implemented that is pre-paid billing system for below poverty people who had less property. The government gives the 100 units current free for month to the below poverty people, but they used all units within below 30 days and uses more units. For this reason the electricity board will get loss. So to reduce the loss, the pre-paid billing system for below poverty people is developed by using the raspberry pi 2 processor, GSM, Relay, Current Transformer. By interfacing all the components the billing system is developed to stop the current when the consumer consumed more than 100 units. When the units count is down from 100 to 0, the raspberry pi 2 Processor is observed and sends the signals to the buzzer by the relay. Then the count comes to zero then the buzzer gives the alarm and automatically the current also stopped, then the information is send to the consumer mobile and the electricity department by the GSM [4, 5, 6].

The main objective of the present work is the measurement of voltage, current, power, frequency, power factor and units consumed for below poverty by using Raspberry Pi 2 Processor. The Raspberry Pi 2 Processor is ARM Cortex Processor, which is a 32-bit processor. The measurement of voltage, current, power, frequency and units consumed is done with help of energy meter and 71M6543F Microcontroller with high accuracy. The measurement values are sent to Virtual Network Connections (VNC) server with wireless network VNCs are able to display the values from minute to

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minute. The Qt WebPages displays the values from minute to minute with corresponding to the VNC server and adds units from web based by paying an amount in online. The remaining part of the paper is divided into sections as follows. Section II discusses the description of hardware and software and section III gives the experimental results and conclusions are discussed in section IV [7, 8, 9, 10].

II. GENERAL DESCRIPTION OF THE HARDWARE AND SOFTWARE

A. *Hard ware Description*

The main power supply is applied to current transformer through single phase energy meter and it is input to the 71M6543F microcontroller. The 71M6543F micro controller has 22 Bit ADC. The 71M6543F Microcontroller is used to convert analog voltage to digital voltage, because Raspberry Pi 2 Processor accepts only digital values. The suitable software is developed in Raspberry Pi 2 Processor for data processing after receiving the required data from a load through current transformer. Raspberry Pi 2 Processor based Pre-paid electricity billing system for below poverty is designed and tested with known watts of load and the performance of the system is quite satisfactory. This electricity billing system can be enhanced as a remote management system by writing appropriate software [11, 12, 14].

Block diagram

The overall setup is as shown in Figure 1 which consists of Raspberry Pi 2 processor, Relay, Buzzer, GSM Module, 71M6543F microcontroller, current Transformer.

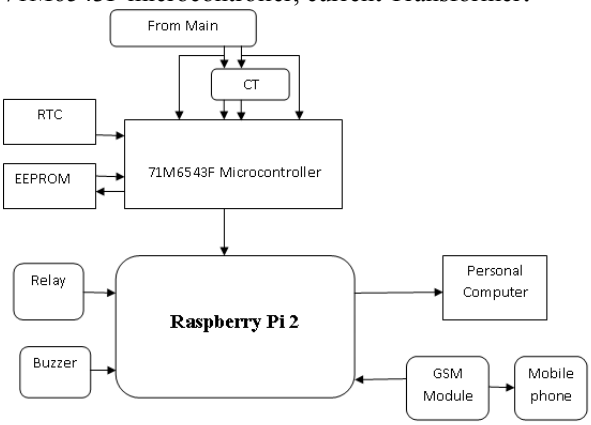


Fig 1: Block diagram of pre-paid energy meter.

A.1. Raspberry Pi 2

Raspberry Pi 2 Model B_+ Processor is a new Processor and it is a 32-bit Linux operating system. The size of the Raspberry pi 2 Processor is Credit size. It is built in ARM cortex-A7, 1GB of RAM (Random Access Memory), 40 GPIO pins, in built Ethernet, which includes an ARM compatible central processing unit (CPU) and an on-chip graphics processing unit. The Broadcom (BCM) 2835 SoC (Single On a chip) used in the first generation Raspberry Pi 2 Processor is somewhat equivalent to the chip used in first generation smart phones and it is also computer functions like as a Ms-offices and Web browsing [13, 15].

A.2. Relay

The Relay is an electromechanical device. It works like as a remote electric switch that either open or closed under the condition of the electrical switch. The current flowing in one circuit sources the either opening or closing of another circuit. This relay is used in many applications because of their relative simplicity, long life, and proven high reliability. In the home, relays are used in washing machines, dishwashers, refrigerators and air-conditioning controls. The operation of the relay of input is electrical and its output is directly mechanical, or vice versa [16].

A.3. Buzzer

A buzzer is an either electronic or mechanical device and it is used to produce sound. This buzzer is developed by Joseph Henry in 1831, which is used in automobiles, household application. It indicates the wronging to alert the condition. Light weight, simple fabricated and low price make it usable in various applications like car/truck reversing indicator, computers, call bells etc. [17].

A.4. GSM Module

GSM is a global system for mobile communication. Its frequency range is 850-1900 MHz. It is a wireless communication system between the Raspberry Pi 2 Processor to Mobile phone and requires a SIM (Subscriber Identity Module) card like as mobile phone to achieve communication with the network. GSM is used to send the alert electricity billing data. By using GSM, the electricity billing data is processed by Raspberry Pi 2 Processor and the data is transferred to the customer [20].

A.5. 71M6543F Microcontroller

71M6543F microcontroller is a 4^{th} generation of polyphaser metering Systems-on-chips (SoCs). It's clock frequency is 5MHz and, 64KB of flash memory, 5KB of RAM, ultra low power process in active, battery modes and 22-bitdelta sigma ADC (analog to digital conversion). It can be programmed with code and data during meter operation [18].

A.6. Current Transformer

Current transformer (CT) is a current sensor and it is used to produce either Alternating Current or Direct Current. It converts a highly accurate, low noise output voltage are directly proportional to the alternating current (AC) or Direct

Current. The Current Transformers is a one type instrument transformer and that is used to convert an alternating current in its secondary winding which is directly proportional to the current measured in its primary [19].

B. Software Description

Raspberry Pi 2 Processor is a new Processor. It has a number of languages to write a program is C, C_{++}, Java, python2 and python3. In this work C++ is used.

C_{++} language: C $_{++}$ is a very powerful programming language compare than C. The abbreviation of OOPS is object oriented programming language. Object Orientation is a concept of dividing the entire system inters of classes and working through its instances and known as objects [10, 11].

Qt Software: Qt software is application software. It is used for developing multi-platform applications and graphical user interfaces. Qt can be used in written C_{++} language and it is used to design WebPages. This language construct introduced in Qt for communication between objects.

The flow chart of prepaid energy meter based electricity billing for below poverty with GSM module authentication using Raspberry Pi 2 Processor and Software are presented in fig 3.

Algorithm

Algorithm is representation of working process of a particular task in terms if theoretical as shown in figure.

Sequence of operation for pre paid energy meter in electricity system:

The following sequence of operation has been followed for controlling the electricity theft of energy meter.

Step 1: Initialize GPIO pins to read or write data on to port.

Step 2: Initialize the Relay, Buzzer, GSM module to prepaid energy meter.

Step 3: To open QT server.

Step 4: To login the client if below poverty customer is automatically to insert the 100 unit of amount in electricity department in first.

Step 5: To display the voltage, current, power, frequency, power factor, unit consumed and balance amount.

Step 6: if check units is below 10 units in below one month to indication of warning using buzzer and send SMS to customer phone number then client pay the amount.

Step 7: The client is not pay amount the entire load will be OFF.

Step 8: After the completion of this month to automatically insert the 100 unit of the amount on below poverty customer.

Flow chart

The flow chart of prepaid electricity meter for below poverty based electricity billing with GSM module authentication using Raspberry Pi 2 processor and Software are presented in Figure 2.

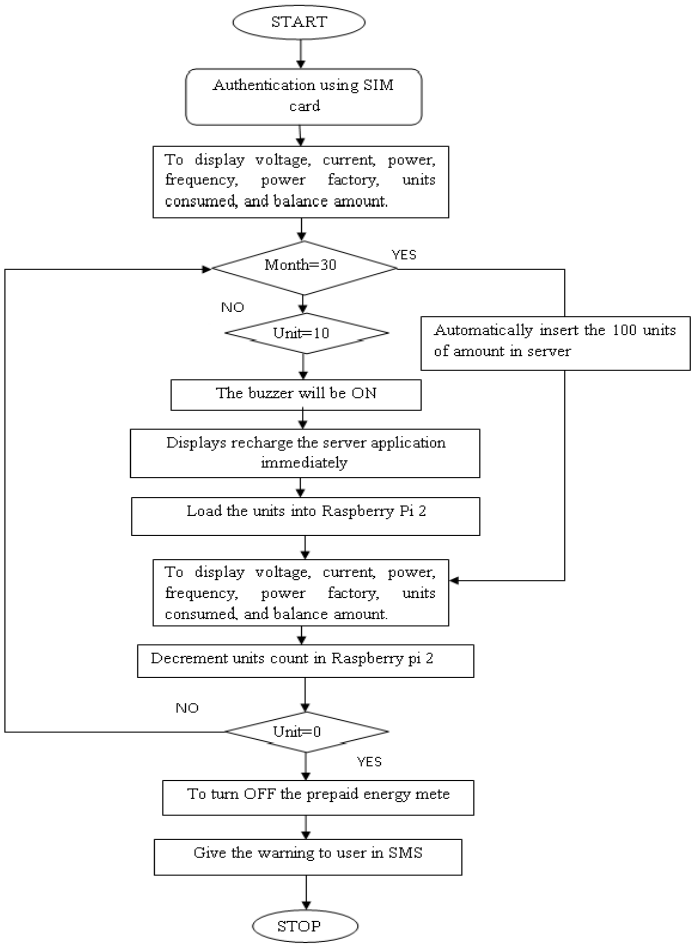


Fig 2: Flowchart of the entire work

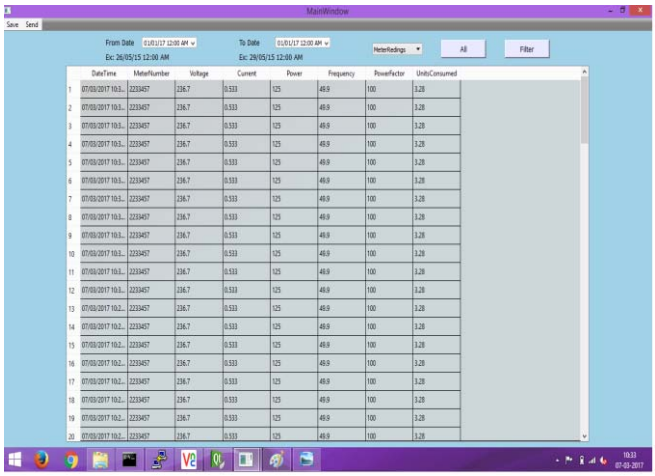
III. EXPERIENTAL SETUP

The design includes an energy meter interfaced to the 71M6543F microcontroller through current transformer. The energy meter will measures the energy consumed and send to the 71M6543F microcontroller ADC port. Here the 71M6543F microcontroller converts the analog value from energy meter into digital values. The measured quantity will give the power consumption, which is given to the Raspberry Pi 2 Processor. Here Raspberry Pi 2 Processor is continuously used to monitor the meter readings for below poverty and gives weekly information about the number of units consumed by the customer and also indicates the price per unit. The information is being sent to the both below poverty customer and electricity department. Some of the state governments providing 100 units/month for below poverty people. The

balance of unites are less than the minimum 10 units limit prescribed by the electricity board on below one month, Raspberry Pi 2 Processor interrupts the relay to disconnect load automatically and no power will be supplied to the house. The buzzer is also attached to the Raspberry Pi 2 Processor through relay to alert the user which indicates low balance of units. In this system the customer was given a unique ID number for every energy meter. This ID number is interlinked to SIM card. GSM module is connected to the Raspberry Pi 2 Processor, which is used to transfer the data of the user meter from Raspberry Pi 2 Processor to remote station by GSM wireless module. The meter reading is stored in database of Raspberry Pi 2 Processor system.

Result obtained from the present development pre-paid energy meter reading system is tabulated below. These current, power, voltage, units consumed are compared with real values which contain 71M6543F Microcontroller, energy meter from load which Research Laboratory setup by the Department of Electronics, Sri Krishnadevaraya University (S. K. U), Ananthapuramu. Good correlation with results obtained the designed system is predictable. From below table 1 it can be observed that the accuracy in prepaid energy meter reading is ±5.

TABLE 1.The voltage, Current, Power, Frequency, Power factor and units consumed in prepaid electricity billing for below poverty



The measured and referenced values of current, power, voltage and units consumed are plotted using Qt software. The graph is shown below. In figure 3 the measured voltage, power, current and units consumed.

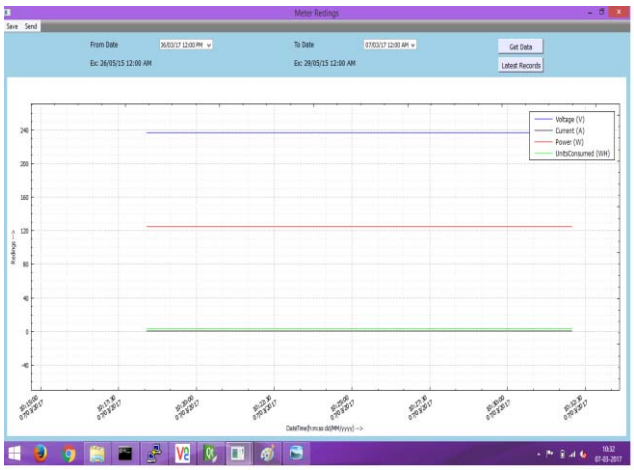


Fig 3: Screen shot of the graph of the values of voltage, current, power and units Consumed

The values of voltage, current, power and units consumed are shown in below. The values of voltage, current, power and units consumed are displayed on the Qt server (personal computer) which has wireless connection. Figure 4 shows the values of voltage, current, power and units Consumed in S. K.U, Ananthapuramu. The overall setup of the work is shown in figure 5. The registration of the below poverty is shown in figure 6. The below poverty customer page and display the values of below poverty depend on load are shown in figure 7 and 8. The SMS alert to the customer is shown in figure 9.

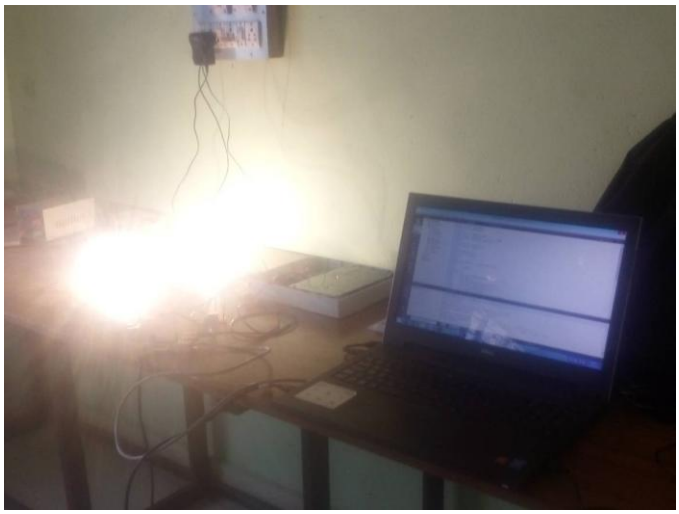


Fig 4: Screen shot of the entire work of prepaid energy meter

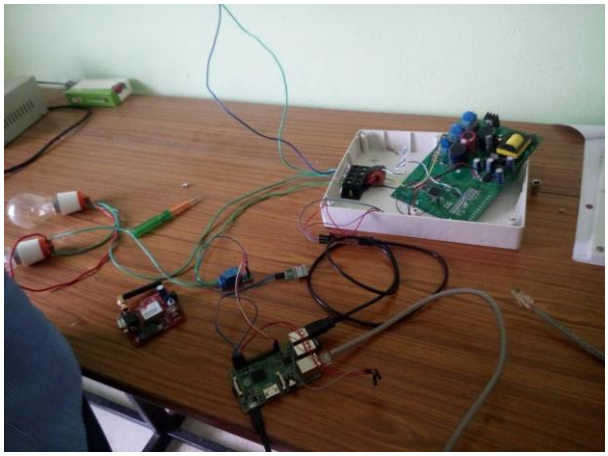


Fig 5: Screen shot of the entire connection of the work

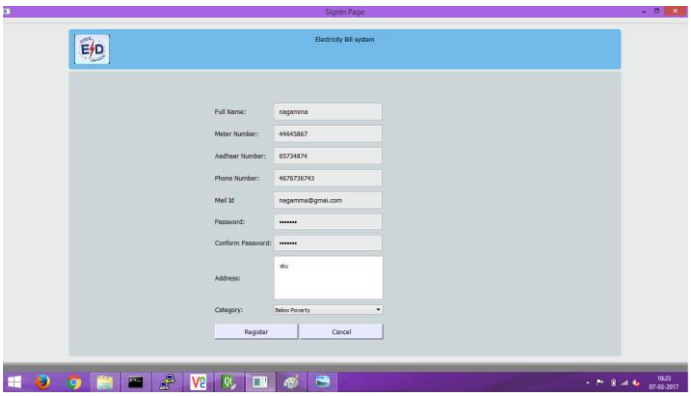


Fig 6: Screen shot of the registration of below poverty

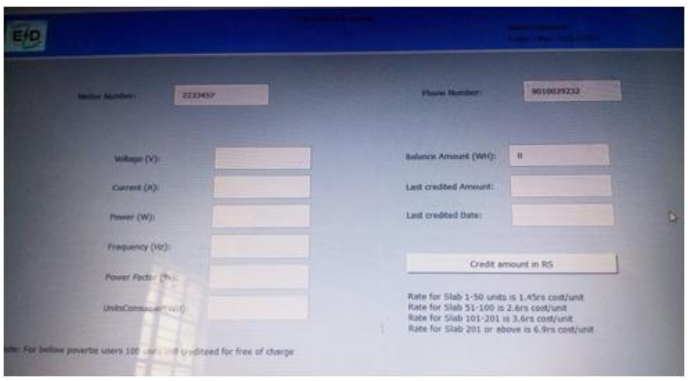


Fig 7: Screen shot of the below poverty customer webpage

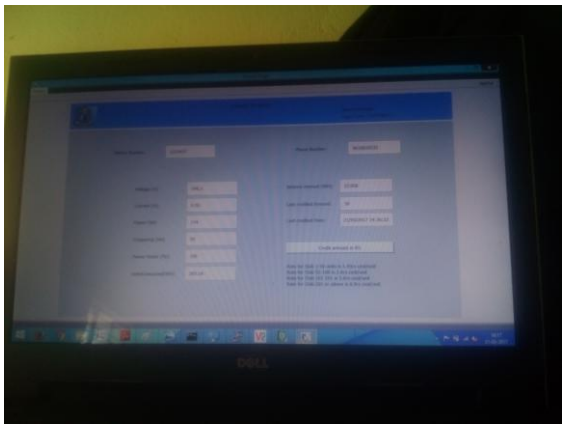
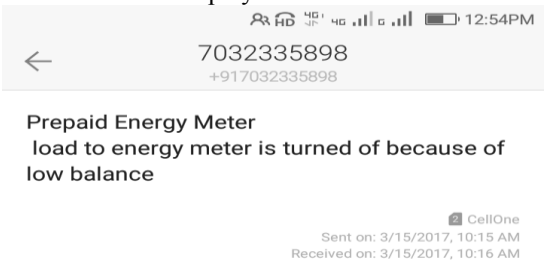


Fig 8: Screen shot of the below poverty customer webpage display the values



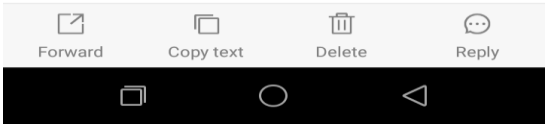


Fig 9: Screen shot of the SMS alert on Mobile phone

IV. CONCLUSION

This automated prepaid electricity meter reading for below poverty is used to measure the current, power, voltage and finally a number of units consumed by the customer is developed using Raspberry Pi 2 Processor; the result obtained and compared the results with another controllers which is available in an Qt webpage server research laboratory in the university campus. Results are more accurate. It controls the usage of electricity on consumer side to avoid wastage of power. The prepaid energy meter reading is designing of a 230v/40A single phase meter reading for household consumers with improved billing facilities and metering to eliminate major drawback of existing energy metering reading

systems. I hope this development meter reading will be very useful for the power utilities in our country since house population who uses traditional energy meter reading because improvement in the existing energy meter reading is more inexpensive than replacing them fully with a prepaid energy meter reading. Prepaid energy meter reading is a concept to minimize the electricity theft with a cost efficient manner. The consumer can utilize the power precisely and the Burdon of payment of bill also reduces. Users can pay the amount what they consumed accordingly. The manpower decreases and also improves efficiency by this automated prepaid electricity billing system for below poverty and reduces problems associated with billing consumers living in isolated areas. This meter is more reliable and user friendly.

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