Design and Development of Raspberry Pi based System for Prepaid Electricity Meter

T.Narmada[1]
Research Scholar, Dept. of Electronics
Sri Krishnadevaraya University
Andhra Pradesh, India
tammineninarmada@gmail.com

Dr.M.V.Lakshmaiah[2]
Head of the Dept. of Physics/Electronics
Sri Krishnadevaraya University
Andhra Pradesh, India
drmvl2009@gmail.com

N.N.Nagamma[3]
Research Scholar, Dept. of Electronics
Sri Krishnadevaraya University
Andhra Pradesh, India
nagamallinagammannn@gmail.com

Abstract— **In this paper proposes, Raspberry Pi Processor based electricity billing system for above and below poverty is developed of household in real-time. Now a days the electricity board on behalf of Government, releases a benefits for the below and above poverty peoples in India especially. This work is more benefits of Government in India. The Aadhar card is based in customer is either above or below poverty and to improve the loss of government in Electricity billing system using Raspberry Pi Processor. The customer is consuming the units by electricity board, if the low balance to indicate wrong and automatically cut-off the load. This experimental setup is successfully complete using Qt software in research Laboratory setup by the Department of Electronics, Sri Krishnadevaraya University, Ananthapuramu.**

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 hours, some of the people may use power illegally as a result, the electricity board will looses 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. In prepaid electricity billing system process initially, the customer will pay the amount for required units and then they use electric power at their respective house. The prepaid Raspberry pi 2 Processor automated electricity billing system improves the economy of Electricity board and indirectly the economy of India. The Raspberry pi 2 Processor based automated prepaid electricity billing system for above and below poverty is the best suitable to introduce at each customer's house or at least at major companies in India so that the economy of each State in India improves.

Raspberry Pi 2 Processor based prepaid electricity billing meter is used to monitor household electrical appliances in real time. This automated prepaid electricity billing meter for above and below poverty (for all customer) is used to measure the current, power, voltage, frequency, power factor, finally a number of units consumed, balance amount, last credited amount and last credited data by the customer. Statistical analysis has been studied for previous years with electricity board that in most of the cases the electricity board is getting a loss because of post-paid electricity billing system. If prepaid electricity billing system is introduced at each customer house, the revenue of electricity board increases rapidly and also the burden of the electricity bill reduced for the customers so that indirectly customer's income also increases. In this work customer are two types, one is above poverty and below poverty.

Resent some state of the Government is announced to give the 100 units of the free current for below poverty. The below poverty is complete 100 units of current in below of the month and uses more units of current. This process is more loss of Electricity Board. The above poverty is paid then given a unit of the relevant paying amount. The both of the poverty conditions is checked to indicate the warning on the buzzer and send SMS using GSM. The above both of the poverty based to developed in Prepaid electricity billing using Raspberry pi 2.

The main objective of the present work is the measurement of voltage, current, power, frequency, power factor and units consumed for below and above poverty based 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 minute. Qt server is a server and this process to pay the

978-1-5386-0814-2/17/$31.00 ©2017 IEEE

amount. The remaining part of the paper is separate into sections as follows. Section II discusses the description of hardware and software and section III gives the experimental setup and conclusions are discussed in section IV.

II. GENERAL DESCRIPTION OF THE HARDWARE AND SOFTWARE

A. 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.

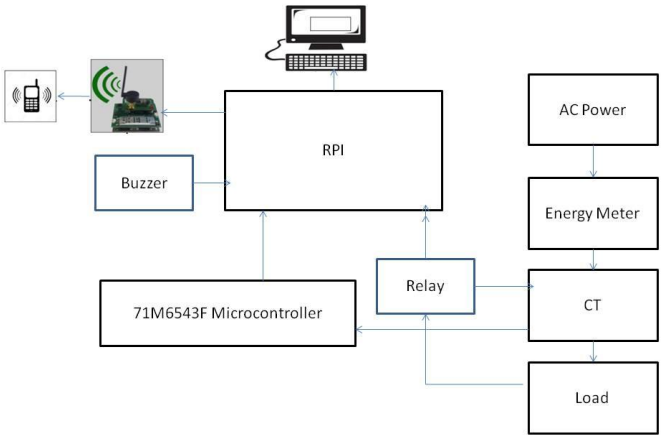

Fig 1: Block diagram of pre-paid electricity billing

B. Hard ware Description

The main power supply is applied to the current sensor through energy meter and it is input to the 71M6543F microcontroller. The 71M6543F micro controller has 22 Bit ADC inbuilt. The Microcontroller is used to convert analog voltage to digital values, 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 the current sensor. Raspberry Pi 2 Processor based Pre-paid electricity billing system for below poverty and above poverty (for all customers) is designed and tested with known watts of load and the performance of the system is quite acceptable. This system can be enhanced as a remote management system by writing appropriate C++ and Qt softwares [1, 2].

B.1. *Raspberry Pi:*

Raspberry pi Processor is a 32-bit Processor and it is Linux operating system. The Raspberry Pi Processor (2835) consists of a model B+. It is a small credit size computer system. RAM size of Raspberry Pi Processor Model B+ is 1GB of RAM and a 900MHz quad-core ARM cortex-A7 CPU (Central Processing Unit). It is 40 GPIO pins. It can be masked anywhere, behind television sets, within walls. It produces a high interpretation. It provides basic computer functions like word processing, web browsing etc[5].

B.2. *Relay*

A relay is an electrical switch that opens and closes under the control electrical circuit condition. In the original form, the switch is worked by an electromagnet which is used to open or close one or many sets of contacts. A relay is able to control an output [6].

B.3. Buzzer

A buzzer is a electronic device. It indicates signaling device, which is used in automobiles, household application. Nowadays, it is trendier to use a ceramic-based piezoelectric sounder which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound on and off. It indicates the wronging to alert the condition [7].

B.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.

B.5. 71M6543F Microcontroller

71M6543F microcontroller is a 4th generation of polyphaser metering Systems-on-chips (SoCs). It's clock frequency is 5MHz and RAM is 5KB, ultra low power process in active, battery modes, 64KB of flash memory and 22-bitdelta sigma ADC (analog to digital conversion). It can be programmed with code and data during meter operation [8].

B.6. Current Transformer

Current transformer (CT) is a current sensor and it is used to produce either Alternating Current or Direct Current. It converts an 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 [9].

C. 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++ and Qt are used.

C ++ is a very powerful programming language and it is superset of 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 it's instances and known as objects [10, 11].

Qt software: Qt is a Quasar Toolbox. It is a application software and to design a webpage. Qt uses standard C++ with extensions including signals and slots that simplify handling of events, and this helps in development of both GUI (Graphical User Interface) and server applications which receive their own set of event information and should process them accordingly.

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

Flow Chart:

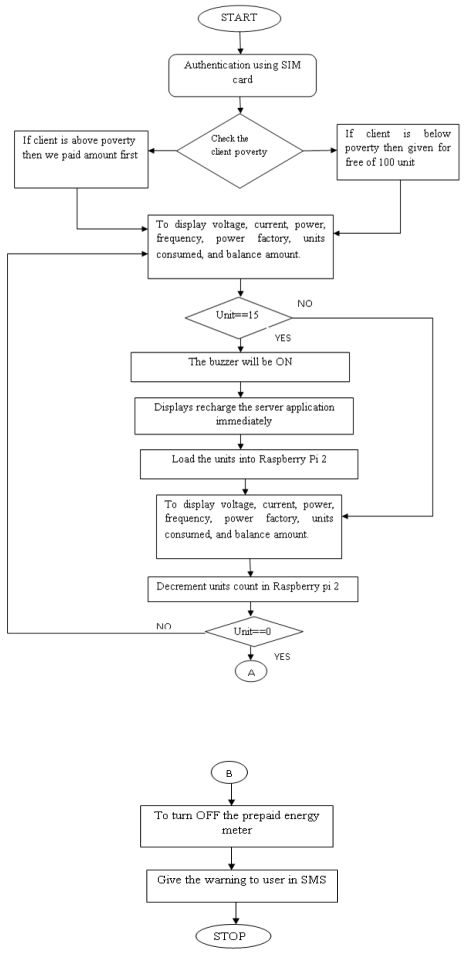

Fig 2: Flow chart of prepaid energy meter

Algorithm

Algorithm is a representation of working process of a particular task in terms if theoretical as shown in fig 2.

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 in electricity department.

Step 3: To open QT server.

Step 4: To login the client if client is above poverty to pay the amount in electricity department first.

Step 5: The client is below poverty governments given 100 units of power free for month after completion of 100 units below one month to indicate warning then below poverty to pay amount.

Step 6: To display the voltage, current, power, frequency, power factor, unit consumed and balance amount.

Step 7: if check units is below 15 units indication of warning using buzzer and send SMS to client phone number then client has to pay the amount.

Step 8: If the client does not pay the amount the entire load will be cut OFF.

III. Experimental Setup

The design includes an energy meter interfaced to the 71M6543F microcontroller through current sensor. The energy meter will measure the energy consumed and sends it to the 71M6543F microcontroller ADC (analog to digital conversion) port. Here the microcontroller converts the analog value from energy meter into digital values. The measured quantity will give the power consumption value, which is given to the Raspberry Pi 2 Processor. Here Raspberry Pi 2 Processor is continuously used to monitor the meter reading and gives monthly 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 customer and electricity department. When the balance of units are less than the minimum limit prescribed by the electricity board, 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, balance amount, last credited amount and last credited data 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.

The overall setup of the work photograph is shown in below fig 3

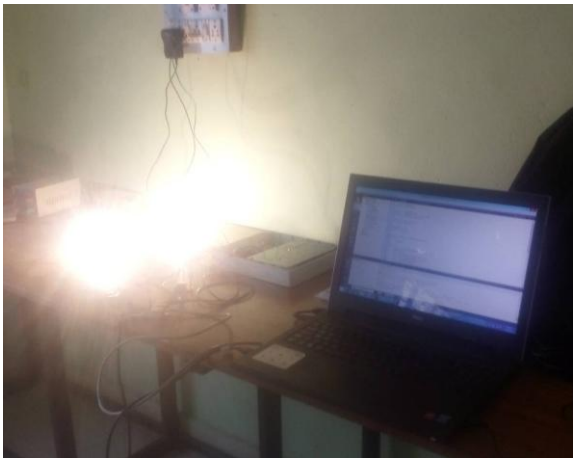

Fig 3: Screen shot of the entire work of prepaid energy meter

Open the Qt Server then go to click headers to display number of files to open. To click homepage.h and click the run option then build it as shown in fig 4.

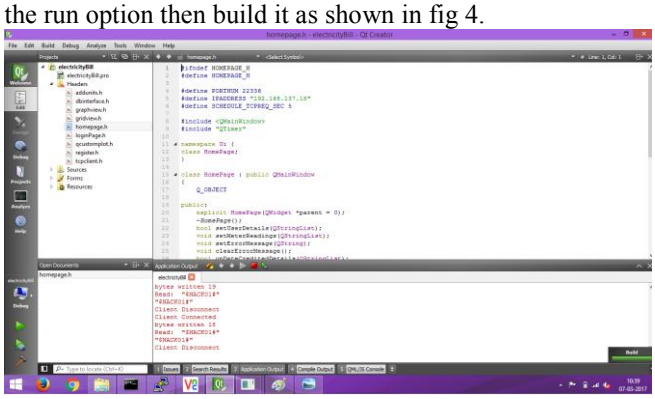

Fig 4: Execution of QT program screen shot

If already paid load will be on as shown in fig 5. If above poverty persons first pay the amount otherwise buzzer will be on to indication of it is low balance and message will be sent to mobile number as balance amount is low, please recharge immediately. If the below poverty person the Government is already announced 100 units of free current. After completion of these units then the buzzer will indicate and message will be sent to the phone of that below poverty individual stating that he should immediately recharge otherwise the power will be cut.

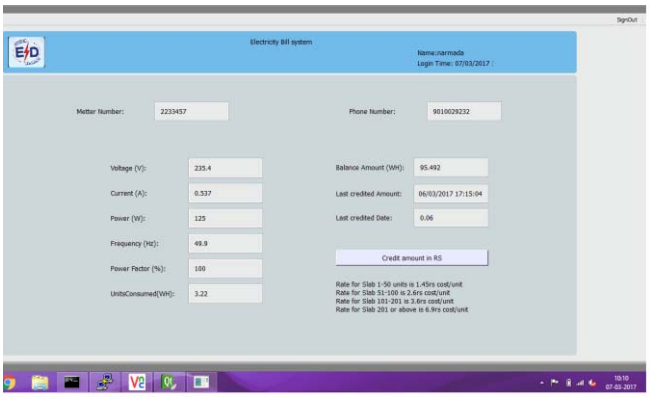

Fig 5: Enter result of values showing in screen shot

If any low balance click the Credit amount as shown in the enter process are the fig 6.

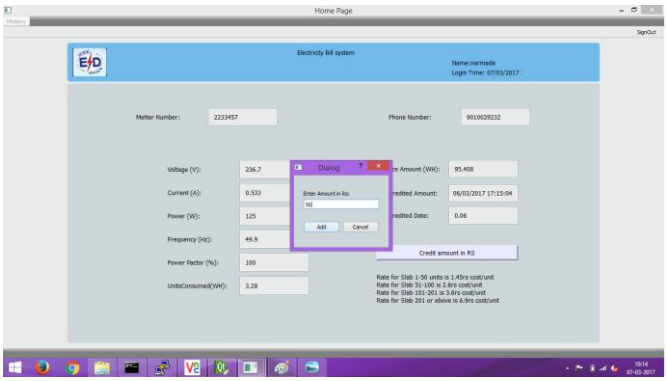

Fig 6: Adding the amount in screen shot

The entire value display in table with timing as shown in table and graphics as shown in fig 7 and 8 Graphics and tables gives below display the day and timing of the values.

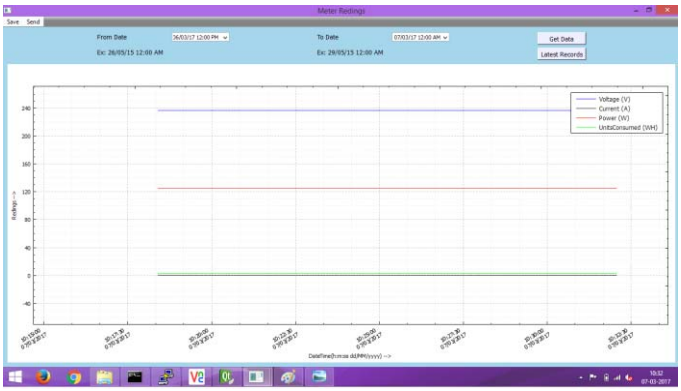

Fig 7: Graphics of these values

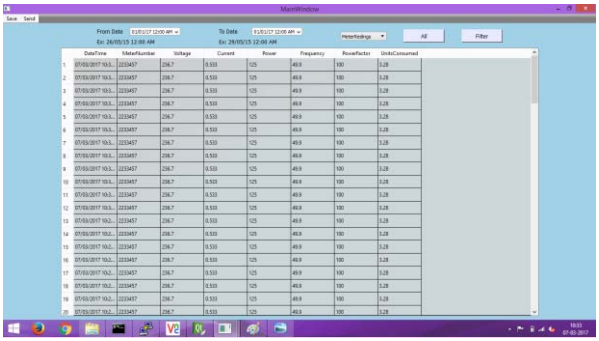

Fig 8: The entire values in Tables

The wrong SMS in our mobile phone for low balance of the electricity billing is shown in fig 9.

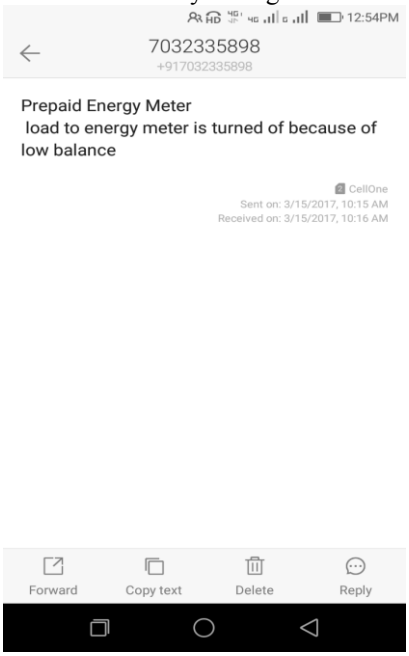

Fig 9: Screen shot of the SMS from GSM module for low balance

IV. CONCLUSION

The present work is focused on the development of energy meter based on prepaid electricity billing (above poverty and below poverty) to avoid the electricity theft, to reduce the human efforts and time. The present developed system is tested and observed that it is working successfully. This system not only reduces the labour cost but also increase meter reading accuracy and saves huge amount of time. This work can be eliminated completely and speed of service is increased.

References

[1] Nabil Mohammad, et.al, "A smart prepaid energy metering system to control electricity theft", IEEE xplore Digital Library.

[2] M.Wassim Raad, " A smart Card Based Prepaid Electricity system", IEEE xplore Digital Library.

[3] Luo Yonggang,"The design of Prepayment Energy Meter ", IEEE xplore Digital Library.

[4] Kosukegawa M., Sakumoto Y. "Traceability system of electric energy standard and tendency in static watthour meter development in Japan. " Sixth International Conference on Metering Apparatus and Tariffs for Electricity Supply, 1990, 4:259-263.

[5] Uwe Hansmann, Lothar Merk, Martin S. Nicklous and Thomas Stober, Pervasive Computing, Springer 2001.

[6] T. B. Smith, "Electricity theft: a comparative analysis," Elsevier Journal Energy Policy, Vol. 32, no. 18, pp. 2067-2076, Dec. 2004. (Pubitemid 40180697)

[7] Brundha, "GSM based Automatic Meter Reading System Using Raspberry Pi Controller",IJSR, ISSN:2319-7064.

[8] Manan Bothra, et.al,"Simulation of PrepaidEnergy Meter on MATLAB",IJAEEE, ISSN:2319-1112.

[9] Gunda Srikanth, et.al,"Automated Electric Meter Reading and Monitoring System Using Zigbee-Integrated Raspberry Pi Single Board Computer via Ethernet",IJSETR, Vol.04, Issue.3, ISSN:2319-8885.

[10] Sneha Salunkhe, et.al, "Raspberry Pi based automatic meter reading", IJAIEM, Vol.5, Issue 9, September 2016, ISSN:2319-4847.

[11] Dinesh Thanth,, et.al,"Wi-Fi based smart energy meter", IJRCCT, Vol 4, Issue 4, April-2015, ISSN (online)2278-5841.

[12] Hamid Hussain Hadwan, et.al, "Smart Home Control by using Raspberry Pi and Arduino UNO ", IJARCCE, Vol.5, Issue 4, April 2016, ISSN (online) 2278-1021.

[13] Subhasimaitra, "Embedded energy meter" A new concept to measure the energy consumed by consumer and to pay the bill, Power systemTechnology and IEEE Power India conference 2008.

[14] Priyakamble, SonaliBodkhe A new approach for the design and implementation of AMR in smart meter, International journal of advanced engineering sciences and Technology.

.