Development of Power Monitoring and Analysis System based on Web Server

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***Abstract*—Electrical systems are necessary in each kind of field such as factories, hospitals, homes and so on. The need for increased power monitoring and analysis system in residential and commercial units is becoming important to protect electrical appliances from damage with over voltage/current and save electricity. As a solution power monitoring and analysis system has developed with purpose of monitoring power continuously to prevent any fault that can affect the electrical device making heat loss, power loss, damaging and provide an instant alarming if anomalous values are revealed. The main aim of the project is to develop remote power monitoring system based on web server using Raspberry pi board consisting ARM11 processor and a Real Time Operating System. It monitors the current and voltages being consumed and sends the data over GPRS to the centralized server. The server collects the data, stores it in database and uses it for analysis. Web server supports the Web page user interface, thus allowing the user to easily control, analyze and monitor the electric appliances.**

***Index Terms*—Power Monitoring, Raspberry pi, Web Server, GPRS.**

I. INTRODUCTION

Power quality is an issue that is becoming increasingly important to electricity consumers at all levels of usage. Sensitive equipment and non-linear loads are commonplace in both the industrial and the domestic environment. The problems about power quality have increasingly caused a failure or a malfunction of the end user equipment for the past few years up to now. The problems have concerned with either voltage or current frequency deviation. Industrial processes differ in their requirements, from a power quality perspective, each having particular `weaknesses' in terms of power quality attributes. The important power quality considerations to be accounted for to the industrial end-user center around costs associated with machine down-time, clean-up costs, and product quality and equipment failure.

To reduce effects of poor power quality power monitoring should be done flowingly and completely. The measurement takes an important role on voltage, current, frequency, harmonic distortion and waveforms which are the basic parameters of power quality. The effects of poor power quality are actively present in the industrial and domestic sector. And this issue led a lot of financial loss also.

Many methods of power quality measurement are available like using various protocols to control the system, data acquisition based on PC or Power Line Communication or TMS320CV5416 DSP Processor; another has applied ARM and DSP processor or has only applied DSP processor to monitoring power quality in real time. These methods are not efficient as we required. Thus the ultimate motivation arose with a desire of mitigate the effect of poor power quality that could lead strong power system. So proposed system has developed power monitoring and analysis system via GPRS modem based on the embedded system with the ARM11 processor embedded into raspberry pi board. Through Web Server System we can connect any electronic device to web server and can get the real time data of devices.

II. SYSTEM ARCHITECTURE

The proposed system is divided into two parts viz. Power monitoring system and centralized embedded server. The power monitoring and analysis is equipped with ARM Processor based embedded system monitoring the current and voltage being used by equipment (load) all the time. The collected data is sent over GPRS network in real time to the server. The server keeps all the data in database and uses it for further actions like notification for any abnormal operation, power failure etc. Through Web Server System we can connect any electronic device to web server and can get the real time data of devices through the web pages released by the server.

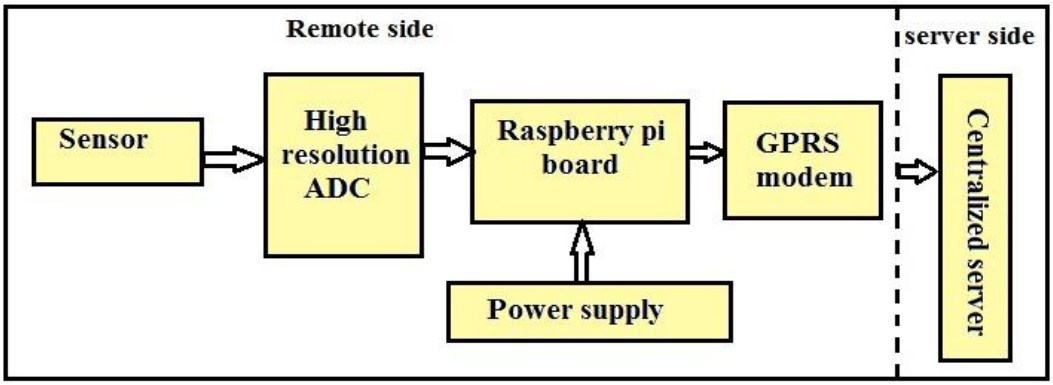


Fig1. System architecture of power monitoring system using GPRS

Fig. shows the system architecture of Power monitoring and analysis system using web server. System runs on a separate power supply independent of the target equipment. For our system, we need sensor to monitor power. We have used current transformer sensor for measure power. The sensors sense the respective quantities and send it to different channels of the ADC. It is capable of sensing the various parameters, their conversion in shortest possible time and sends it over GPRS network. It ensures the real time monitoring and any abnormality in target system's function is reflected. For ensuring the accuracy, high resolution ADC is preferred over traditional 8 bit ADCs. Here ADS7841 has used which is 12 bit 4 channels ADC.

A GPRS is a best medium for communication between two systems over large distance with accuracy and uninterrupted communication feature. Other wireless communication protocols like Zigbee, RF communication etc. are bounded by distance limits. A GPRS can provide unlimited connectivity, sufficient baud rate and reliable communication in a cost effective way. Also it has been adopted by several mobile remote control/access systems. A central server is based on an application which extracts the data from TCP/IP protocol, sent by the power monitoring agents. The entire communication system is based on TCP/IP protocol which is a standard adopted by almost all the systems. It provides a static link between monitoring system and central server based on IP addresses. For more number of agents, addressing may be done dynamically but not recommended over the static one.

III. IMPLEMENTATION

A. Hardware Design

The Raspberry Pi is a low cost single-board, credit card sized Linux computer. It is developed by the Raspberry Pi Foundation in the UK. It is controlled by a modified version of Debian Linux optimized for the ARM architecture. It has two models model A and model B. The Model B has 512 MB RAM, BCM2385 ARM11, 700 Mhz System on chip processor.The Raspberry Pi is connected with the ADC that will be in turn connected to the various sensors. The sensors will have an analog output which can be converted into digital with the help of ADC. The ADC is connected with the Raspberry Pi through SPI configuration. The ADC used here is ADS7841 that is 12 bit 4 channels ADC.

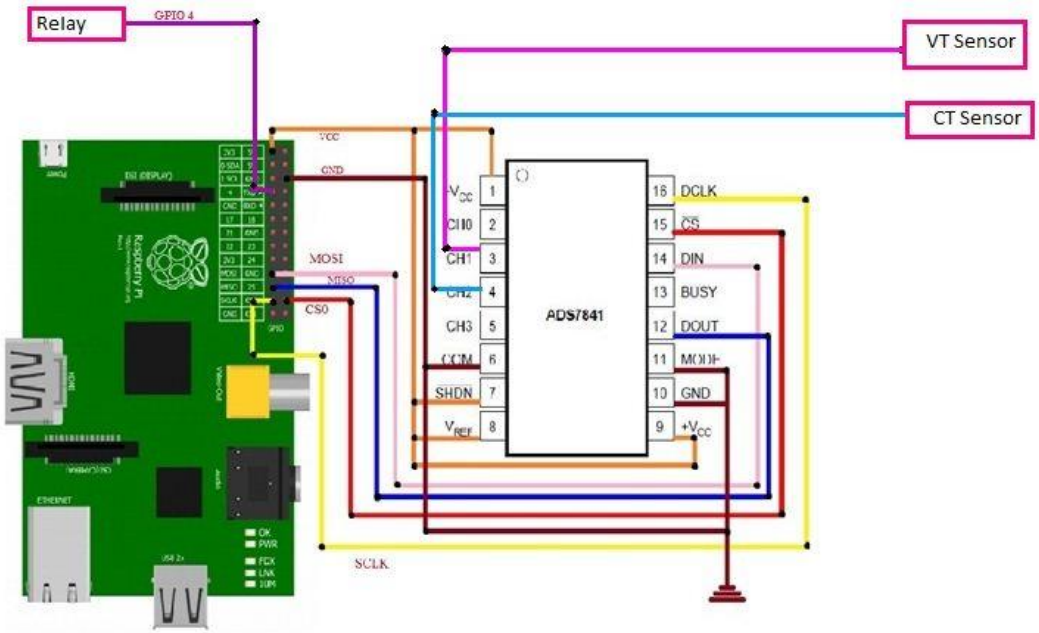


Fig 2. Hardware Configuration

The current and voltage are measured using Current Transformer sensor and Voltage Transformer sensor. Using these sensors, continous monitoring of voltage and current is carried out. The result of monitoring is saved automatically in a pdf format at regular interval.

If the readings exceed the normal limit, an automatic control system is designed that will invoke the relay. The relay is connected to the device whose current is being monitored. Whenever the result exceeds a certain limit, relay will cut off the connection with the hardware device connected to it.

B. Software Design

In this system, the user interface is designed by QT Creator. Qt/Embedded is developed by Trolletch Company in Netherlands for embedded systems. It is popular GUI that is mainly used in embedded Linux. It is easy to transplant to Linux as well as Microsoft Windows. A friendly man machine system is very important for monitoring system. Using QT Creator, the man machine interface looks much sophisticated and easy for monitoring the voltage and current of any system.

The GUI is designed to display the desired sensors results in a graphical format. This means that the monitoring is achieved in real time. As the sensors data is updated, the changes can be immediately seen on the graph in real time. The graph will update itself and add the latest results continuously. Various power related parameters are calculated and displayed on the screen. As well as stored in a text file. The text file consists of the readings of voltage and current and all the related parameters calculated in numerical format. The real time graph is stored in a PDF format.

C. Development of Web based system

The parameters sent over GPRS network are collected by centralized server on real time basis. The server application is developed using Qt creator. The server extracts data received from GPRS through TCP/IP protocol using a static IP address. Each power monitoring system agent's IP address is provided to the server for continuous monitoring. Web server continuously collects the data and stores on real time basis. This stored data is used for further analysis.

IV. IMPLEMENTATION RESULTS.

Fig. 3 is the GUI result obtained when the current sensor is connected with a 100W bulb. And the voltage transformer sensor is measuring the input voltage.

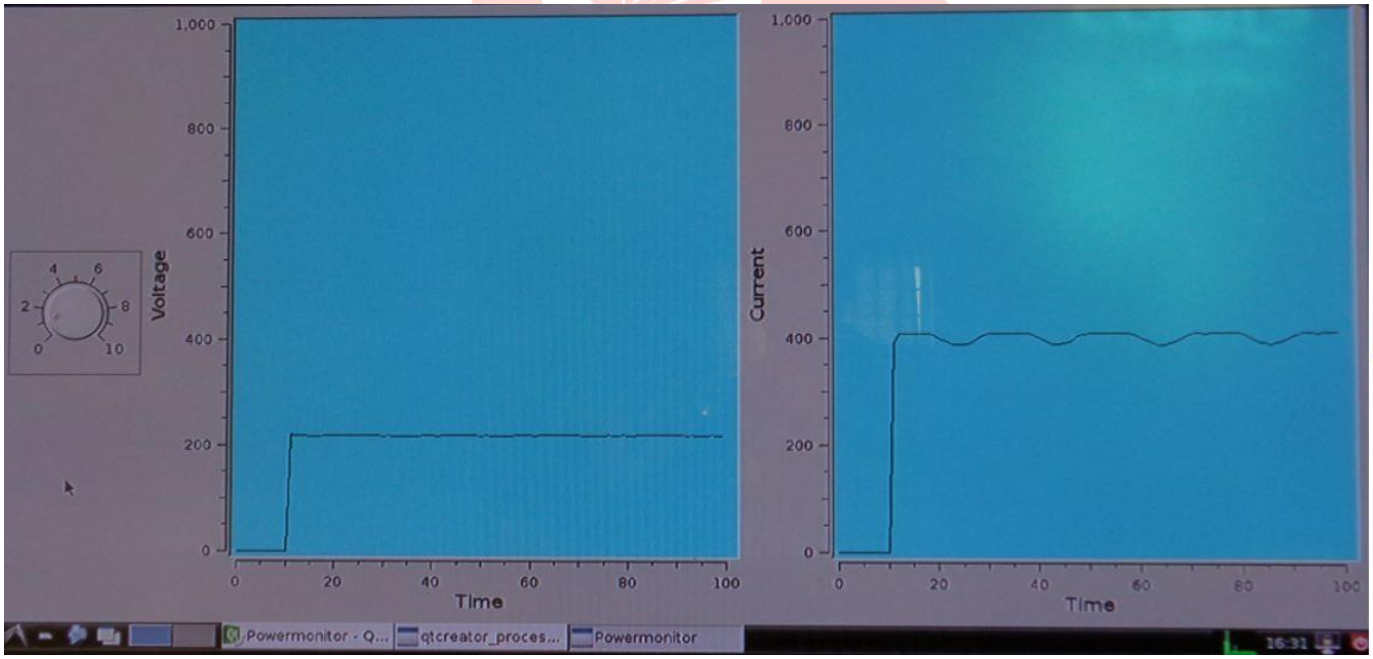
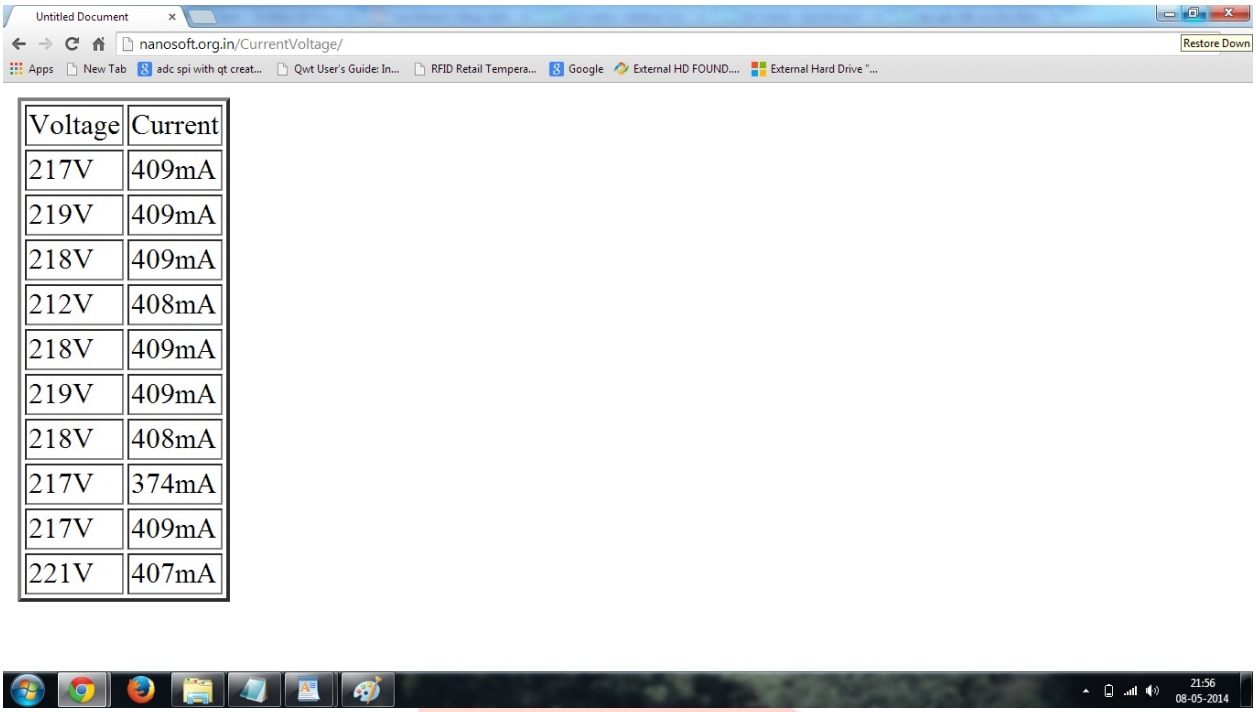


Fig 3. Real time power monitoring graph

- Following figure shows power monitoring with web server. Server provides continuous monitoring and stores the data for analysis.



Voltage	Current
217V	409mA
219V	409mA
218V	409mA
212V	408mA
218V	409mA
219V	409mA
218V	408mA
217V	374mA
217V	409mA
221V	407mA

Fig 4. Power monitoring using web server

V.CONCLUSION

Poor Power Quality can be described as any event related to the electrical network that ultimately results in a financial loss and equipment failure. So it is necessary to reduce poor power quality effects. With high resolution ADC and reliable GPRS communication medium, the system provides a good medium to monitor and keep track of power used by remote equipment. And with automatic control capability we can protect the device from damage. The proposed system provides 3G speed using USB GPRS. It results in a reliable system for monitoring. Through Web Server System we can connect any electronic device to web server and can get the real time data of devices through the web pages released by the server.

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