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Remote Monitoring Of Power Quality Analyzer with Cost Effective Web Server Module

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ABSTRACT: The Power quality analyzer node (PQA) will measure different power quality parameters. These parameters are used to monitor devices of production or manufacturing industries. The power quality parameters are sag/swell, transient, frequency, harmonics, voltage imbalance etc. If the industrial devices is subjected to irregular voltage or any other power quality issues it will reduce the life time of the devices, so continuous monitoring of these parameters are necessary. The power quality analyzer node will measure different power quality parameters and provide instantaneous data. In the proposed system the remote monitoring of this data is achieved through cost effective web server module. The power quality analyzer node and web server module communicate through Modbus Remote Terminal Unit protocol (RTU) and store the data in database. The configuration parameters can be given by users from the website to view necessary data. Then the data is efficiently retrieved from database and displayed in webpage for the authenticated users.

KEYWORDS: Modbus RTU protocol, ATmega328P, Ethernet Shield, Transceiver

I.INTRODUCTION

The different power quality parameters are measured by power quality analyzer node [1]. The existing PQA works in standalone mode, displays data in alphanumeric display and it can be interfaced to building energy management system through costly i.Lon Smart Server for remote monitoring. To improve the user friendliness and to reduce the cost, advanced power quality analyzer node including modern technology has been developed. The advanced power quality analyzer node can work in standalone with self-graphical display and capable of displaying in multiple pages like text, graph and bar chart. Remote monitoring/Web publishing is achieved using cost effective web server module [7]. In Modbus RTU communication PQA node will act as a slave and microcontroller ATmega328P will act as master [3]. Interfacing between PQA and microcontroller is done using transceiver. Web monitoring of power quality analyzer helps to identify power quality disturbances, to take corrective measures to maintain the costly equipment. For efficient data storage and reporting of parameters, database is essential [5]. To view the database details modern technology of web application framework, PHP, jQuery, CSS and Html is used. PHP is used for server side programming, session handling, to retrieve data from database and to dynamically update data in webpage. The data is plotted in graph which helps to identify the variation in parameters easily [8].

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II.RELATED WORK

1. **ChenthamaraiSelvam, Kota Srinivas, G.S.Ayyappan, M. VenkatachalaSarma[1]**, power quality analyzer has been developed as part of advance metering for smart grid implementation. The power quality analyzer measures different power quality parameters along with the basic electrical parameters. These parameters are displayed in Liquid Crystal Display (LCD). It works in standalone mode. The parameters are published in internet using costly internet server.
2. **Yu-congKuang [3]**-This paper explains the communication between the Arduino and PLC using Modbus RTU protocol. They establish a master/ slave communication. The frame structure, functions of Modbus RTU is discussed. Programming Arduino to act as master and the library functions are also explained.
3. **Dong Wu; Lu Likun; Li Yeli[4]**- Ethernet Shield has W5100 chip which integrates TCP/IP protocol. It is connected to microcontroller using serial peripheral interface (SPI). It is used for remote monitoring. It act as a web server. Then is connected to LAN through RJ45 cable. This is implanted for remote monitoring.
4. **SuwarinPattamavorakun, JaturapithKrohkaew, KraimonManeesilp [5]**: Obtained accurate and real-time data of luminaire measurement of street and public lamps. The data is stored in database and a new webpage is created using web application frame work, PHP, JavaScript, CSS, and HTML. Then displayed the measured data in the webpage. Only authenticated users can view the data.

III.SYSTEM OVERVIEW

Fig.1: Picture of remote monitoring module

In Fig 1 and Fig 2 Power quality analyzer and transceiver connected using RS485. This act as interface between the ATmega328P and PQA. The transceiver and ATmega328P are connected using universal asynchronous receiver transmitter mode (UART). ATmega328P uses 5V power supply. Differential line transceiver can transmit up to 10Mbps and it operates in low power. The microcontroller ATmega328P and Ethernet shield W5100 is connected using serial peripheral interface (SPI) [4]. Ethernet shield is connected to Local area network (LAN) using RJ45 cable.

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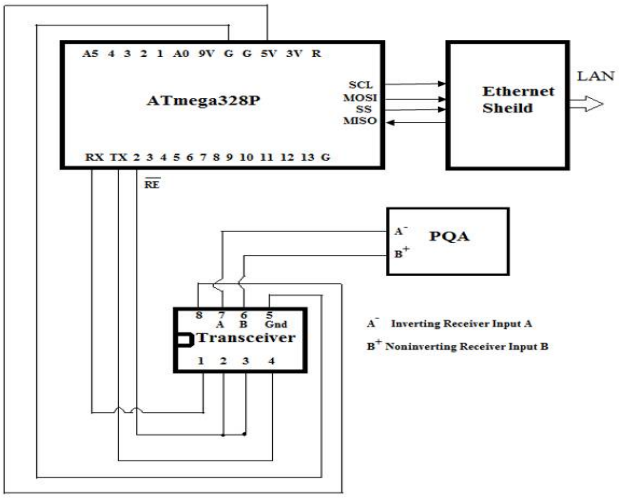

Fig.2: Architecture of remote monitoring module

IV.METHODOLOGY

1. Establishing communication between PQA and ATmega328P

The PQA and any Modbus based devices can communicate with microcontroller ATmega328P through Modbus RTU protocol. The Modbus RTU protocol establishes master/slave communication. The microcontroller which is programmed to act as master will request the necessary data from the slave. The slave will read from the register requested by the master and send the response to the master. The master request consists of different configuration parameters. The configuration parameters instruct the slave device to do appropriate action. The microcontroller ATmega328P and Ethernet shield is connected using serial peripheral interface. To receive the configuration parameters from the front-end this module has to act as server and personal computer should act as client. The data is stored in the memory of microcontroller

A. Modbus RTU

The Modbus RTU protocol is used to serially communicate between devices over RS485. If there is 3.5 character times gap between two messages it denote the end of one message and start of another message [9]. Each message can have gap up to 1.5 character times, if it exceeds receiving device flushes the message. There are different functions to perform. Functions are Read Coil Status, Read Input Status, Read Holding Register, etc. Each function has a specific request and response format and function code. For example, to read two registers in holding register which consist of binary values [2].

A (i) Request:

Slave id		01
Function code		03
Start address	High	00
	Low	00
No of registers	High	00
	Low	02
Error check	Low	C4
	High	0B
Total bytes		8

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A (ii) Response:

Slave id		01
Function code		03
Byte Count		04
Data	High	00
	Low	02
Data	High	00
	Low	03
Error check	Low	DA
	High	31
Total bytes		9

2. Role of cost effective web server module

The microcontroller ATmega328P and Ethernet shield connected using serial peripheral interface will act as cost effective web server module. ATmega328P will act as a SPI maser. Ethernet shield will act as a SPI slave (Fig 3). It is used to receive the configuration parameters from front-end and to send the measured data which is stored in microcontroller to the database through http request [4].

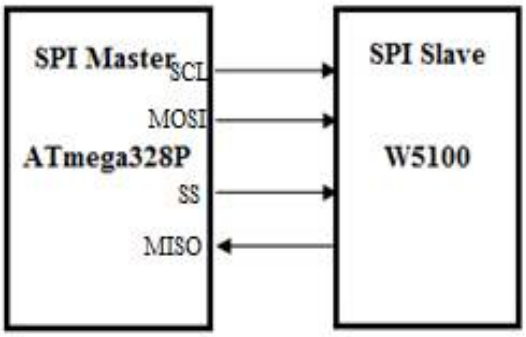

Fig.3: Cost effective web server module

3. Storage of data in database

The personal computer acts as server and the microcontroller module act as client. The data is logged into the SQL Server database using ATmega328P and Ethernet shield. The different power quality parameters are stored in the database. For creating the database Internet Information Server (IIS) is used [6]. Then data is send from the ATmega328P using the Ethernet shield through the internet router. The http request is used to send data from ATmega328P to database (Fig 4).

4. Displaying data in webpage

To display the data in the database a new webpage is created, that will read the data from the database and get refresh every five seconds (Fig 5). So the real time data can be viewed from remote location. Since the data is stored in the database the historical data can be viewed in the webpage. The retrieval of data is in the backend, SQL injection attacks can be reduced. The webpage is developed with the bootstrap framework. It helps to build a quick and responsive

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webpage. The data is displayed in the table in the webpage and provided the facility to view all data in one page itself instead of continuous scrolling. The necessary data can be filtered. The data is plotted in graph with respect to time. The data will be updated for every five seconds (Fig 6). Power quality disturbances can be easily monitored, to take necessary corrective measures to maintain the costly equipment. The data in the website can be viewed only by the authenticated users.

5. Generating report:

The daily report can be generated from the website. Since database consists of historic data any specific day report can be generated. It retrieves data of that specific date from the database. This data can be converted into excel or pdf and can be send through mailing facility in the website to the authenticated users.

V.RESULTS

The measured data from PQA is stored in database so that data can be retrieved for any specific date and this helps to monitor the changes in each parameter for certain period.

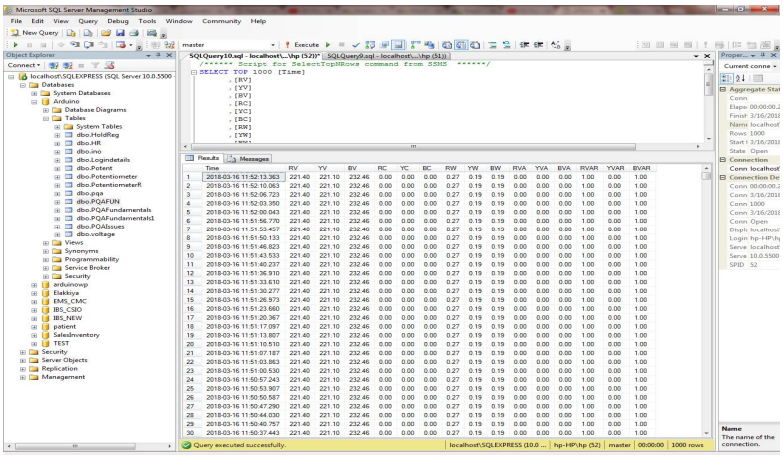

Fig.4: Logging data into SQL Server to view historic data

The data is displayed in webpage, authenticated users from remote location can view the measured data. This helps to take quick action when some disturbances occurs.

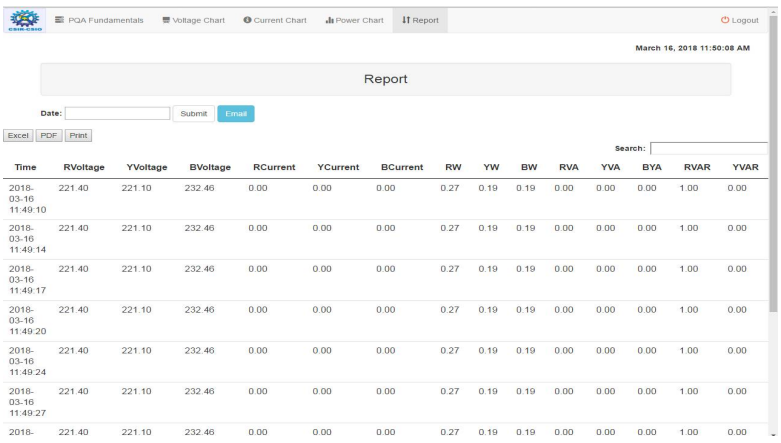

Fig.5: Publishing the data in the website for remote monitoring

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The graph is plotted for different parameters such as three phases of voltage, current, power with respect to time.

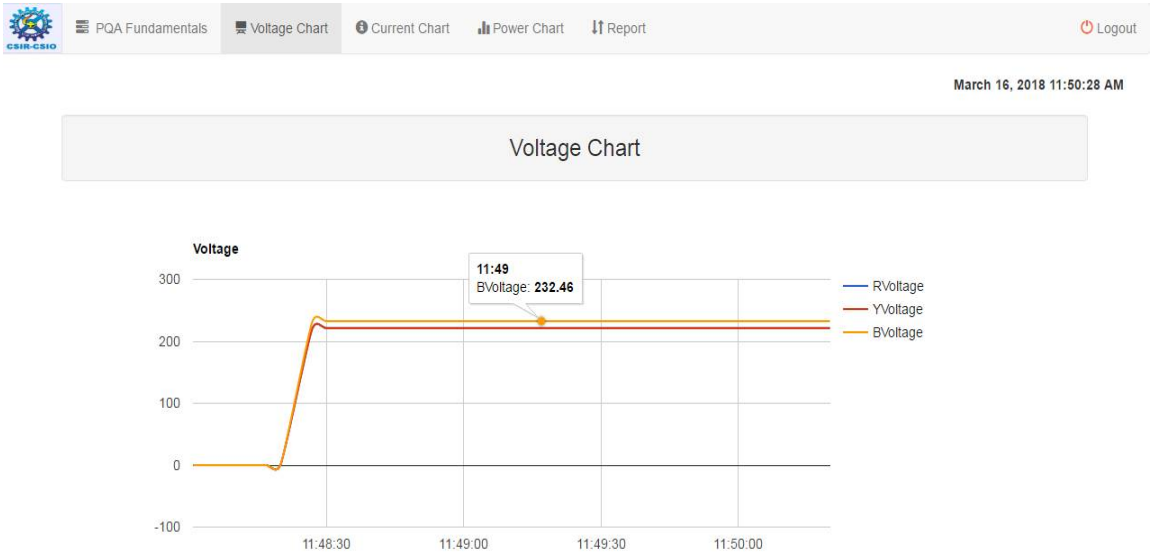

Fig.6: Data is plotted in graph with respect to time to view the variations

VI.CONCLUSION AND FUTURE WORK

The microcontroller based cost effective web server module is to collect the measured data from any Modbus based devices one at a time and to publish in the webpage. Now the data is received from PQA and stored in microcontroller. Then through cost effective web server module, data is sent to database. From the database the data is displayed in the webpage for remote monitoring. Live and historic values are viewed by the authenticated users. In future more Modbus based devices can be connected at a time.

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