An on-line distributed power quality monitoring system based on internet and labVIEW

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***Abstract*— Poor power qualities affect functioning of utilities, different industrial units, productions, and customer services another system performance and operating costs. There is an ever increasing need for power quality monitoring systems due to the growing number of sources of disturbances in AC power systems. Monitoring of power quality is essential to maintain proper functioning of utilities, customer services and equipments. Online power quality monitoring system is the development of the Internet as a vehicle for the use of electronic information and communication technologies to provide and support power quality monitoring when distance separates the different sites and data centre. Current power quality monitoring applications are usually developed for remote power quality inspecting and analyzing. It is possible for engineers to diagnose the faults and evaluate power quality at the data centre via Internet. On other hand, we also carried out the monitoring of power quality with the help of virtual instrument using labVIEW software.**

Keywords-Power Quality Monitoring system, Internet, Power Quality Meter, labVIEW, Virtual Instrument.

I.INTRODUCTION

The term power quality is applied to a wide variety of electromagnetic phenomena on the power system. The increasing application of electronic equipment and distributed generation has heightened the interest in power quality in Recent years, and this has been accompanied by the development of a special terminology to describe the phenomena. Power quality monitoring is the process of gathering some data about voltages and currents; transporting that data to somewhere it will be useful; and converting that data into decision-making information. Any power problem manifest in voltage, current or misoperation of customer equipment.

Power quality events have been proposed using on-line monitoring. This technique involves the monitoring of power quality with the assistance of power quality meters, and also with the help of client computers, web servers and power quality database and communication networks. In the earlier stages different instruments were used for monitoring different power quality problems.

- Transients.
- Short duration voltage variation.
- Long duration voltage variation.
- Voltage Interruption.
- Voltage imbalance.

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A proposed power system for power quality monitoring with the help of virtual instrument using labVIEW software [2].

Virtual instrument with a wealth of software, hardware, simple structure, highly intelligent, and other characteristics [3]. In order to evaluate power quality more accurately, presents a three-layer distributed online power quality monitoring system (PQMS),which uses the General Packet Radio Service(GPRS) wireless network as its communication channel. This PQMS consists of three parts; the power quality monitor(PQM),the monitoring software(MS) in upper computer and the web platform(WP).The PQM which is designed on the structure of DSP(Digital Signal Processor)&CPLD(Complex Programmable Logic Device) ensures the real-time and precise monitoring. Then the MS collects and analyzers the monitoring data. At the same time, GPRS network provides the communication channel for PQM and smother WP provides the monitoring data and the analysis results through internet, and supervisors can monitor and manage the power quality from a long distance [7]. Due to the great progress made on the Internet, the World Wide Web has become a convenient way to access information on the net. As the WWW has matured, three major classes web HTML "language" combined with HTTP application protocol provided a mechanism for the remote viewing of such documentation.

DSP-based power quality monitoring instrument is proposed for real-time disturbance recognition and source detection.

The deregulation and restructuring of the electricity industry is changing how utilities and customers approach power quality monitoring. Drantez-BMI Ltd introduced the first PQ monitor in the mid-1970s which was a microprocessor based monitor analyzer without graphic display. In the last few years, the rapid advances in semiconductor technology have increased the performance and reduced the cost for PQ monitors. There are various types of PQ monitoring instruments available in the market depending on their functions in which they are considered as revenue meter, digital fault recorder and permanently installed PQ monitor .All these instruments come with software and communication capabilities for data collection, data processing and result presentation. In terms of architecture and instruments are based on either PC or DSP with advanced commercial software like Matlab, LabVIEW or general programming languages such as C++. Examples of DSP based PQ monitoring instruments which are commercially available are the reliable power meter and PowerGuide 4400.However, these instruments can only record waveforms and use a software for collecting data and viewing monitoring results including voltage profiles and harmonic distortion information.

To Implement an intelligent PQ monitoring instrument which can process raw measurement data and provide useful information for PQ diagnosis, a new DSP-based PQ monitoring instrument is proposed.

II.RECOMMENDED IEEE STANDARDS

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- IEEE std 141-1993,IEEE recommended practice for Electric power Distribution for Industrial plants.

- IEEE std 142-1991,IEEE recommended practice for grounding of Industrial and commercial power system

- IEEE std 241-1991,IEEE recommended practice for Electric power system in commercial buildings.

- IEC 61000 series, Electromagnetic compatibility

[illegible]

III.VARIOUS POWER QUALITY MONITORING TECHNIQUES

A.POWER QUALITY MONITORING OVER INTERNET

Power quality monitoring is a easy-to-use technology, there tends to be a web application between the different sites and data center that it can simply be made available to engineers who will easily use the power quality monitoring systems [2]. With the advancement of information and communication technology, Internet connecting millions of hosts worldwide has been getting more and more popular in power systems. Computer networks have made it possible to share electronic data. In this paper, we developed an Internet-based power quality monitoring system for remote power quality inspecting and analyzing. The major features of the system are described as following:

1.Provides GPS-based power quality meters (PQM) for synchronously sampling data on the remote site;
2.Sets up site data manager client software that will manage the nodes that will collect, store and compress the power quality data produced by the PQMs;
3.Provides the efficient and convenient methods for the different sites and data centre to communicate with each other and allows the different sites to send their data through the Internet;
4.Provides computer-based investigator client software that provide relatively easy and fast access to large databases and that permit the application of powerful statistical methods for analyzing and displaying those data.

GPS technology to synchronize sampling data in the power quality meter, foundation of network platforms with Win2003 Server/IIS, application of power quality database using Microsoft SQL, site client software to collect, store and compress the power quality data from the power quality meters and investigator client software to

analyze and calculate relevant power quality parameters. This system can provide assurance to power system security.

SYSTEM ARCHITECTURE

While both the PQMs and the network interface to the instrument might reside in the remote site, nothing prevents these instruments from being dispersed geographically. For example, the instruments might be located in the remote site while the interface mechanisms are located at the data center. In addition; this approach to system design makes it possible
for the PQMs to be monitored by the datacenter, thereby allowing the remote site to interact with the data centre. It is this distributed web-like model of power quality monitoring system interactions in which "clients" and "servers" dynamically confederate for a period of time and then disassociate from one another. Taking this step lays the necessary foundation for Internet-based power quality monitoring system.

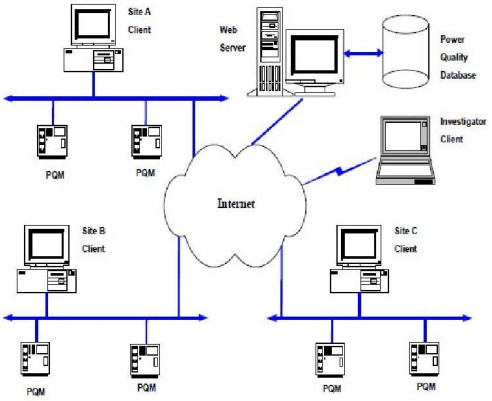

Fig.1.An Internet Based Power Quality monitoring System.

PQM (Power Quality Monitoring)

The power quality monitoring system is a collection of technologies including a web server, computers, communication networks, and specialized PQMs. The most common feature of a power quality monitoring system is the ability to transmit high-quality data across a communication line. Critical functions include data acquisition and downloading, data processing, and delivery of results and reports. Traditionally, separate computers have handled these functions, but new technology is enabling them to be handled either from a central station or from stations throughout a Monitoring network. The system topology is presented in Fig.1. The power quality monitoring system is structured using a set of basic components. They include PQMs , client computers , web server and power quality database, and communication networks.

The PQMs are connected to the power system via current and potential transformers. These instruments constantly record the voltage and current waveforms at a resolution of up to 1024 samples per cycle. This data is compressed on board using the wavelet-based data compression technology. The compressed files are transferred site data manager client Software. The site data manager client software stores the data collected from the PQMs and responds to requests from client workstations running Investigator software.

When an engineer using the Investigator software wishes to analyze the data collected by the PQMs from a certain time frame, the investigator client software decompresses the requested data, performs the necessary mathematical calculations to display the electrical parameters requested by the client and then arranges and configures the data to be displayed on the specific screen used by the client.

Power Quality Monitor

The PQM is an accurate electronic power meter capable of sampling voltage and current waveforms. PQM represents mechanisms for acquiring power quality data, delivering data to site data manager client software. All the PQMs are connected to the local network and by using unique time synchronization based on GPS. In this way, it was possible to monitor all the information from different location on the same graph and the same time base.

For real time power quality measurement, voltages and currents of all measuring nodes must be measured simultaneously. The pulse of GPS is used as synchronization signal of the measurement system. PQMs are partitioned into two layers. The first layer is the physical device; the second layer is a software "proxy" that represents the device in another piece of hardware. In either case the device presents an established interface that "wraps" the components actually used to provide the functionality. In addition, the technologies used to deliver the requested services may be transparent.

B.USING GPRS

In order to evaluate power quality more accurately, presents a three-layer distributed online power quality monitoring system (PQMS), which uses the General Packet Radio Service(GPRS) wireless network as its communication channel.

This PQMS consists of three parts; the power quality monitor(PQM),the monitoring software(MS) in upper computer and the web platform(WP).The PQM which is designed on the structure of DSP(Digital Signal Processor)&CPLD(Complex Programmable Logic Device) ensures the real-time and precise monitoring Then the MS collects and analyzers the monitoring data. At the same time,GPRS network provides the communication channel for PQM and MS.

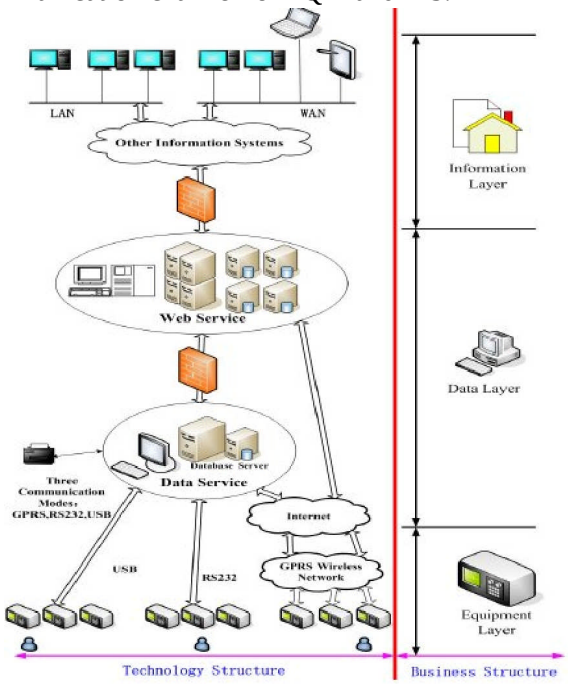

Fig.2.Power quality monitoring using GPRS technique.

The WP provides the monitoring data and the analysis results through internet, and supervisors can monitor and manage the power quality from a long distance.

C.USING WEB BASED TECHNOLOGY:

The HTML "language" combined with HTTP application protocol provided a mechanism for the remote viewing of such documentation. Lack of interactivity soon appeared via HTML form elements (CGI-The common gateway interface)is used. In recent year, other technologies have emerged on the Internet: the Active Server Pages (ASP) and Java. Like the CGI, ASP is also executed on the Web Server and sends the results to the client in HTML document format. But it provides more powerful functions and an easier interface than that of CGI.

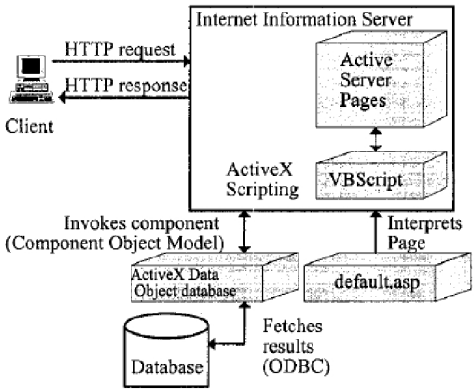

Fig.3.Working of Active Server pages.

D.Monitoring power quality by virtual instrument using labVIEW:

Now-a-days much works are done on Real-Time power quality monitoring, still much improvement is required for present day problems. We are in need of an intelligent system with up-to-date and appropriate software that works smoothly with appropriate hardware to form a compact single station/system for power quality monitoring and controlling without the use of different devices from different vendors.

The solution for these problems is obtained by designing and implementing a simple power quality monitoring system. Its development is based on software using graphical programming to work along with appropriate hardware to form a compact single station for power quality monitoring without the use of different devices from different vendors. This work addresses especially on the measurement of the signals to detect any disturbances or distortions of the voltage power line, and giving priority to the needs of the small scale industries and also for the domestic consumers.

Different virtual instruments (VIs) were implemented using graphical programming language (virtual instruments) by way of software development and manipulation.

The simulations VIs are used to generate voltage waveforms .The interfacing devices are send to connect the software and hardware through serial communication with some additional/necessary hardware. The main aim of this paper has been to develop an improved and intelligent PQM system by using software along with necessary hardware's and to test a prototype system for real time PQM. The results show a success in this object.

The software is developed using graphical programming language called LabVIEW which is the trade mark of the National Instruments (NI), Austin, Texas, USA.

The full form of LabVIEW is laboratory virtual instrument engineering workbench and is a graphical development environment which can be used to conduct scalable tests ,measurements, and control applications, in addition to the ability to interface real-world signals and analyze data for meaningful information .[9],[10].

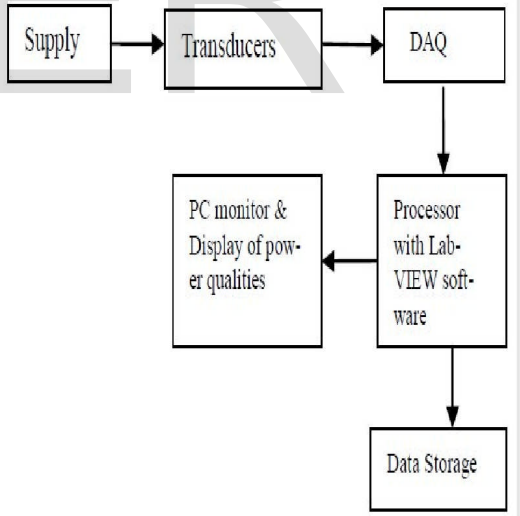

Fig.4.Main elements of PQM system.

Virtual Instruments:

Virtual instrument refers to organically integrating the computer resources of the universal application with the hardware devices through applied

programs.Consequently, the powerful computing capability is combined with the devices capacity of measurement and control. The cost an volume of hardware devices had been greatly narrowed. Users can operate this computer through the friendly graphical interface like operating a single instrument defined and designed by users themselves.

Advantages-Virtual Instruments:

Compared virtual instruments with traditional instruments, virtual instruments have specific advantages as follows:

1) They have enriched and enhanced the function of traditional instruments.
2) Equipment from the user's own definition.
3) To highlight the concept software is instrument.
4) Open industrial standard.
5) To facilitate the complex testing systems.

INTRODUCTION OF LabVIEW SOFTWARE:

LabVIEW is referred to as Laboratory Virtual Instrument Engineering Workbench, is developed by National Instruments a data-driven programming language substitute text programming language to create the development tools of application, this program emphasize and that the process of signal processing ,simple programming and debugging easier.

Virtual instrument development platform LabVIEW has the following characteristics.

1) Graphical equipment programming environment.
2) Feature-rich library.
3) Flexible means of procedure debugging.
4) Open development platform.
5) Network.

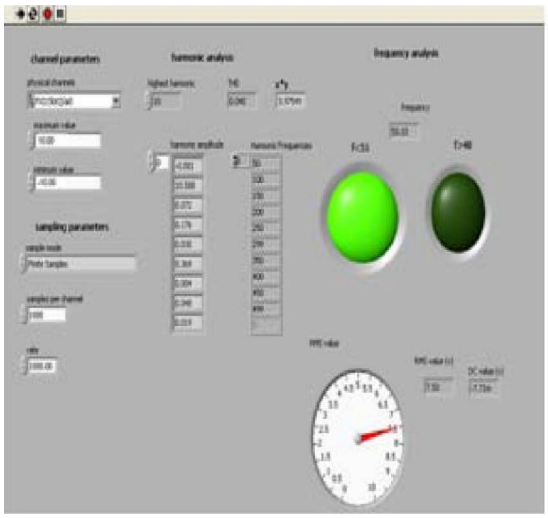

Fig.5.Front panel of LabVIEW program.

LabVIEW programmes are called virtual instruments (VI), because they have the look and feel of physical instruments. It is divided into front panel and block diagram. Front panel is the user interface of the Inbuilt with controls and indicators. Block diagram is the VI's source code, constructed in LabVIEW graphical programming language and it is the actual executable program. Different virtual instruments are implemented using the NI LabVIEW graphical programming language.

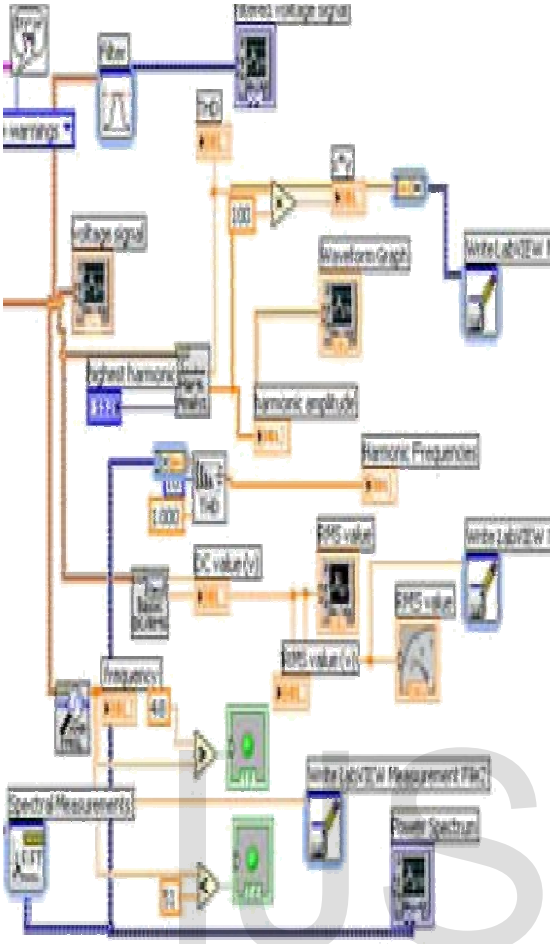

Fig.6.Block diagram of LabVIEW program.

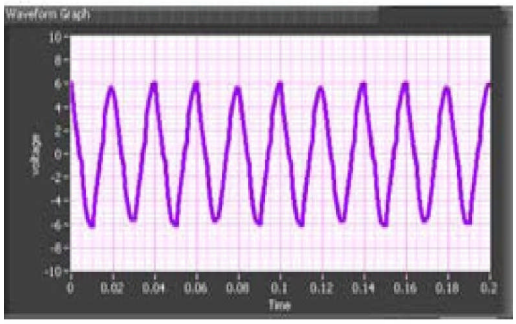

Fig.7.voltage signal in time domain.

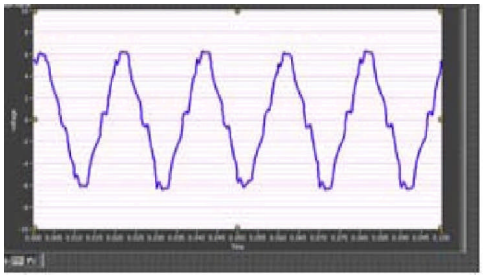

Fig.8.voltage distortion.

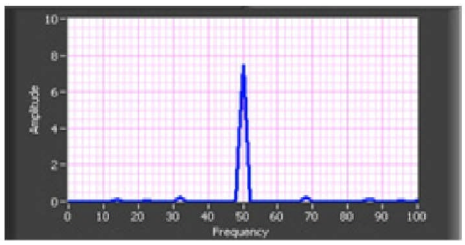

Fig.9.voltage transients.

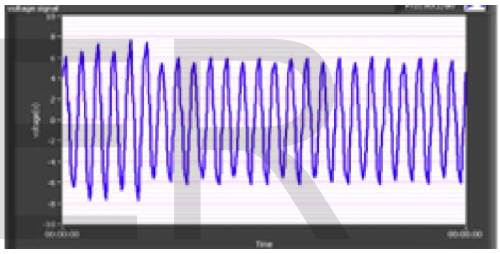

Fig.10.voltage sag.

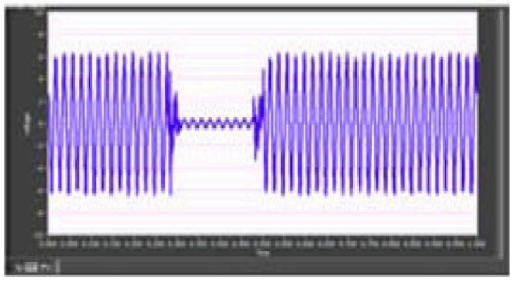

Fig.11.Interruption of power supply.

CONCLUSION

In this paper we discussed about the various techniques available, to monitor the power quality issues and also, the analysis is carried out and we find that the on-line monitoring technique support

remote power quality inspecting and analyzing across global wide area networks. On other hand, the advantages of LabVIEW technique is, numerous large-scale experiments show the rich advantages of this system with easy management, short term for development, good cost performance, along with the other features as convenient software updating stable operation, complete functioning and high automation, etc.

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