18

Development of A Distance Microprocessor-based Platform using Graphical Interface via the Internet

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1. Introduction

The microprocessor like 8051 has been still playing an indispensable role as a controller in industry applications because of its programming process, low-cost, small size and low power consumption, etc. That is why many microprocessor-related courses still open in electrical fields in Universities around the world. The microprocessor, however, usually lacks of capability in the Internet connection and/or graphical interface. With increasing demand of industrial e-platform facilities, it may suffer from such as restriction.

This chapter is to describe how to set up a distance microprocessor-based platform using graphical-interface via the Internet. It can perform on line real-time monitor and control function via World Wide Web. The client (remote PC) and sever (nearby PC) communicate with each other according to TCP/IP. The server is linked with the microprocessor (Intel 8051) through RS232. The graphical interface is designed by using LabVIEW package. Accordingly, the microprocessor can not only carry on its own task but also allow remote client to monitor or control its programming process. The conventional microprocessor can be thus delivered into many e-platform applications by the supplementary functions.

A case study for signal analysis using Fast Fourier Transform (FFT) will be presented in this chapter. A PC-based virtual instrument (VI) that can carry out a remote measurement and monitoring using LabVIEW and the microprocessor (Intel 8051) for power system harmonics is proposed. The history of Total Harmonic Distortion (THD) in the waveform signal can be also recorded and tracked in the data base. This distance e-learning environment using a graphical programming tool is to help electrical students and engineers for enhancing the microprocessor applications using the Internet Explorer (IE). In deed, a good vision for the microprocessor-based remote e-platform with graphical interface will be demonstrated in details. For further applications, the proposed system can be simply extended to perform an instant control and surveillance activities on line in automated industry.

2. Structure of the system hardware

The system hardware is shown as Figure 1. A remote on-line harmonic detection and monitoring can be operated by two clients (remote PCs), respectively. These clients communicate with the server (nearby PC) by way of TCP/IP and Web connection. The server is to collect the real-time waveform data from the microprocessor (Intel 8051) through RS232 via the I/O interface (IC8255). The analog data (distorted current signal) that is initially captured by the Current Waveform Sensing Circuit is converted to digital data. The Zero-Crossing Detector is used to ensure the current waveform to be captured from the zero-point for very cycle, thus avoiding spectrum leakage.

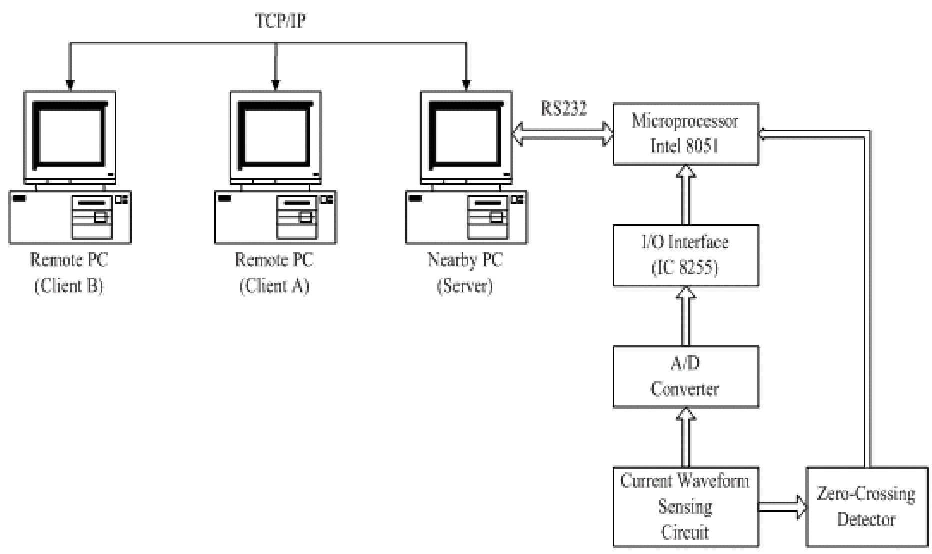

Fig. 1. Structure of the proposed system hardware

The basic facilities or modules required for the proposed system are as follows.

(1) Three PCs. One works as a server for the collection of current waveform data, and the other two PCs are as the clients (A and B) through TCP/IP. Client A is to perform the remote real-time harmonic analysis, and Client B is to view the instant analysis results obtained from Client A.
(2) One microprocessor (Intel 8051) connected with the server via RS232.
(3) I/O interface module using IC8255.
(4) A/D converter module.
(5) Current Waveform Sensing Circuit (module).
(6) Zero-Crossing Detector.

3. Description of the system software

Besides the hardware system, two system softwares, i.e., 8051 programming and LabVIEW programming, are needed to operate the proposed system, described as follows.

(i) Flowchart of the 8051 programming

The microprocessor (8051) is to construct the bridge for communication between the server and I/O interface. The programming flowchart is shown as Figure 2. The main procedure is briefly described as follows.

(a) Set COM1 as the serial communication with the outside world. SCON is set to as transmission mode 1, and TMOD is set as timer mode 2. All related registers are set as the following table.

Table 1: control registers status

SCON	TMOD	SMOD	TH1	Bps	TI	RI
50H	20H	1	FDH	19200	0	0

Note that the value of TH1 is to determine the transmission rate. Bps is the Baud rate per second.

(b) 8051's communication operation is chosen as Mode 1 to transmit the message via TXD and to receive the message via RXD. TXD is the transmission bit in the Universal Asynchronous Receiver transmitter (UART), and RXD is the receiving bit.
(c) The data (waveform) in the serial port buffer (SBUF) is read from 8255 through 8051.
(d) Upon complete transmission of data from UART serial port (TXD) to LabVIEW, TI will be set to 1 by the system.
(e) Set the sampling rate $f_s\,(=1/\Delta t)$ as 1000 and sampled points N=1000.
(f) Go back to step(b) until the sampled points are reached.
(g) Set time delay.
(h) Go back to step(b) until the power in 8051 is turned off.

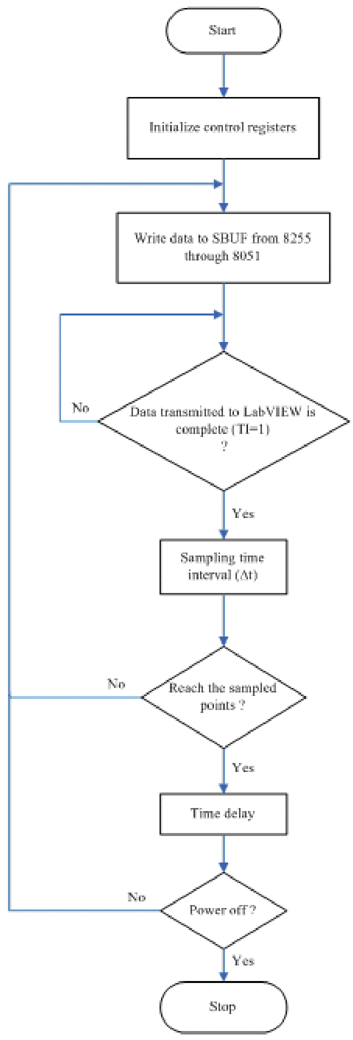

Fig. 2. Flowchart of the 8051 programming

(ii) Flowchart of LabVIEW programming

In the server (nearby PC), the serial port (COM1) in LabVIEW uses the TXD and RXD of the UART to receive data from the microprocessor (8051) via its own UART. The Bps, i.e. 19200, of the serial port must match the 8051 transmission rate. The data ready for transmission is held in the Transmission Holding Register (THR) temporarily until the data is transmitted completely. Similarly, the received data is temporarily held in Receiving Buffer Register (RBR). Figure 3 shows the programming flowchart.

The main programming procedure is briefly described as follows.

(a) Set the serial port (COM1) for LabVIEW communication with 8051.
(b) Initialize the TCP/IP connection with Client A.
(c) Read the SBUF data that is transmitted from 8255 through 8051.
(d) Set the sampling rate $f_s (= 1/\Delta t)$ and sampled points N. They should match the 8051 status.
(e) Go back to step(c) until the sampled points are reached.

(f) Display the current waveform signal in the waveform chart.
(g) Send the waveform data to Client A via the TCP/IP.
(h) Go back to step(c) until the TCP/IP is disconnected.

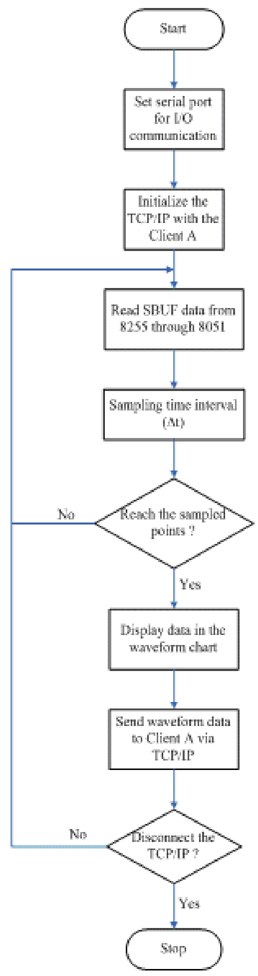

Fig. 3. Flowchart of the server programming

In Client A (remote PC), the waveform data is received from the server, and the waveform harmonic is analyzed instantly. The flowchart is shown in Figure 4. The main programming procedure is briefly described as follows.

(a) Initialize the TCP/IP connection with the server.
(b) Read the waveform data that is transmitted from the server via the TCP/IP.
(c) Display the current waveform signal in the waveform chart.
(d) Harmonic analysis using FFT.
(e) Display instant THD history and record it in the data file.
(f) Set time delay to wait for next data reading cycle.
(g) Go back to step(b) until the TCP/IP is disconnected.

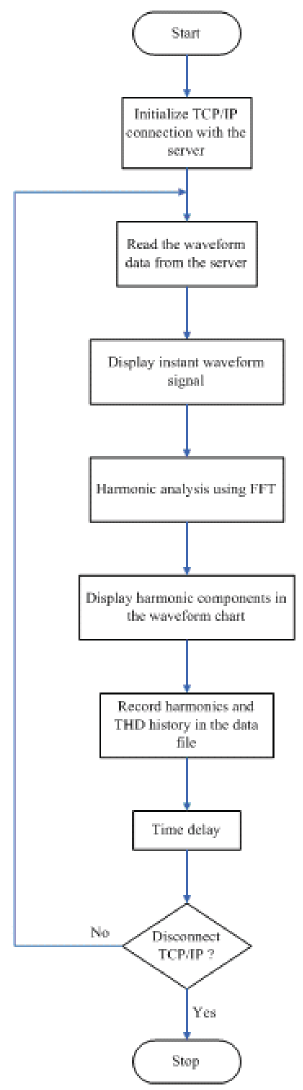

Fig. 4. Flowchart of the Client A programming

In Client B (remote PC), the harmonic analysis results same as Client A can be viewed by the Web Site (Internet Explorer) simultaneously. The flowchart is shown in Figure 5. The main programming procedure is briefly described as follows.

(a) Initialize the Web connection with the Client A.
(b) View the front panel of the Client A via the Internet Explorer.
(c) Go back to step(b) until the Web connection is disconnected.

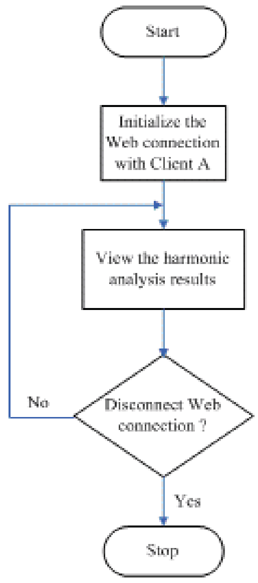

Fig. 5. Flowchart of the Client B programming

4. Internet connections

(a) TCP/IP connection between the Server and Client

In the server side, initially Port Number is set to listen for connection, and time out is set a limit of 5 seconds. The server will send data to the TCP port specified once a connection requested has been detected. Numeric data is thus cast into string data and sent via TCP Write. The first TCP Write sets the amount of data to send, and second TCP Write sends the data. Error checking of the loop will stop the loop if a connection error occurs. The connection is closed once the waveform data has been sent. Connection errors will be converted to warning message, and additional errors will be checked as well. The key program for TPC/IP connection is shown in Figure 6.

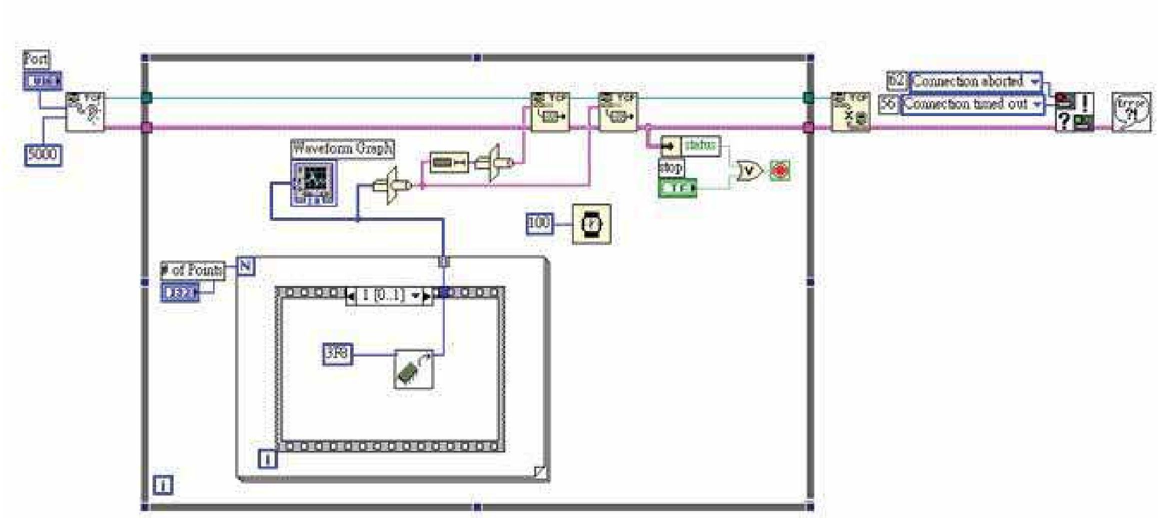

Fig. 6. TCP/IP connection program for Server

In the Client A side, the connection function is opened with port and IP address. The data is read at the port specified with a numeric representation. First TCP Read acquires the size of the data, and the second TCP Read reads the data and passes it to the chart. Error checking of the loop will stop the loop if a connection error occurs. The connection will be close when the reading procedure is done. Connection errors will be converted to warning message, and additional errors will be checked further. The key program for TCP/IP connection is shown in Figure 7. For simplicity, only TCP/IP connection is presented for illustration in Client A program (Block Diagram).

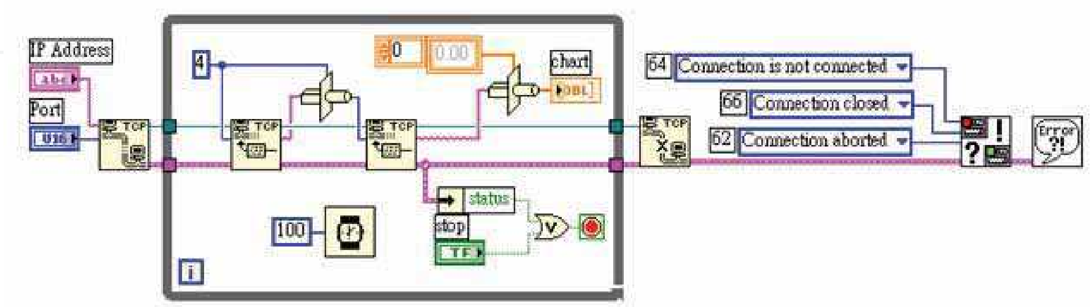

Fig. 7. TCP/IP connection program for Client A

(b) World Wide Web connection between the Clients

In Client A, LabVIEW front panel can display the working status on line, as shown in Figure 8. The spectrum of waveform can be viewed in the chart, including the individual frequency and amplitude. The waveform THD (%) is shown up immediately and can be recorded in a data file, i.e. a:\IO.txt. Once the THD (%) is over the predefined limit, for example 25%, the warning LED will be operated as “on” stage.

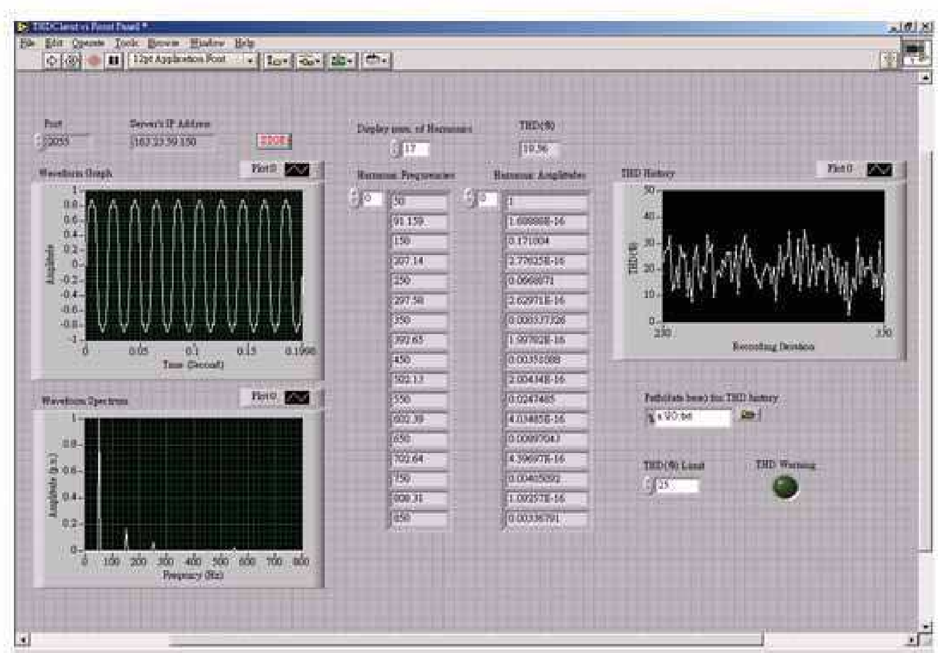

Fig. 8. VI panel of the Client A

The VI panel can be published to World Wide Web to be viewed by for Client B via Internet Explorer. Figure 9 shows the Web Publishing Tool to display the VI front panel. The document is then saved in the web server's root directory. The URL should be created, and this VI panel page can be accessed from an Internet Explorer browser, shown as in Figure 10.

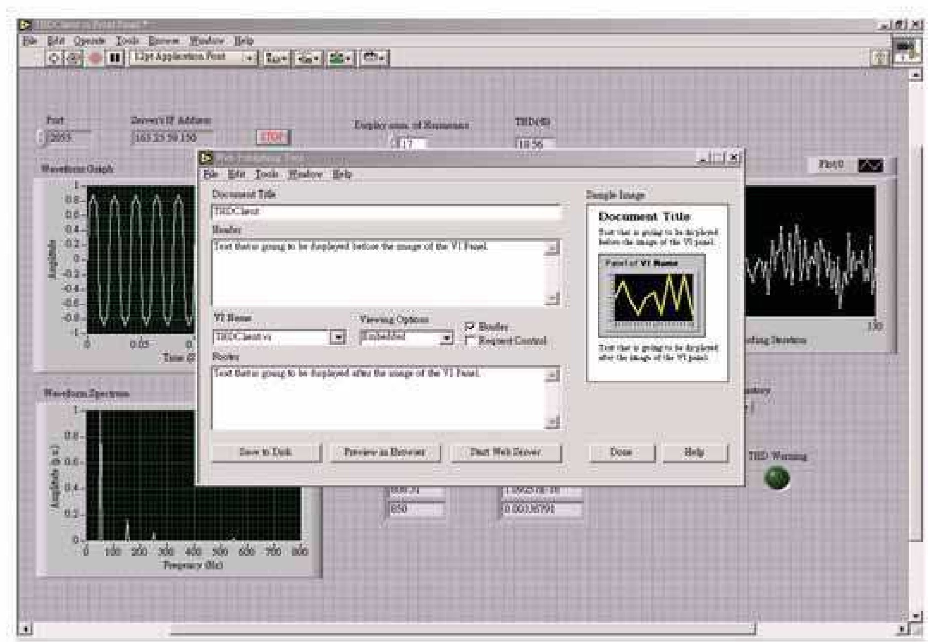

Fig. 9. VI panel for Web Publishing Tool

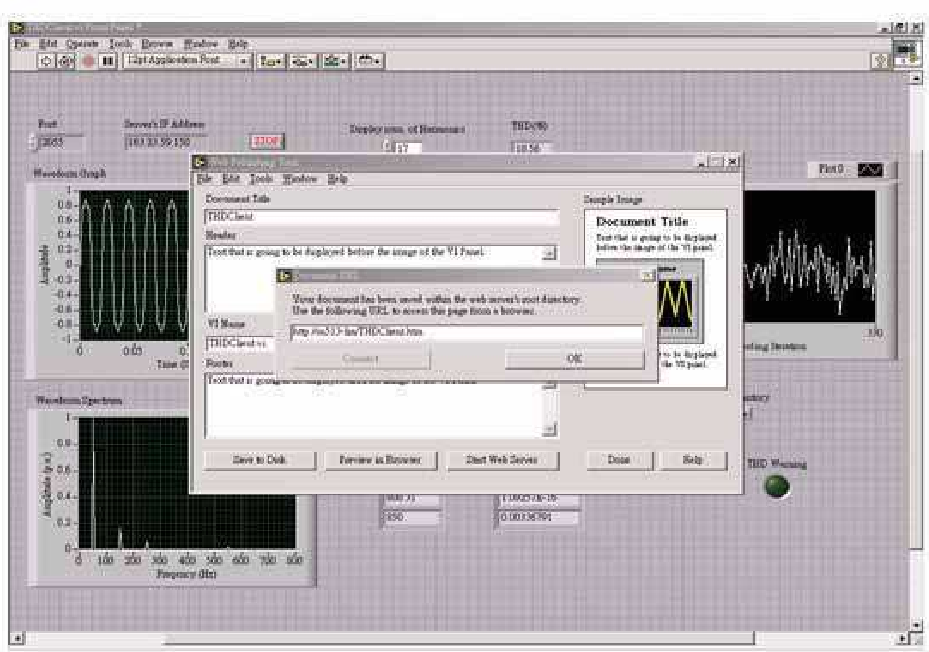

Fig. 10. VI panel for URL access

Note that **m513-lin** in the URL path (shown in Figure 10) should be replaced by the server's IP address, for example 163.23.59.150, to be viewed and controlled by the client B (remote PC) via World Wide Web. For security considerations, the Fire wall has been set up to avoid a stranger (or hacker) invasion, shown as in Figure 11. Only the certified IP (163.23.59.141) allows viewing and controlling, while the IP (163.23.59.128) allows viewing only; all others are prohibited.

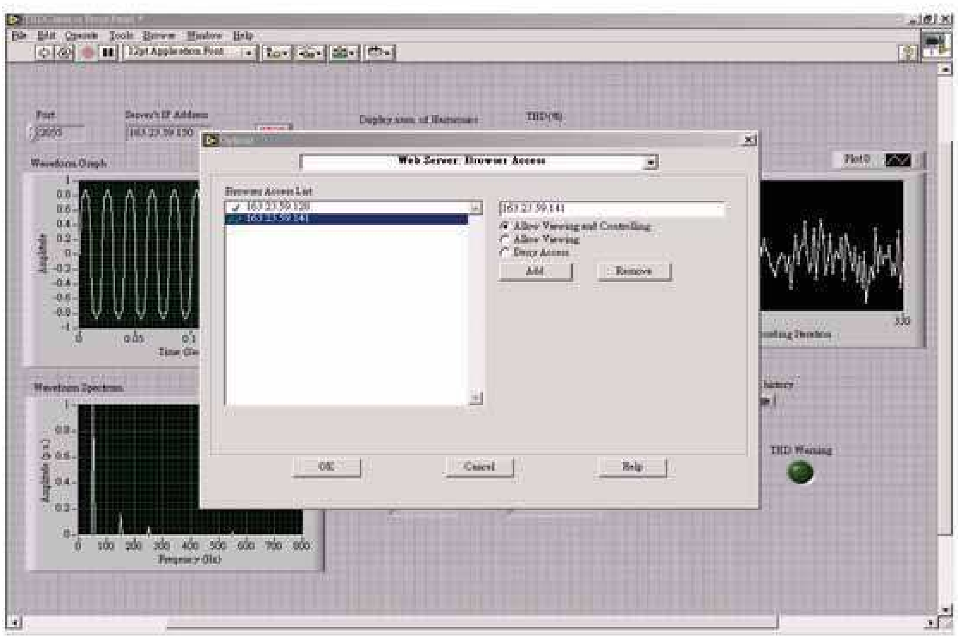

Fig. 11. VI panel for Brower Access

5. Experimental results with TCP/IP and Web connection

The proposed system under on-line real-time control via TCP/IP as well as Web connection was implemented successfully. The front panel of the server was illustrated in Figure 12. As can be seen, the waveform data can be collected and displayed in the Server.

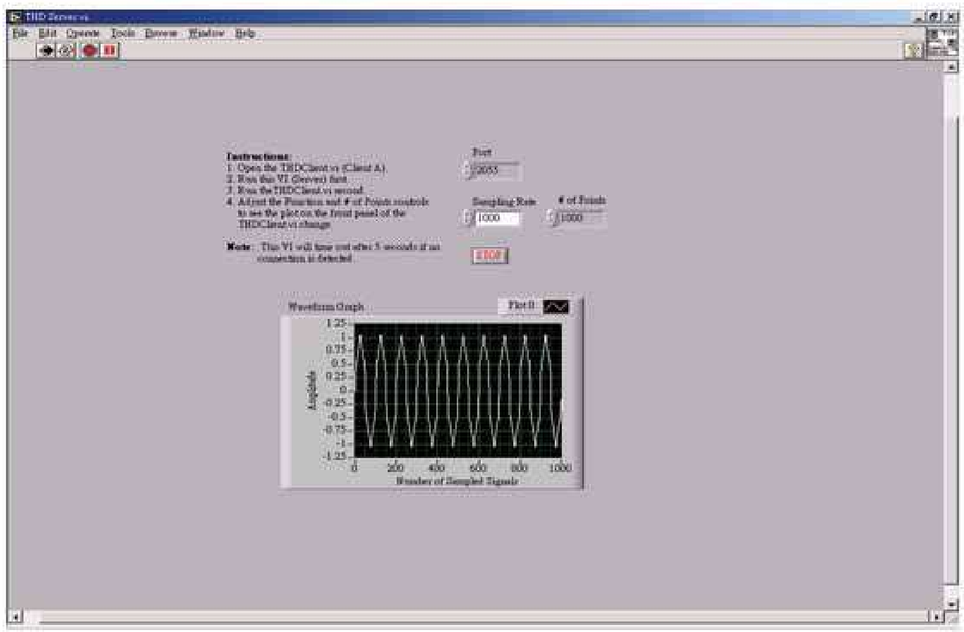

Fig. 12.VI panel of the Server

The VI panel of the Client A is showed in Figure 13. The waveform that contained up to 17th harmonics was displayed in the waveform chart. Not only THD of the current waveform but also the individual frequency and amplitude can be monitored by the VI panel. The path to save the THD history in a data file was set up in the system. A warning sign was switched on if the THD was beyond the predefined limit. Also, 100 harmonic measurement results were showed up in the waveform chart (THD history) at the same time.

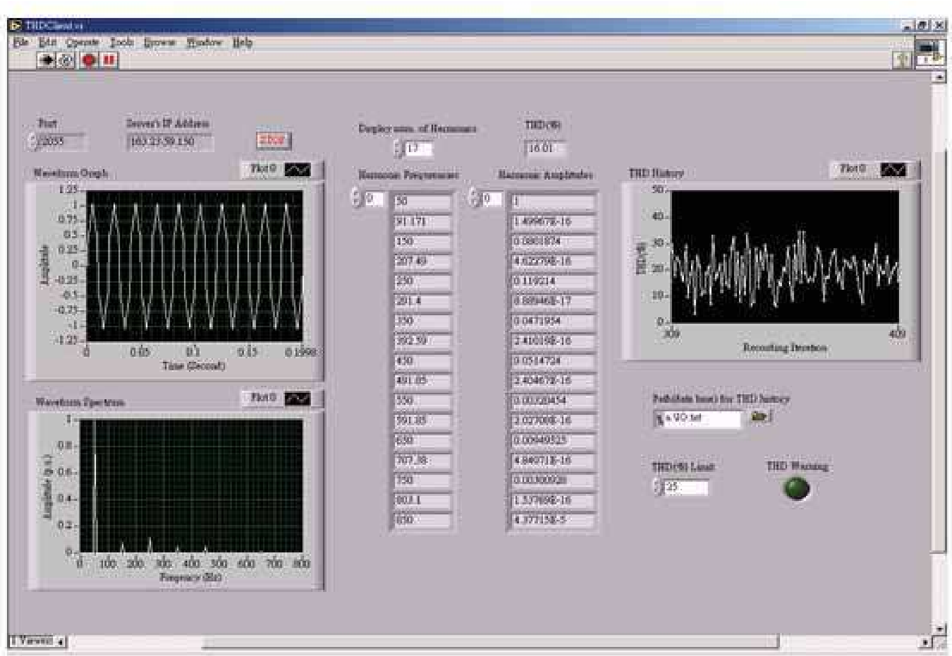

Fig. 13. VI panel of the Client A

From the World Wide Web, the Client B located at the other remote PC can view the VI panel that is the same front panel as the VI panel of the Client A, as shown in Figure 14. In particular, the control of VI panel can be transferred to the client under the protection of Fire wall. Therefore, Client B can be allowed to take over the server for controlling operation.

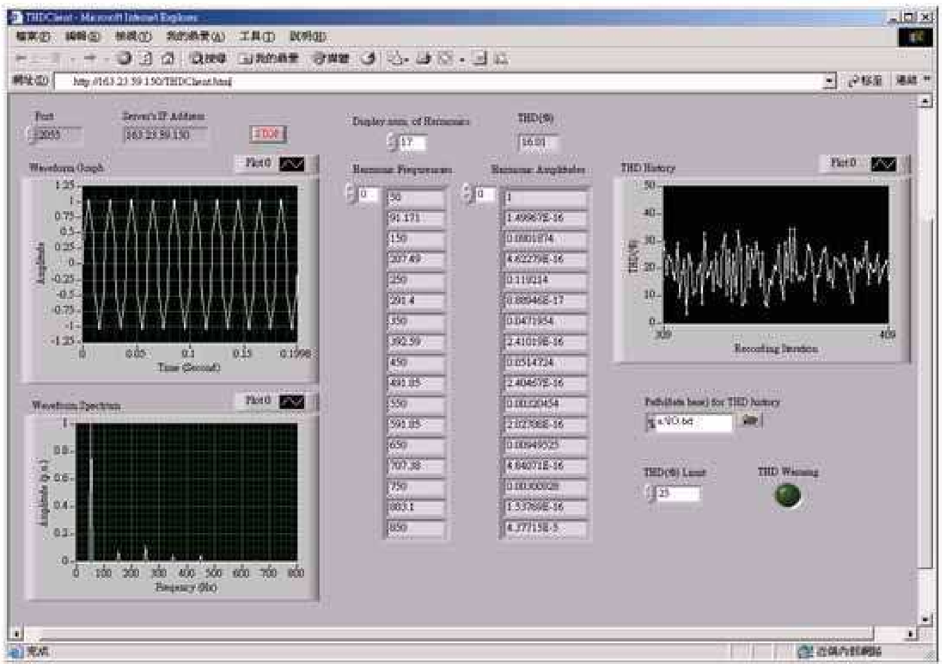

Fig. 14. Web front panel of the Client B

The waveform's THD was recorded once for every 30 minutes (i.e., time delay in Figure 2) so that the history can be easily tracked by a data file. For simplification, only 20 THD results were shown in Table 2. Time delay can be adjusted according to the user's requirement.

Iteration	Date	Time	THD(%)	Status
0	2009/3/9	PM 12:15	23.06	Normal
1	2009/3/9	PM 12:45	29.15	High
2	2009/3/9	PM 13:15	18.72	Normal
3	2009/3/9	PM 13:45	27.46	High
4	2009/3/9	PM 14:15	10.88	Normal
5	2009/3/9	PM 14:45	12.30	Normal
6	2009/3/9	PM 15:15	24.89	Normal
7	2009/3/9	PM 15:45	31.78	High
8	2009/3/9	PM 16:15	19.18	Normal
9	2009/3/9	PM 16:45	27.15	High
10	2009/3/9	PM 17:15	26.42	High
11	2009/3/9	PM 17:45	5.61	Normal
12	2009/3/9	PM 18:15	11.24	Normal
13	2009/3/9	PM 18:45	7.11	Normal
14	2009/3/9	PM 19:15	14.23	Normal

15	2009/3/9	PM 19:45	8.69	Normal
16	2009/3/9	PM 20:15	28.80	High
17	2009/3/9	PM 20:45	16.95	Normal
18	2009/3/9	PM 21:15	6.45	Normal
19	2009/3/9	PM 21:45	23.13	Normal

Table 2. THD history

6. Conclusions

The material based on proposed hardware/software schemes has provided comprehensive concepts and techniques in focusing on the power system harmonic measurement using graphical programming and Internet connection. In addition, the Fire wall was built up to secure the system. This paper has also presented a good vision for that the graphical interface programming upgrades remote monitoring and control technology that is easy for extension to on-line applications in industry. Internet-based techniques, in fact, are becoming more important to develop research/technical skills about advanced ideas in engineering fields. For further applications, the proposed system can be simply extended to perform an on-line control and surveillance activities in automated industry.

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E-Learning is a vast and complex research topic that poses many challenges in every aspect: educational and pedagogical strategies and techniques and the tools for achieving them; usability, accessibility and user interface design; knowledge sharing and collaborative environments; technologies, architectures, and protocols; user activity monitoring, assessment and evaluation; experiences, case studies and more. This book's authors come from all over the world; their ideas, studies, findings and experiences are a valuable contribution to enriching our knowledge in the field of eLearning. The book is divided into three sections. The first covers architectures and environments for eLearning, while the second part presents research on user interaction and technologies for building usable eLearning environments, which are the basis for realizing educational and pedagogical aims, and the final last part illustrates applications, laboratories, and experiences.

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