Sensors & Transducers, Vol. 21, Special Issue, May 2013, pp. 66-72

Sensors & Transducers

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Design of Remote Power Plant Monitoring System Based on LabVIEW and VC++ Software

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Received: 30 March 2013 /Accepted: 14 May 2013 /Published: 30 May 2013

Abstract: This study designs a real-time remote monitoring system based on LabVIEW and Microsoft Visual C++ for Plant Units. The server written in LabVIEW uses for data acquisition and storage. The server adopts the TCP and DataSocket to communicate with the VC client. The remote VC client can accept real-time data and process data, enabling remote monitoring. *Copyright © 2013 IFSA.*

Keywords: LabVIEW, Online monitoring, VC++, Mixed programming, DataSocket.

1. Introduction

Through field investigation and research, at present the plant power plant production systems exist the following problems: geographic distribution is wide, handan power plant production points is much, workload is very big to connect the control system. With long relied on manual pickup, manual meter reading statistics, it is less access to production information , slow the transmission speed, long processing cycles, not conducive to the discovery of the hidden problem, at the same time it will cause fluctuations and energy waste in production. With the production process more and more complex, the factory workshop each other incomplete coordination is worsening contradictions. Online monitoring has been taken for the main equipment in the existing units in power plant, such as gas turbine, steam turbine, generator. After data processing in mean way, once fault occurs, the machine will shut down immediately. The cause of the failure cannot be determined, and data can't be long-term preservation.

This paper designs a set of power plant real-time remote monitoring system monitoring and recording the key data (displacement, vibration, and differential expansion, pressure, temperature, and other real-time data) of the main equipment of the unit based on C/S mode.

Remote real-time monitoring system designed in this paper a set of C/S mode Plant Units monitoring and recording the key data (displacement, vibration, and differential expansion, pressure, temperature, and other real-time data) of the main equipment of the unit, as well as a failure occurs, it is convenient to call the historical data to determine the cause of the malfunction for engineering and technical personnel.

2. Server Design

The power plant includes 10 units. There are 618 measurement points among units (224 acceleration measurement points, 52 displacement measurement points, 56 rotational speed measurement points, 186 temperature measurement, 90 flow measurement points and 10 differential expansion measurement points). Due to the wide geographical distribution of units and so much the measuring points, if all the collected data centralizes storage and processing on one server, it would be a very heavy burden on the server. According to the geographical distribution of the 10 units, all acquisition signals are processed with three servers. Each server has the following five functions: data acquisition, data storage, warning judgment, monitoring database, remote communication.

2.1. Data Acquisition

Shown in Fig. 1, the measurement signal from the sensor after signal conditioning is transferred to the computer by DAQ card [1]; finally the programs written in the LabVIEW extracts the data [2]. Shown in Fig. 2, it's a high-frequency signal acquisition task.

2.2. Data Storage

For signals such as temperature, speed, differential expansion, pressure and flow, the sampling frequency is low; all the original data stored will not take up a lot of space, so a direct storage. However Acceleration and displacement signals with higher frequencies save the data in event-triggered and time-triggered Control ways [3]. It saves characteristic values of the signals in Time-Triggered Control ways (Fig. 3) and save original data of the signals in event-triggered control ways (Fig. 4). For example, an acquisition task which sampling frequency is 3.2 kHz and it has 16 channels extracted once data each second, the number of the original data is 51200. After transforming the original data into characteristic values which contains the average, maximum and minimum values, the data amount is reduced to 0.09375 % of the amount of original data. If the average value exceeds the warning threshold, then the server save the raw data of the measuring points to provide the basis for the failure analysis. After pretreatment (Fig. 5), it ensures that the useful data is long-term storage without affecting the online monitoring.

2.3. Early Warning Judgment

Shown is Fig. 6, compared with the alarm threshold characteristic data from the database, if the average exceeds the warning threshold, the alarm signal is sent to the client, while raw data collected is stored.

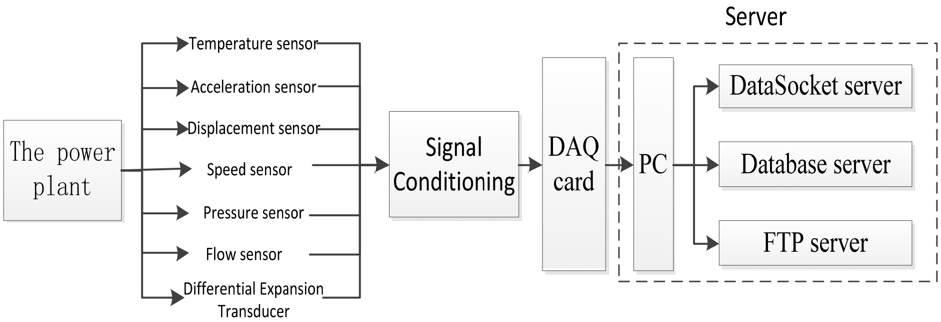

Fig. 1. The diagram of the data acquisition.

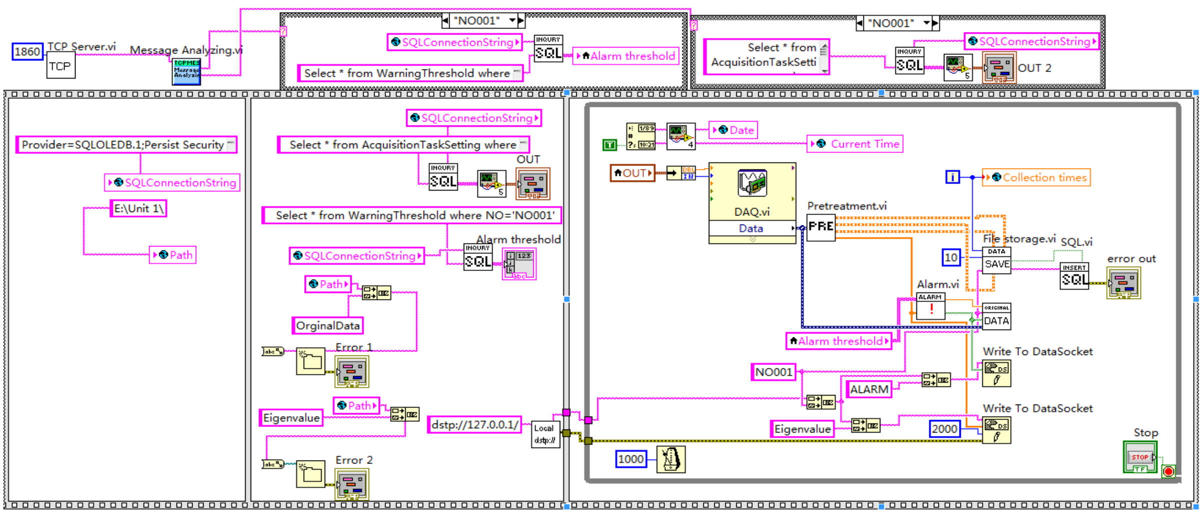

Fig. 2. A high-frequency signal acquisition task.

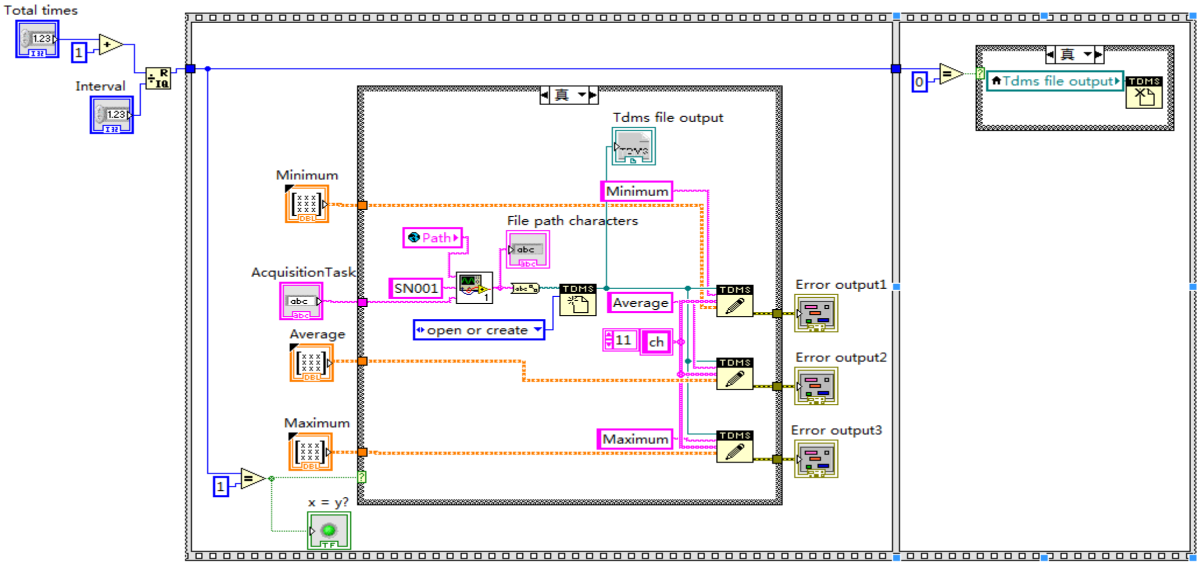

Fig. 3. The characteristic data storage.

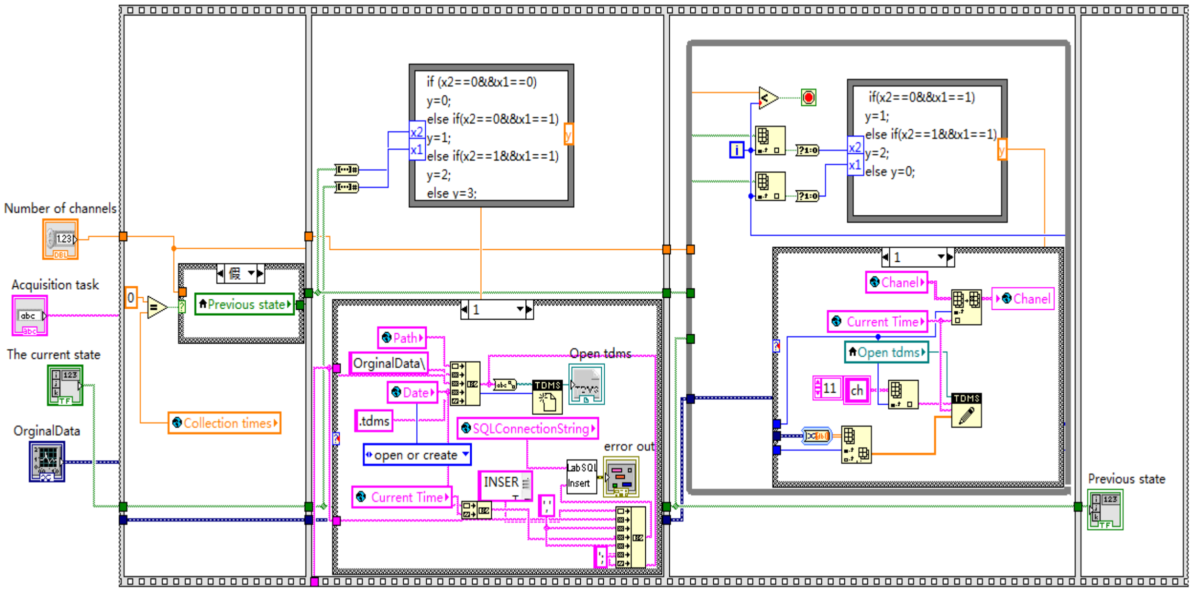

Fig. 4. Store the original data according to the alarm signal.

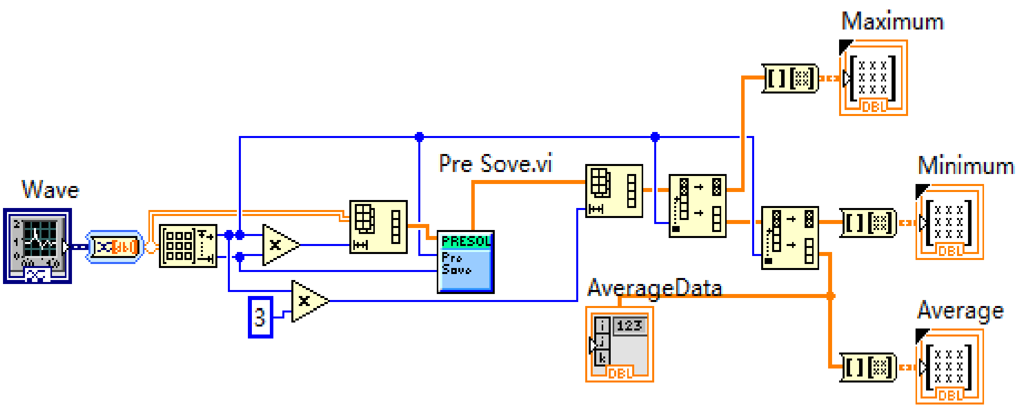

Fig. 5. The Pretreatment of the high-frequency signal.

2.4. Monitoring Database

The acquisition system uses SQL Server as the back-end storage database, the database system has three main functions [4]: (1) static data storage including the unit number of the design parameters, sensor information, the measuring point, the transmission of data communications (FTP address, TCP port connection Datasocket Server URL); (2) dynamic data storage including channel sampling parameters, alarm thresholds; (3) real-time data storage including the characteristics of data storage information, failure data storage information, condition information, message log. Structure of the database relations is shown in Fig. 7, and the procedure of database query operation is shown in Fig. 8.

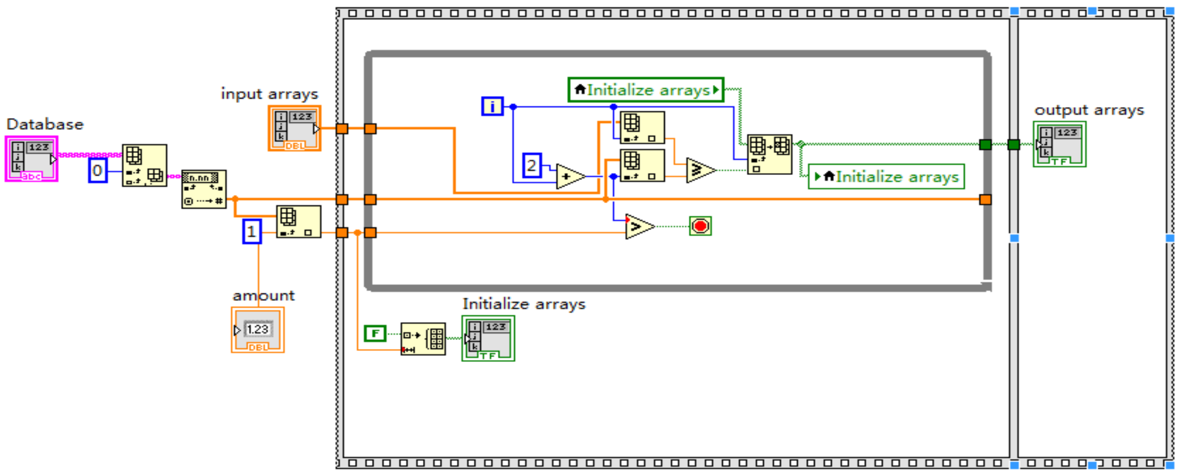

Fig. 6. Warning judge.

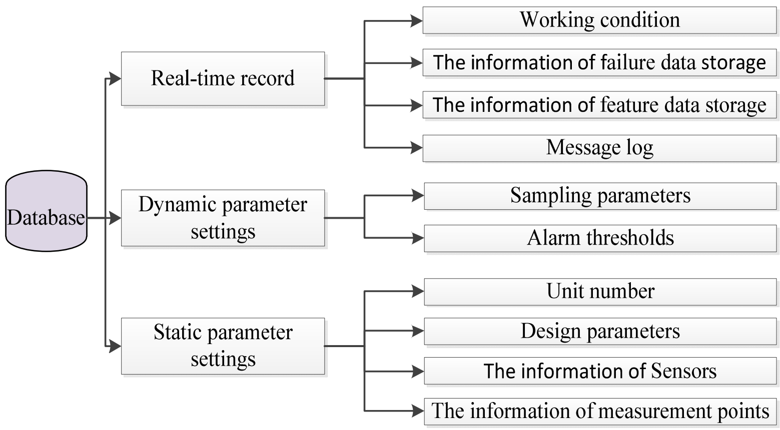

Fig. 7. The relation of database structure

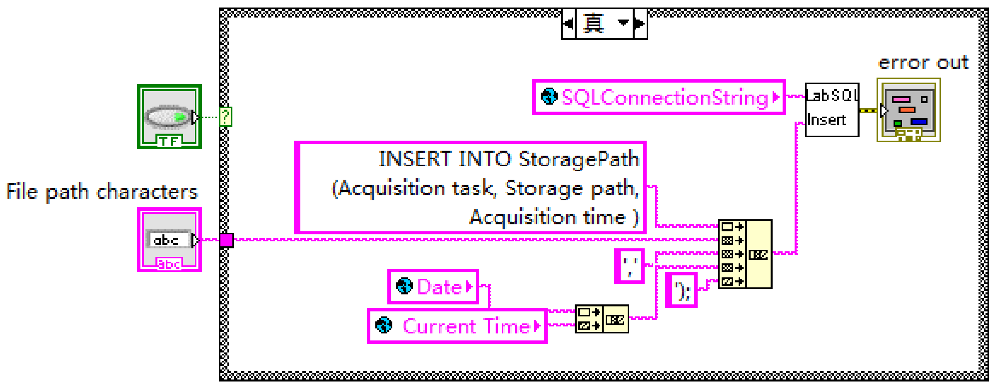

Fig. 8. Database query operation.

2.5. Remote Communications

The remote communication includes real-time data communication, message communication and file communication. Real-time data communication is based on DataSocket Server [5]. All data is passed from publishers to subscribers through the DataSocket server. The DataSocket server is identified on the network using a Uniform Resource Locator (URL). URL sets as "dstp: // native IP/ unit number + acquisition signal type number + acquisition card number", so that each acquisition task corresponds to a unique URL. The corresponding information of acquisition card and data channel of all URLs is stored in the server database. Clients can acquire the information from the server through the TCP. Clients can connect to DataSocket Server through the URL, in order to obtain the feature data corresponding to the point. According to the corresponding information of acquisition card and data channel, the clients can have knowledge of the equipment operation. Clients can have access to data stored in the server through the FTP server [6]. The structure diagram of C/S communication is shown as in Fig. 9.

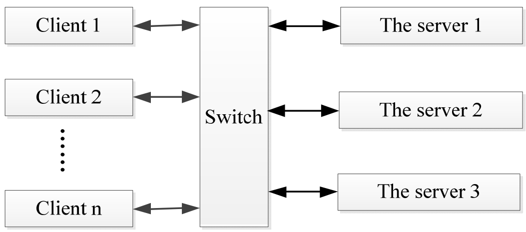

Fig. 9. The structure diagram of C/S communication

3. Client Design

The advantages of the C / S structure is able to give full play to the client PC's processing power, a lot of work are processed in the client-side and then submitted to the server [7]. The functions of customer service are divided into the following sections: system settings module, real-time signal display module, and signal monitoring and analysis module, Fault diagnosis module, recalling the accident module.

3.1. The System Settings Module

When using this module, the system requires a password to obtain the appropriate permissions to set system parameters.

The function is that the settings of power plant critical equipment's sensors and the settings of the upper and lower threshold of important parameters such as vibration, voltage, displacement, temperature. It ensures timely detection of equipment failure and reduces the economic losses caused by equipment failure.

3.2. Real-time Signal Display Module

Client uses the control of DataSocket communicate with the server to obtain real-time signal data. The date of power plant critical equipment, like voltage, vibration, displacement, the gap, the temperature and flow of acquired signals, would be displayed according to the user's requirements. The client can conduct real-time display and real-time status analysis according to the user's requirements.

3.3. Signal Monitoring and Analysis Module

Signal detection analysis module is applied to field data analysis and processing, in order to provide data support for intelligent fault diagnosis module and field staff's Judgment [8].

Function: signal time-domain waveform analysis: using different equipment to obtain the characteristics of signals in time domain diagram, auto-correlation, cross-correlation, probability density, time-domain envelope, and for time domain analysis .Signal frequency domain analysis: the analysis of equipment acquisition signal such as amplitude spectrum, phase spectrum, cross-power spectrum, envelope spectrum and cepstrum. Signal three-dimensional spectrum analysis: using the three-dimensional spectrum observed the rotor's dynamic response process under its many frequency components. Analysis of the signal amplitude: Signal acquisition, including the mean, maximum, minimum, rms value and kurtosis, etc. Signal trend graph: historical data for the use of statements (day\month\year), observing whether there is a significant change in trend on the magnitude of the equipment's key parameters and then predict the possible failure of a position.

3.4. The Intelligent Fault Diagnosis Module

Data using real-time signal data acquisition module and the detection analysis module, key equipment working condition of the power plant, the failure mechanism, the cause of the failure to make judgments and to provide a reference for the engineering staff to provide troubleshooting measures. Function: failure mechanism analysis: acquisition signal analysis using fuzzy mathematical principles to judge the malfunction site conditions. The main reason for the failure: the main reason for equipment failure, the decision to provide a scientific basis for people whether the failure of the unit and take safeguard measures. Fault Analysis of the salient features: equipment failure occurs, especially scene gathering the salient features of the signal [9].

3.5. Recall the Accident Module

Recall the accident module stores the historical accident data of power plant critical equipment, and offers a variety of ways to search for the engineering staff.

Function: direct inquiries can carried out through the use of workshop, equipment name, time, accidents name .etc. Providing the indirect way input keyword fuzzy query. By clicking on the using name of the equipment, you can link to all historical accident records of this equipment, and view all incidents information this equipment recorded. Simultaneously having the modifying permissions of the user can conduct modified operation

4. Software Test

A waveform of the client from the server to obtain real-time data is shown in Fig. 10. The servers use collection procedures written by LabVIEW to get real-time signal from the scene, while they store and post the data. Local clients can selectively receive data according to their own needs, and display the data in the form of a waveform on client [10].

When the device fails, the client can download the raw data from the server to find faults, and give diagnostic results back to the server in the form of a data file, enabling data sharing between other clients.

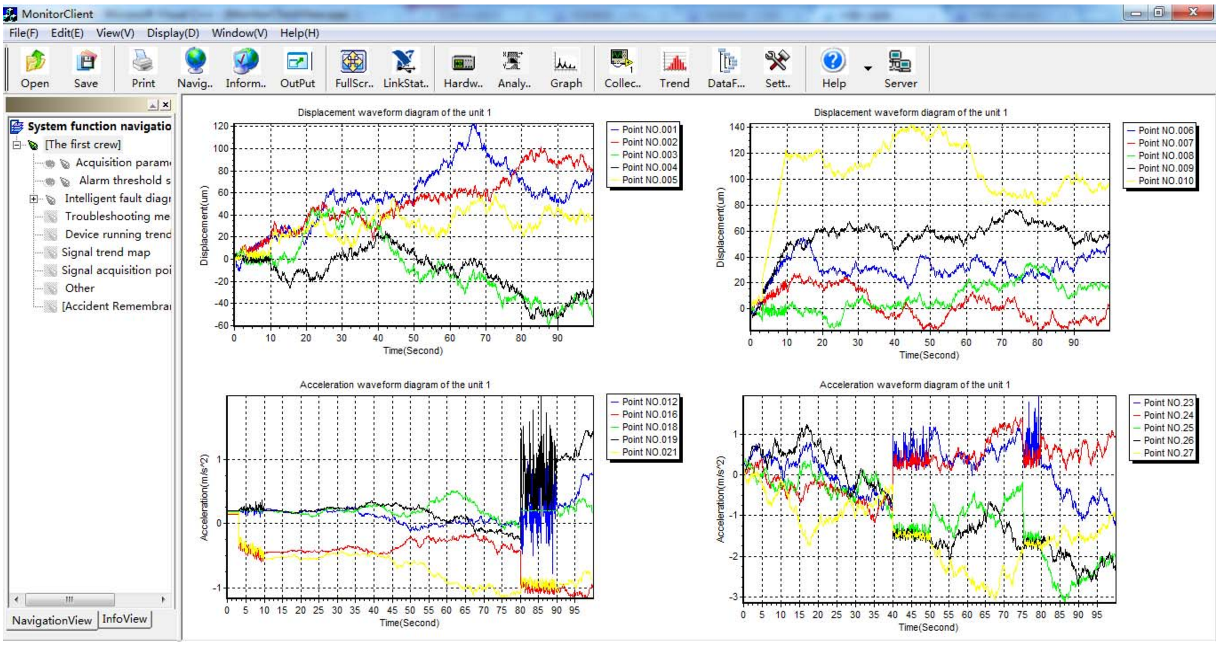

Fig. 10. Client monitoring interface.

5. Conclusions

This article by LabVIEW and VC communication, design a set of C/S mode multi-unit multi-points remote monitoring system. The system uses DataSocket, TCP and FTP communication to make the remote real-time data communication, information communication and file communication come true. It makes sure engineers and technicians to easily understand the operation of the various units. Once a device comes to failure, engineers and technicians can download the original data which acquired from the corresponding measuring points on the event of a failure from the server to carry out fault diagnosis. Clients can take full advantage of the server publishing feature data and raw data provided, and use a variety of knowledge and experience (including knowledge of the equipment and parts failure or failure mechanism, as well as the principle of the device structure, kinematics and dynamics design, manufacture, installation, operation, and maintenance of knowledge),to make identification and diagnosis of the state of the equipment and to make prediction and forecast of its development trends for providing the technical basis for troubleshooting and equipment maintenance decision. Continuously improving the equipment operation quality and state control level to make maintain the equipment high precision, high efficiency, low failure and low operation cost is of great significance to realize the equipment's life and cost optimization.

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