LAN 과 MODEM을 이용한 ECG 원격 진단 시스템 구현

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Design for the Remote ECG Diagnosis System using LAN and MODEM

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ABSTRACT

We have developed a remote diagnosis system using the LAN and MODEM which enables a routine check for a patient remotely.

We used LabVIEW™ as the pograming development tool and DAQ (Data AQuisition) board from National Instrumentfor for data aquisition. The LAN card and MODEM are used for the transmission of patient's data. A patient data are aquired by DAQ board and signal processing is done by LabVIEW™, which is a graphical prgamming language.

Two methods for the data of transmission. One is the Client-Server model using TCP/IP (Transmission Control Protocol / Internet Address) in the LAN (Local Area Network). Another is using MODEM to transmit the measured data from a patient. In this case, the data trasnmission is accomplished by the FTP (File Tranfer Protocol).

I. Introduction

Medical science make great strides especially in terms of treatment and the diagnosis by the development in a biomedical engineering. The remote diagnosis is one of the most prominent field among them and still in its progress.

Many systems were designed for remote diagnosis system, and still have many serious problems associated with its prtocol, economy and efficiency.

Usually a developing system takes long research and development, and also a great deal of cost is spent as well. Once the system is completed, it is hard to modify its design or its function.

We have introduce a system which is not only as a remote ECG diagnosis system but also as a developing system tool. Each part of the function are modulized so that it can be easily modified and substituted with minimum expense.

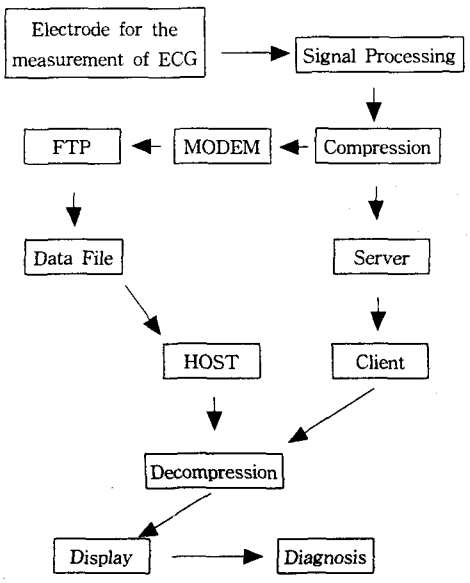
Therefore, it shortens developing time. Even if whole design concept were changed, simply each funtional block need to be changed or rearraned. The user can easily apply new developped algorithm or method in this system.

The algorithms such as filtering or compression can be taken in real time even before required hardware implementation. In this way, we believe the time and the cost for a developing a prototype of a remote ECG diagnosis system can be greatly reduced.

After all, we designed the system which consist of the modulized components. Minimized dependency to hardware, increased flexibility in software are realized.

In this paper, we present the structure and function of each modulized components of remote ECG diagnosis system using LAN and MODEM.

II. Basic Concepts



< Fig 1. The Block Diagram of the Remote Diagnosis System >

1. DAQ (Data AQuisition) Board

The aquisition of ECG signal for a patient is accomplished by the DAQ board. ECG simulator is used for signal source in stead of human subject. Each analog input channel of a DAQ board is configured as a differential mode.

If any additional measurement in needed, the modulized software unit - called VI in LabVIEW™ - can be easily copied and pasted. After wiring between the DAQ board and the measurement device connected, the entire measurement system is then completed with modulzed software.

The number of analog input terminal for the DAQ board is 16. Each of analog input terminal is linked to the input terminal of the PGIA (Programmable Gain Instrument Amplifier).

In the differential mode, the number of usable terminal is reduced to 8 because the analog input terminal from AI0 to AI7 wired to the non-inverting input terminal of PGIA and one from AI8 to AI16 wired to the inverting terminal of PGIA. For example, in ECG measurement system we can observe 8 channels simultaneously in any combination of load system we need LEAD I, LEAD II, LEAD III, V1 ~ V6, aVL, aVR, and aVF with suitable switch box.

Some of the important properties of this DAQ board is shown in table 1.

Type of ADC	Successive Approximation
Resolution	16 bits, 1 in 65,536
Maximum Sample Rate	20kS/s guaranteed
Relative Accuracy	±20kS LSB typ, ±1 LSB max
FIFO Buffer Size	512 samples
Type of ADC	Successive Approximation

< Table 1 The Properties of DAQ Board >

2. LabVIEW™

The LabVIEW™ is graphical programing language The hardware/software interface and the user interface can programed graphically without any lengthy text. The hardware /software interface is programed ready to transmit the measure data of patient obtained by the DAQ board. Two vehicles for a data transmissioncan be used. One is MODEM. And another is a LAN. MODEM is usual way to to link the transmission line from a patient area to hospital area LAN to LAN can be utilized as well for the data transmission such from hospital to hospital.

The LabVIEW™ is able to transmit the data of the patient in two ways, one from MODM to LAN, the other from LAN to LAN. By observing the transmitted patient's data, a medical doctor is able to diagnoses.

Except for the portion of preconditioning hardware, DAQ board, MODEM and LAN for communication, all the functions are implemented as VI visual interface icon.

Especially, the signal processing such as a filtering, a noise reduction, a fixing base line , etc., are implemented in VI and performed in real time in pentium PC. A VI is a functional, structural unit in the LabVIEW™. Therefore, as mentioned above, the entire system can be realized by the modulized unit without any additional hardware. This flexibility and expandibility without any additional cost is a great advantage of this system.

3. Data Transmission

① Using the LAN

When we transmit the patient's ECG data using the LAN, we used the Client-Sever model to the LAN (Local Area Network). Two informations about the LAN need to be supplied to VI.

One of the doctor's office is the IP address and the port number for each of client-server model. We were able to realize 12-lead ECG remote to diagnosis system for one patient. This can be extended to multiple patient at the same time by the assigning different port number to the IP address. If you want to obtain other measurement data such as EMG, EEG and so on, it is possible too.

The VIs related to a network system or communication in the LabVIEW™ are a TCP (Transmission Control Protocol) VIs, UDP (User Datagram protocol) VIs, DDE (Dynamic Data Exchange) VIs. Therefore we are able to realize this system in any network system by the programing and application using LabVIEW™.

② Using the MODEM

Usually, a modem uses a serial port in the computer. When we use MODEM for communication, we use the Serial VIs. The serial port VIs configure the serial port of the computer and perform I/O using that port.

Byte VI reports the number of bytes available in the serial port input buffer. Break VI sends a break on the specified output port. Init VI initializes the selected serial port by specifying the protocol, handshaking, and buffer size. Read VI reads characters from the specified serial port. Write VI writes a data string to the specified serial port.

we used the FTP (File Transfer Protocol) in order to the transmission of ECG data using MODEM.

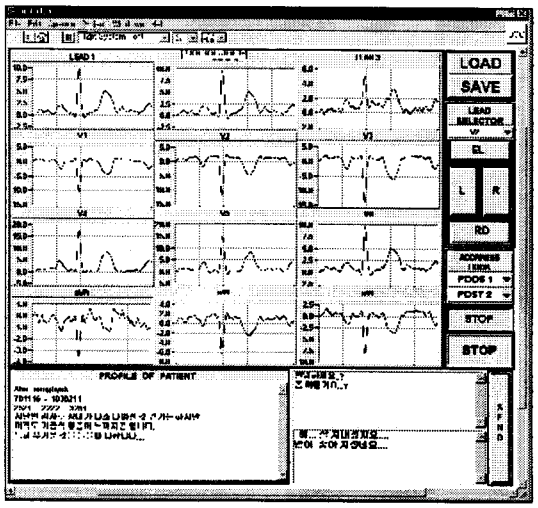
4. Filtering and Compression

The method of the compression and filtering for ECG signal is well known. In this system, we use the following general methods for filtering. To eliminate of EMG noise, we use Butterworth low pass filter and to eliminate of high frequency noise such as 60Hz noise, we use Band reject filter.

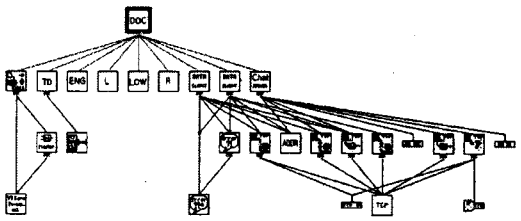
In the compression, we were also to reduce of the data of ECG signal through the AZTEC (Amplitude Zone Time Epoch Coding) algorithm.

B. PROGRAMING

1. Doctor's Monitor



< Fig. 2 The Doctor's Monitor in LAN >



< Fig. 3 The Hierarchy of Doctor's Monitor in LAN >

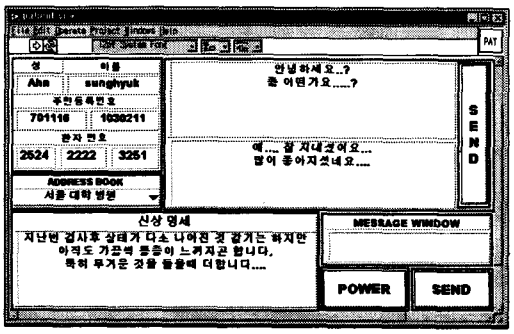
The user interface window for the doctor is shown in Fig. 2. The window is divided into several parts. The first part shows the transmitted ECG data of a patient. The keypad consists of the LEAD SELECTOR, the LEFT/RIGHT SCROLL BUTTON, and the ZOOM IN/OUT BUTTON offers easier interface for the user.

The user has control of these function through key pads. In addition the user can obtain the patient information through the ' patient profile

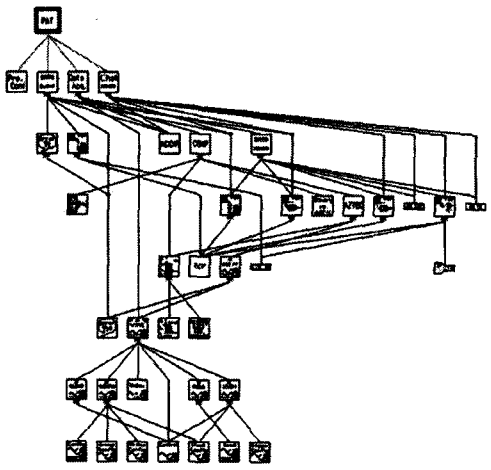
window '

A dialog box can be used for interactive conversation between patient and doctor in real time. The other part is dealing with the save and load function of patient's data, the address book for networking, and getting a file transmitted by MODEM from FTP .

② Patient's Monitor to the LAN



< Fig. 4 Patient's Monitor to the LAN >



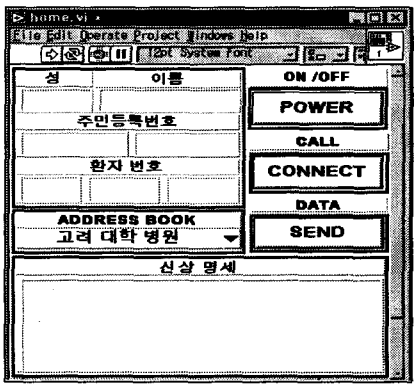
< Fig. 5 The hierarchy of Patient's Monitor to the LAN >

The window for patient is quite different from the one for doctor. It includes the dialog box for conversation with a doctor also.

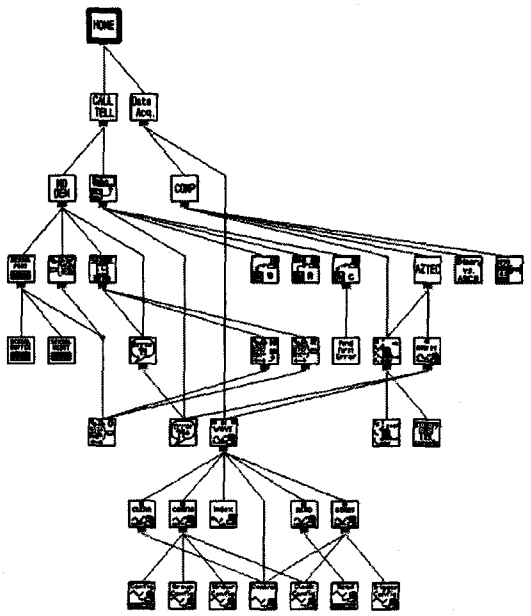
There is a part to recording the name, identification number, registration number, and private profile of a patient on the upper left.

To connect with a desired hospital, the user can select hospital from the address book which can be found from full down menu. As an additional function, there is message window which shows the state of system.

③ Patient's Monitor to the MODEM



< Fig. 6 Patient's Monitor to the MODEM >



< Fig. 7 The hierarchy of Patient's Monitor to the MODEM >

The fundamental architecture of the Monitor for remote diagnosis system using MODEM is shown Figure 7.

The program begins to work after the personal data such as a name, patient number,

and profile is filled. If the MODEM is connected with the host, the LabVIEW sends a specified ID (Identification) and password automatically. The Program will write the command on the MODEM continuously until the connection is made the host system. The LabVIEW sends the ECG data file of a patient. After file transfer is completed, the LabVIEW™ will be logged out automatically to the host system. Most of processes are carried out automatically.

III. Conclusion

The remote ECG diagnosis system using LabVIEW™ is presented. Since it is the graphical language, the system design easily modulized and iconized. The hierarchy of the system is also easy to follow and so does the debugging.

In the field of research and development, one should be able to add and remove function easily, another words, it sould be very flexible. Our system satisfies well of this requirement.

This system can utilize not only the TCP/IP in the Client-Server Model but also the DDE or UDP. In the future, multi-media function need to be implemented for the user friendliness. New algorithms for signal precessing or compression can be tested without any additional cost. Also other protocols such as DDE, UDP can be tested and compared with each other. In this way, one can develope a general real time remote diagnosis system. This system can be applied a variety of systems in bio-medical engineering.

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