Real Time Medical Telemetering of Sustainable Health Care Measuring Devices

CARMEN AURORA BULUCEA 1
MARIUS CONSTANTIN POPESCU 2 CORNELIA AIDA BULUCEA 2
ANCA PATRASCU 1 GHEORGHE MANOLEA 2

1Faculty of General Medicine, Obstetrics and Gynecology Department
University of Medicine and Pharmacy of Craiova
2Faculty of Electromechanical and Environmental Engineering
University of Craiova
ROMANIA
abulucea@gmail.com, popescu_ctin2006@yahoo.com, aidan5678@em.ucv.ro, ghmanolea@gmail.com

Abstract. An important issue of medical world concerns the creation of systems for online medical parameters monitoring. The solution is to pervade into computing systems which have the capabilities of monitoring, data acquisition and data transfer from medical devices. In the paper the medical measurement devices which are realized on basis of optoelectronics and microwave, and the adaptation and use of these devices or sensors in instrumentation systems and telecommunications are taken into account. The study aims to create a user-friendly interface software that enables the steering vector network analyzers vector via the Internet.

Key-Words: Biological parameters monitoring, Computing systems, Health care research

1 Introduction
To reduce hospital expenditure sometimes it is reasonable to monitor patients at home rather than in hospital [1]. This study overviews the necessity of patients or elderly people to monitor constantly some biomedical parameters. A reason of use for automated data capture systems is a patient being monitored from home where they will be able to transfer their reading online without involving medical professionals. The medical measurement devices which are realized on basis of optoelectronics and microwave, and the adaptation and use of these devices or sensors in instrumentation systems and telecommunications are taken into account in this paper [2],[3]. To monitor patients at home it could be a sustainable and practical solution [1], by utilising existing medical devices and by using their connectivity together with appropriate software modules (Fig.1). It means that the developed software modules will allow building flexible systems for medical devices which are monitoring, measuring, recording, storing, processing and transmitting different human biological parameters [4], such as:
- blood pressure;
- oxygen saturation;
- body temperature;
- cardiac rhythm;
- respiratory rhythm;
- pH data;
- ECG channel;
- fetal heart rate
- uterine contractions of labor.

The study aims to create a user-friendly interface software that enables the steering vector network analyzers vector via the Internet. The measuring devices that will be controlled remotely are two network analyzers, used in the fields of microwave and radio frequency: HP 8751A (5 Hz – 500 MHz) and HP 8510 B (45 MHz – 20 GHz). The proceeds will be used on machines compatible PC with the Windows
operating system (98, ME, NT, XP, Vista) connected to the Internet, or via the CTS network (modem) or broadband connection [5]. The platform will be patient-server structure or medical professionals-server structure or patient-medical professionals-server structure.

The server will be based on the place of experimentation in communication with the device through a GPIB card and receive commands Patient software, which will have a graphical interface very close to the real appearance of the analyzer vector [5]. The ultimate goal of this project is to provide for SMEs and SMIs switchgear specific and specialized. In this way, SMEs and SMIs, but also universities and training bodies could use remote expensive equipment for their own [6].

2 Study Theoretical Overview

The various actions that are undertaken are as follows:
- implementation of software to enable the local steering of the measuring device; achievements from existing software make possible the remote via the Internet of the medical measuring apparatus - allow communication between software remote steering and acquisition measures;
- implementation of a software interface dedicated to monitoring the remote handling - the product's graphical interface (GUI) will be as close as possible to the user interface devices real so that the user is not disabled if he had the opportunity thereafter to make measurements on actual devices, or facilitate the use of software to students or to medical professionals (Fig. 2).

2.1 Microwave Analyzers

The HP 8751A and HP 8510B are vector analyzers of the parameters of reflection and transmission (S parameters). They measure and shape the magnitude, phase and group delay responses of active and passive RF networks. Two independent chains display and a colour screen to draw the results of measurements in square or polar / Smith card formats. The functions are selected using the panel operation and menus on the screen. The frequency range of measurement is 5 Hz - 500 MHz for the HP 8751A and 45 MHz - 20 GHz for the 8510B [5].

2.2 Matrix transmission [S]

The linearity of Maxwell's equations applied to linear media to suggest a wave $b_i$ emerging as the sum of all incoming waves $a_j$ affected by the constants SIJ [6]:

$$ b_i = \sum_j S_{ij}a_j. $$

The SIJ coefficients are independent of the variable variables ($b_i, a_j$) and characterize the behavior of multipole. These are complex numbers without dimensions. The relationship matrix that connects the different quantities is:
with: \([b] - \) matrix column emerging or outgoing, 
\([a] - \) matrix column incident, or incoming and \([S] - \) matrix of transmission or diffraction - "Scattering matrix".

**Dipole and quadrupole.** \(V\) is the sum of an incident voltage and a reflected tension (Fig. 3):

\[
V = V_i + V_r
\]

(3)

The coefficient of reflection is defined by:

\[
S_{11} = \frac{Z_i - Z_0}{Z_i + Z_0},
\]

(4)

or using reduced impedances, with \(z_i = \frac{Z_i}{Z_0}\) and

\[
S_{11} = \frac{z_i - 1}{z_i + 1}.
\]

\[\text{Fig. 3 Schematic: a) dipole; b) quadrupole represented by its graph of influence; c) quadrupole.}\]

3 Technical Achievements

3.1 Description of General Architecture

The software architecture of the system focus on sustainability and flexibility. The system is clearly separated into two applications [2]:

- **Server application** placed on the office PC is where the map GPIB installed, and which is connected to the medical measurement device. We can also imagine that this software can be installed on a laptop with GPIB card format PCMCIA. In both cases, the PC must be connected to the Internet. Each instrument has its own server since each has its own language of communication. The server will receive patient connections and will be responsible for administering and controlling the medical measuring device generating a response to the patient's request;

- **Patient application** placed on a PC connected to the Internet, which requires no installation. The patient software will be the same for any machine, specific information will be sent with the executable in a fichier.ini bitmaps and the GUI. The patient merely notifies the user actions and display graphics in various formats (actual measurements returned by the unit). The platform allows for many users so only one of them will fly the equipment in every moment. The decision to allow several units (for students or medical professionals) includes if one thinks the purpose of the product, tele-education. A chief (professor) will lead the device and others could follow in handling the screen and watch the results of the measures. In the server, the patient "Issuer" can easily be changed from users connected.

3.2 Justification of Technical Choices Made

**Operating system.** The platform is developed for OS Windows because the drivers for certain specific cards (such as card National Instruments GPIB) are not always available for Linux. That on the server. The user does not need a specific driver to operate: it could consider using the Windows server, and develop an issuer in a different OS.

**Programming language.** The choice of C++ with Borland Builder represents a good compromise between the two languages following:

- The language used by the LabView software LabWindows. It allows you to easily drive the bus GPIB and realize GUI close to the actual device. However, it hardly manages connections patient / server.
- The Java, multi-platform par excellence, which manages very well all communications patient / server, but the steering HPIB bus is not (yet) implemented. The C++ represents a good compromise between LabView (whose sources are in C) and Java, because it compatible LabWindows station using the power of object
encapsulation, including the management of communication sockets (use simplified). The display of the GUI-level user is also simplified because Builder VCL components using standard graphics, easier access USE that controls the MFC (Microsoft Foundation Class) MS Visual C++. Builder can also import new components (Delphi, ActiveX, ...) which will be interesting to improve the appearance score thereafter [2].

**Interface.** We chose the VISA interface that is not specific to the GPIB bus, which has the same functions for the serial link, for example. It is a layer above the layer HPIB or series.

**Bus instrumentation.** We opted for the bus GPIB (or IEEE-488) because the interface is the most commonly encountered on measuring devices. There are also serial link, but it is slower and less widespread, and the FireWire interface, newer and faster than the IEEE-488, but also low at the moment.

**PC Card interface.** The map National Instruments PCI bus and PCMCIA (for a laptop) that was chosen. This brand uses drivers that, a priori, have fewer problems than HP. Not having been echoed on the quality of maps of the Keithley mark, it has instead opted for relatively cards are known by researchers. NI also has the advantage of providing with its drivers, its two known programs in LabView and LabWindows trial version, especially in C libraries for each device HP, which are more to the point that those of HP and Keithley.

**Login.** We chose a connection through the Internet, rather than a modem connection for example, to allow easier access to the server (no need to call to connect).

**PC's server and patient.** We must use a fairly powerful PC (PIII 800 per instance).

**Piloted equipments.** Given the nature of the project (Real-testing), it is natural that we turned to laboratory equipment, thin, powerful but expensive, fragile, bulky and not necessarily accessible to a group of students. One could think of Pilot simper devices (oscilloscope), but the interest would be limited.

### 3.3 List of main classes

**A. CTransfert Class** - this class, common server and client, manages the transfer information (messages actions, tables of measures) between the server and the patient. His role will be to serialize the information in the form of a compressed frame that the client will decode. The main methods of this class **Class2Byte** and **Byte2Class**. The first serialized all of the information in the fields of the class (action, size and content of tables of measures, display format, News ...) in a first stream, then this will compress flows. The **Byte2Class** method is the reverse of the previous one, which will decompress the flow specified before completing all fields in the class with the values in the frame. The table’s measures, if any, will also be established so that the main class can access thereafter.

**B. Server. Device Class** (HP7551A or HP8510B) - this class to own each unit and manages the device, using the functions provided by National Instruments. It realizes the interface between the main class and class transfer, managing the applications and by providing the class transfer relevant information (tables of measures) to form the frame. Used in this class type’s standard VISA (ViStatus, ViReal64 ...) contained in the library "visa.lib" and can be studied in the file "visa.h." The main method of class, **TraiteDemande** responsible action to address sent by the client. It returns a feed store and its length, corresponding to the answer frame to be sent to the patient. For each action requested, it uses the corresponding settle HP or the acquisition of measures on the device. If an acquisition is made of measures, the method fills an array of complex **Class CTransfert**. There are also actions settings current settings of the device, contained in the fields (reglfreqd for frequency start, reglfreqf for the final frequency ...) which will be sent to the device to match demand in real setting. Indeed, for certain input parameters, the user manually enters a value. According to the button pressed, our class will simulate the actual behavior of the device and must accurately update the contents of current setting. Once the treated **TraiteDemande** launches flow generation, conducted in the classroom **CTransfert**, then returns the flow compressed the main class.

**TmainForm Class** - class that declares the main menu of the application server, menu items and manages the events that occur in the form. Be
careful methods AppSocketPatient-Connect, AdminSocketPatientConnect, AppSocketPatientRead, AdminSocketPatientRead which are methods of learning peeled event when receiving a connection from a client or receiving a string representing a client's message. It was decided to separate information about the connections, logins ... (Admin) messages of each device (App) into two sockets to facilitate management. At each new connection, the server verifies that it is a valid user with the password he compares to the list included in the file "serveur.ini." If it finds a match and if this login is not already connected, it sends a message to the opening of the connection. Otherwise, it returns a message of non-authorization and closes the socket connection. Each action received for the patient order, then we run the method of TraiteDemande of the Camera class: this action is decoded and the response to the motion is generated in the form of data stream. The user can have three types: Neutral (when it does not control device, but it does not receive the measures), Issuer (when he commanded the unit) and Receiver (when he does not visualize it in its display measurements). Once the action is treated on referral response sockets patient transmitter and receiver doctor. Another important method is the ChangeEtatPatient called in a double click on the login of a patient, and that changes the status of user choice and, if necessary, other users (because he can not have more than one user issuer at a time).

C. Patient. TMainForm Class - class that declares the main menu application main patient, menu items and manages the events that occur in the form.

4 User Guide Interface

Installation. Open the file "WebAnalyzer.zip with Winzip. Unpacking the entire archive in the same directory. You now have an executable file "Pacient.exe" and two cases (one each) that contain the files needed to start the program.

Launch. Run the file "Patient.exe" in the previous directory. Click on the item "Connect" menu, then click "Connect ..." (Fig. 4). Enter the server name, your login and password, then click OK. There is no need to type apparatus to which you connect because once the connection is made the server notifies the patient device which it is connected. Once connected and received the name of the device you are connected, the user to complete the loading graphic (neutral state, Fig.5). In the study, we will work on the HP8510B [7].

Use. Once the cover charge, must wait until the server allows us to order (as issuer), or receive data while another user controls the machine (as receiver). Let's see if issuer (Fig. 6). Now, piloting through the software is the same as in the real machine, so the software can chat with other customers and server to facilitate remote. To send the text chat, just write on the white bar and click OK. The message is received messages appear on the window in Figure 7. To save the measure displayed, click on the item "File" and then "Save the table of measures" (Fig. 8). To disconnect the software, click on "Connect" then "Disconnect" and quit the application click on "File" then "Exit".

Fig. 4 Launch Window.

Fig. 5 Graphic interface (GUI)
5 Conclusions
The primary objective of this study is to realize a link between Computer Science and Medical Equipments, in order to establish a reliable health care environment. The main purpose is to make possible to connect the medical measurement and monitoring devices to any type of personal computer and retrieve the measurements directly from devices.

The main distinguishing aspects of the device are a combination of self-training and mentoring strengthened introduction of a course of long-term - during the patient’s education and training, consisting of modules for distance education easy opening a training system by issuing modules Independent.

Three other objectives are covered through this distance learning: the strengthening of educational exchange within the network R2A by pooling various modules, the creation of partnership school / company around research and development projects carried by enterprises, development of the offer continuing education in Medicine Faculties.

References