Designing and implementing Electromyography (EMG) portable systems to check the health of the pilot in the cabin of the aircraft remotely

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Abstract
In this paper, the design and implementation of a portable PC based on EMG system to check the health of the pilot in the cabin of the aircraft is discussed. The objective of this paper is to present a Real Time pilot Monitoring System using LABVIEW and Visual studio which enables continuous monitoring of a pilot and helps the doctors with better diagnosis.
Generally, the project is divided into three following sections: First, signal preparation by AD8232, Second, analog-to-digital conversion by DAQ, and third, signal display in a computer. Firstly, the received signal from a body is amplified by AD8232 module. After that, the analog signal is converted to digital, and simultaneously the information is sent to PC (DAQ) to be presented through some engineering software like LABVIEW or Visual studio for the doctors in order to diagnose from anywhere in the world (telemedicine). Benefits of the device include the ability to send heart rate to another system remotely through the TCP / IP and SOAP protocol, the ability to communicate video and text remotely, displaying the signal on the mobile phone.

Keywords: Electromyography, EMG, Remote Monitoring by web server, health of the pilot

Introduction
In recent years, the prevalence of cardiopulmonary diseases has increased due to a very busy lifestyle and deterioration of environmental health factors. Insurers and Employers are putting big pressure to reduce healthcare expenses. Spending time at a hospital could be a difficult experience due to high costs, travel time, staying away from home and family, and less freedom to move, etc.
With advancements in Bio-instrumentation, computers, and telecommunications technologies, it becomes feasible to design home-based vital sign telemonitoring systems in order to acquire, record, display and transmit physiological signals from the human body to any locations. Several studies were done in telemedicine applications field in order to perform a real-time ECG telemonitoring via multiple communication networks like telephone network.
In recent years, computer based systems have become an inevitable part of every healthcare environment. Remote patient Tele-monitoring system using LABVIEW and Visual studio in a computer enables doctors to monitor the vital bio-signals such as electrocardiogram and heart rate of patients by using the real-time waveform and data monitoring function of LABVIEW and Visual studio installed on the computer.
The need for real-time notification of vital signs of pilot to the doctor is of prime importance, thus the need for active database system arises, and that is grouped with a pilot monitoring device. In order to minimize the time utilized for procedure preparation, it would be convenient if patient's clinical data reaches the doctors well in advance; this is where telemetry comes to play, so they are well-prepared on the arrival of the patient. The vital parameters can be processed in an ambulance implemented by LABVIEW with greater accuracy and at cheaper price; then, transmitting them dynamically to a mobile phone from where it is sent to a doctor via internet and moreover, it alerts in charge about abnormal parameters by sending alert signal on in his/her mobile. Moreover, the medical world today faces two basic problems when it comes to patient monitoring: firstly, the need for healthcare providers' presence bedside the patient, and secondly, the patient's being restricted to bed and wired to large machines. In order to achieve a better quality patient care, the above-cited problems have to be solved.

1. Proposed system

The patient is referred to as the pilot in the article. this paper deals with acquiring biomedical parameters from the pilot and digitizing them by using a DAQ. Then the digitized data is given to a virtual instrument running on the computer which is connected to hospitals LAN. The biomedical parameters to be monitored and shared are of Electromyography and ECG. These physiological signals are acquired by using various sensors. AD8232 uses the sensor to sense the Electromyography rater. Besides, to acquire ECG signals, three electrodes are used. TCP/IP network helps with monitoring and sharing the pilot parameters information to the doctor's system by knowing only the IP address.
As the bio-instrumentation, computers and telecommunications technologies are developing, it has become feasible to design a home-based vital signs telemonitoring system in order to acquire, record, display and transmit the physiological signal from the human body to any location. This may help saving the time spent at hospitals and helps for better diagnosis. Integrated health records may be created by saving the parameter values on a spreadsheet. This provides an excellent provision for future reference and helps the doctors to analyze the pattern of variations for the pilots' conditions at regular intervals.

2. System configuration

ECG/EMG sensor AD8232 is used to receive the signals from the body of the pilot. The data acquisition module NI USB Jitv2.0 transfers the EMG signal into the computer installed with LABVIEW or visual studio. The signals are analyzed and processed by various tools in the LABVIEW platform which further displays the EMG parameters and the pulse rate of the subject. The processed parameters are sent to a mobile phone via Bluetooth services, and then, are sent to a medical care professional for further analysis. The physiological parameters can be saved on a spreadsheet to form an integrated health record which may be referred to at a later point of time to analyze the pilot's condition.

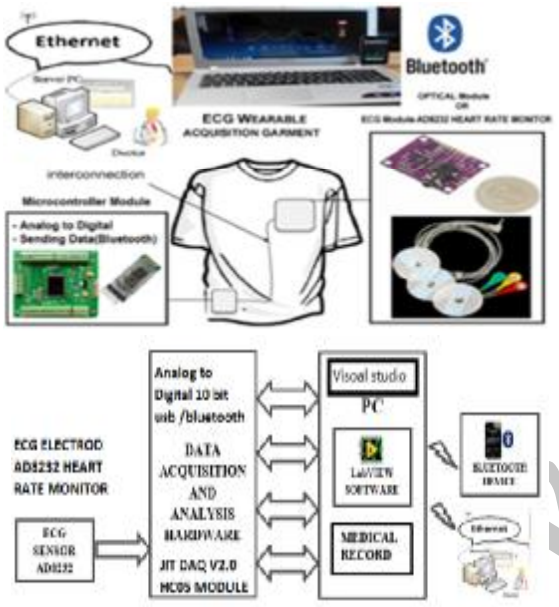

Figure 1: block diagram of real-time patient (pilot)

To enhance the mobility of the doctor and the patient, we propose the design and development of a module as shown in Fig.1, thereby leaping a step forward in health care industry. When the values of the parameters exceed the normal value or decrease from the normal value, the doctor identifies the patient's condition via TCP/IP network and immediately takes steps to treat the patient. The system module consists of the sensors which sense the patient's biomedical parameters. The output from AD8232 is in analogue form which is converted to digitized data using DAQ. The digitized data is sent to the computer of a doctor. The AD8232 Single Lead Heart Rate Monitor is a cost-effective board used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram and output as an analog reading. ECGs can be extremely noisy, and the AD8232 Single Lead Heart Rate Monitor acts as an op amp to help obtain a clear signal from the PR and QT Intervals easily. The AD8232 is an integrated signal conditioning block for ECG and EMG and other bio-potential measurement applications. It is designed to extract, amplify, and filter small bio-potential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement.

The AD8232 Heart Rate Monitor breaks out nine connections from the IC that you can solder pins, wires, or other connectors to. SDN, LO+, LO-, OUTPUT, 3.3V, GND provide essential pins for operating this monitor with a DAQ or other development board. Also provided on this board are RA (Right Arm), LA (Left Arm), and RL (Right Leg) pins to attach and use your own custom sensors (see Fig.2.). Additionally, there is an LED indicator light that will pulsate to the rhythm of a Heart Beat. Biomedical Sensor Pads and Sensor Cable are required to use the heart monitor and can be found in the Recommended Products section below. Now that the electronics are complete, let's look at sensor pad placement (Fig.3). It is recommended to snap the sensor pads on the leads before applying them to the body. The closer to the heart the pads are, the better the measurement. The cables are color coded to help identify proper placement.

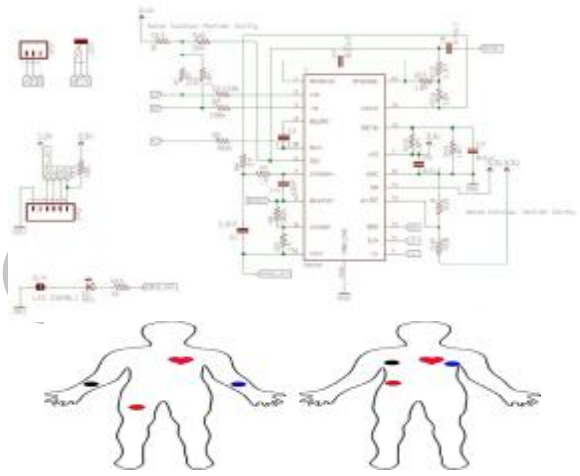

Figure 2: single lead heart rate monitor - AD8232

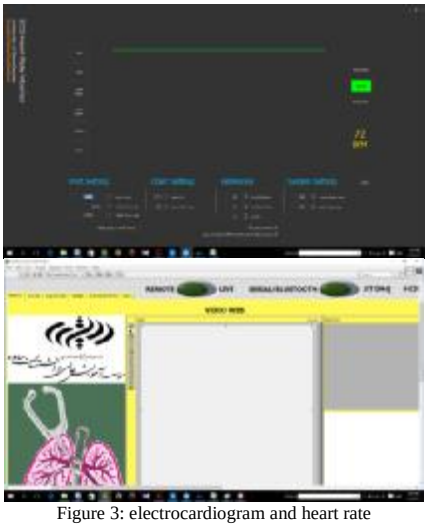

Figure 3: electrocardiogram and heart rate

4. Acquisition and processing of physiological parameters

The parameters of a patient are continuously monitored using sensors. The data acquisition system provides an interface to acquire the readings and process it on the LABVIEW or Visual studio platform. Electromyogram and ECG is the most effective and efficient tool in diagnosis and monitoring of patients with cardiac disorders. It provides enormous amount of clinical information regarding the electrical activity of heart. As the heart pushes blood through the arteries, the arteries expand and contract with the flow of the blood. Taking a pulse not only measures the heart rate, but also can indicate the heart rhythm and strength of the pulse. The normal heart rate for healthy adults ranges from 60 to 100 beats per minute. The pulse rate may fluctuate and increase with exercise, illness, injury, and emotions. The raw ECG/EMG signals are obtained using ECG/EMG sensor AD8232 via electrodes, from which ECG parameters and heart rate can be obtained. The AD8232 is an integrated signal conditioning block for ECG and EMG and other bio-potential measurement applications. It is designed to extract, amplify, and filter small bio-potential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. For recording and measuring these electrical signals, electrodes are placed on the skin of a patient. Locations specified for picking up the signals through electrode are between muscles on the upper arms and lower legs based on Einthoven triangle. The waveform which is obtained after connecting electrodes is acquired using DAQ assistant and processed using various elements of LABVIEW and Visual studio. The result helps the specialist in observing the condition of heart and diagnosing the problem associated with various heart activities of the subject. By using LabVIEW Wavelet Detrend VI and Wavelet Denoise Express VI of Advanced Signal Processing tool Kit, the baseline wandering and wideband noise in the acquired ECG/EMG signal data can be removed. The Discrete Wavelet Transform is used to represent the signal and various ECG/EMG parameters are generated. The processed signal is compared with the normal ECG signal available in the biomedical toolkit of LABVIEW by using LABVIEW Wavelet Detrend VI and Wavelet Denoise express VI of advanced signal processing tool. Whenever any variation occurs, a warning signal can be generated which can be transmitted to a mobile phone using Bluetooth along with pulse rate and other body parameters.

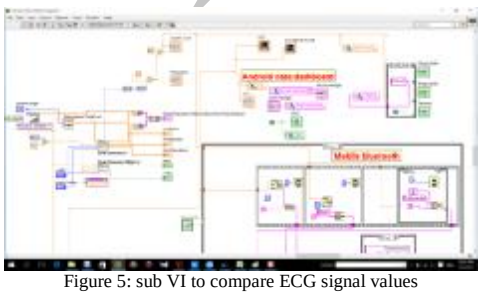

Figure 5: sub VI to compare ECG signal values

3. Bluetooth services for alert file generation

Bluetooth technology provides flexible, low-power communication among Bluetooth devices over a radio frequency. In LABVIEW and Visual studio, VIs running on separate computers or on Mobile devices can use Bluetooth capabilities to communicate. Bluetooth is a wireless technology that uses 2.4 GHz radio frequency to allow devices to communicate. The Bluetooth connection ranges from 30 to 40 feet, depending on the device and the environmental conditions.

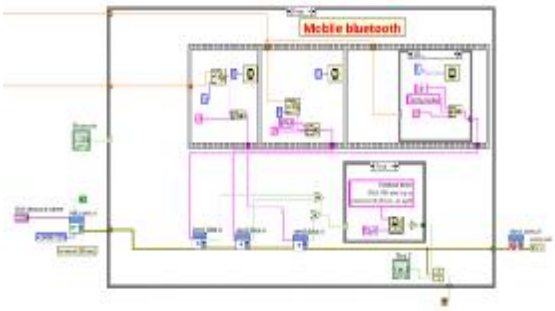

Figure 6: final VI to transmit messages via Bluetooth

The LABVIEW and Visual studio Bluetooth VIs and functions use RFCOMM which is a connection protocol the Winsock interface exposes. RFCOMM is a simple transfer protocol that emulates serial communication. The RFCOMM interface defines Bluetooth servers and clients. Creating Bluetooth server and client applications in LABVIEW is similar to creating server and client applications for TCP communication.

Figure 7: monitoring data on a mobile phone

A Bluetooth server uses the Service Discovery Protocol (SDP) to broadcast the availability of the services that the server contains, and listens for inbound connections. A client creates an outbound RFCOMM connection to a server. Once the client and server connect to each other, they exchange data until the client or server terminates the connection or until the connection is lost. The android application, Bluetooth SPP (Serial Port Protocol) Manager is installed on the mobile phone. Whenever any parameter varies from its normal conditions, the warning signal is sent to the mobile phone via Bluetooth and received on the BT messenger. The values of different body parameters at different instants can be saved on a spreadsheet for future reference using Write-to-Measurement File palette.

6. Remote connectivity by Ethernet network

The network can actually be pretty complicated to work with in order to allow machines to talk to one another. The complexity of networks is completely dependent on the situation outside devices which try to communicate with the company network through the Internet.

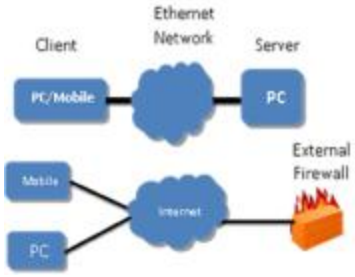

Figure 8: common company network topology

The first thing they encounter is an external firewall. This could be software or hardware and its primary function is to monitor the data being transmitted from the Internet and to make the decision whether this data should be let in or not. Each firewall has its own set of rules, the known trusted sources, and okay protocols that define its logic. We are just passing data across a network so that we could build up a simple TCP server and client architecture

Server executable to PC, and run the TCP client on the Windows PC We have access to install applications on the Windows PC so all we would need is the LABVIEW Run-Time Engine installed once the executable is built and deployed, see fig.9.

The one downfall is that this method would take some time to develop. There are shipping examples showing how to create TCP and UDP client and servers but this needs more work than I expected.

Figure 9: LABVIEW executable

6.1. Programming in LABVIEW

Two computers with LABVIEW software installed are kept one at patient room and the other at doctor's cabin. The PC on the patient side is termed as SERVER. The PC on the Doctors side is termed as client.

6.2. Server side programming

The TCP Listen icon on the server side block diagram looks for data from the client. Once the data is obtained, some error exists. This error is displayed and terminated. This is given to unbundle the icon which separates the error from other information. TCP Read icon in the block diagram is used to read the data. The server transmits the characters to the client.

7. Conclusion

The presented result shows that the developed communication network enables users to see the image and the text being sent to their own terminals. On the other hand, they are also able to send the image and the text to the other terminals as well. It means that this monitoring system allows both parties to remotely exchange information over the communication line, show the development of a small scale, low-cost monitoring system between two terminals, receive the EMG signals through serial port /Bluetooth and display EMG signal on a mobile phone. The system is able to put the image in a two-way communication, on top of the sent message between them.

The features may look

Simple, but the applications vary. For example, it can be used for long-distance learning in which the student and the lecturer can have an interactive discussion over the Internet. It also can be used in monitoring a certain process in a highly hazardous area in which the user can supervise the process remotely without exposing himself in a dangerous environment. Thus, this remote system is useful to be applied in small-scale applications such as for education purposes.

Visual studio and LABVIEW graphical programming platform provide an efficient environment to process and to keep track of various physiological parameters of a patient like EMG and heart rate in real-time. Any variations in the parameters from the normal value result in the generation of a warning message which is sent to a mobile phone via Bluetooth. The values of the parameters at any time can be saved to an excel file for future references.

This device can be used at all hospitals, emergency rescue, clinics, hospitals and universities to link education, physiotherapy, companies and factories.

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