Biomedical Signal Acquisition Equipment Using LabView Environment

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1. Abstract

The objective of present study was to set up an ergonomic and practical equipment for biomedical signal acquisition, intended to be used for studies concerning cardiological stress tests at anaerobic threshold, using National Instruments data acquisition board, and LabView graphical programming environment.

Design of the equipment was made with LabView graphical programming environment, using PCI – 6024E National Instruments Data Acquisition Board, CB-68LP Extension Board, and a differential input, electrical insulated buffer board. The result was an electrical insulated multichannel input equipment for data acquisitions from an ECG type Bioset 6000, CO_2 mass spectrometer type CAPNOLYSER, and from a treadmill stress test equipment (velocity and slope).

One of the purposes of this study was to develop a graphical interface, very easy to use by persons who are not well trained in computer use.

Measurements were made on a number of 35 patients chosen for the stress tests by a cardiologist, in order to complete or set a diagnosis. The measurements were made in the Stress Test Laboratory of the Cardiology Clinic of the County Clinical Hospital Sibiu.

Key words: data acquisition equipment; graphical interface; LabView graphical programming environment; anaerobic threshold; respiratory gases.

2. Introduction

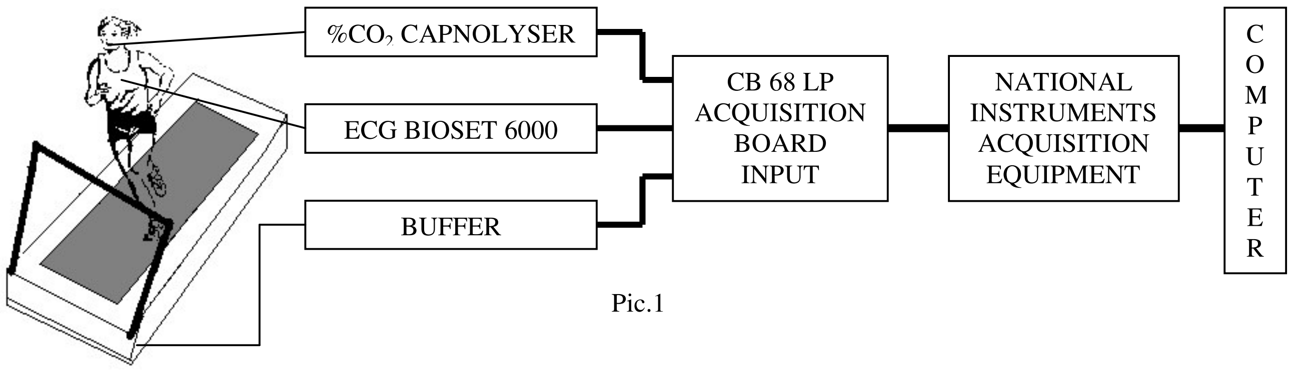
This equipment is the result of a great experience in the introduction of computerized equipments in medical practice, especially in the field of stress tests, referring to the effort threshold. It is composed – according to fig.1 – of a computer drive treadmill with adjustable velocity and slope, a Bioset 6000 ECG, and a Capnolyser CO_2 concentration analyzer from respiratory gases. From these equipments the computer acquire through an PCI-6024E National Instruments Data Acquisition Board and an CB-68LP extension board the following signals:

from computerized treadmill, through an galvanic signal-formatting insulated buffer, two parameters consisting of velocity and slope,

from Bioset 6000 ECG, the D_2 derivation in standard or another desired derivation, is acquired,

from Capnolyser CO_2 Concentration Analyzer an analogical signal, with tension level between 0 and 1 V, which corresponds to a CO_2 concentration of 0 to 10%.

The outputs of these equipments are connected to a CB68LB board and from here to the National Instruments data acquisition board. We specified that all the signals involved in the acquisition process are electrically insulated through optical insulated buffers according with CEI standard. Thus, a virtual instrument, with the front panel detailed in fig.2, was created. An important characteristic of this system is the high functionality, because all the parameters can be visualized in real time and because at the moment when the anaerobic threshold is achieved, a sound- and visual-signal is generated.



Pic.1

3. Design

The virtual instrument created in a LabView graphical programming environment has three functional blocks corresponding to the implemented functions.

The first functional block is the signal acquisition block, which uses the time multiplexing signals method with constant sampling rate. Taking notice that the widest band among the input signals is the one of the ECG – the maximum is 50 Hz – a sampling frequency of 100 Hz is completely between the boundaries set by the Sampling Theorem.

The second functional block is destined to save the acquired data in a special file, which can later be accessed in order to process the data.

The last block has the purpose of real time data processing.

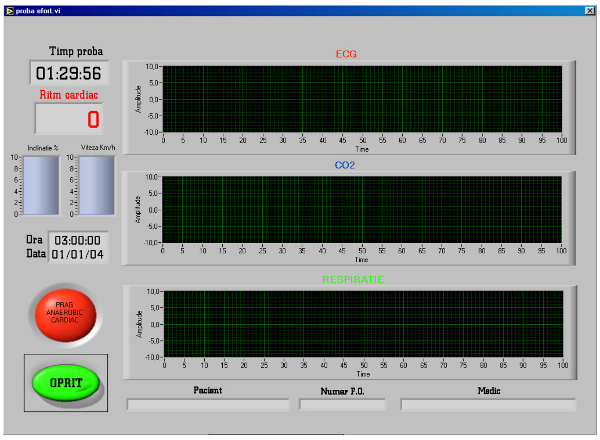
This includes:

For the ECG channel: the filtering of the signal (so that the noise created by the power supplies - 50Hz and the muscles does not interfere with the signal), the detection of the QRS complex and the calculation of the HR;

For the %CO_2 Capnolyser: the filtering of the input signal, the detection of the local maximum values (END TIDAL) and the minimum ones (INSPIR) and the calculation of the respiratory rate RR. The cardiac anaerobic threshold is detected from the filtered peak signal, using the correlation between HR and the peaks of the seven points Givens polynomial interpolating signal technique;

For the velocity and slope channels: the input signals are used for displaying the treadmill actual value of velocity and slope. These signals also help determine the work rate done by the patient.

The functional bloc 4 is designed for graphical user interface. This is comprise by data patient input interface, medic name, and graphical draw for ECG, %CO_2, Respiration, HR, RR, MW, Time, Cardiac Anaerobic Threshold as output interface, as see in picture no.2.



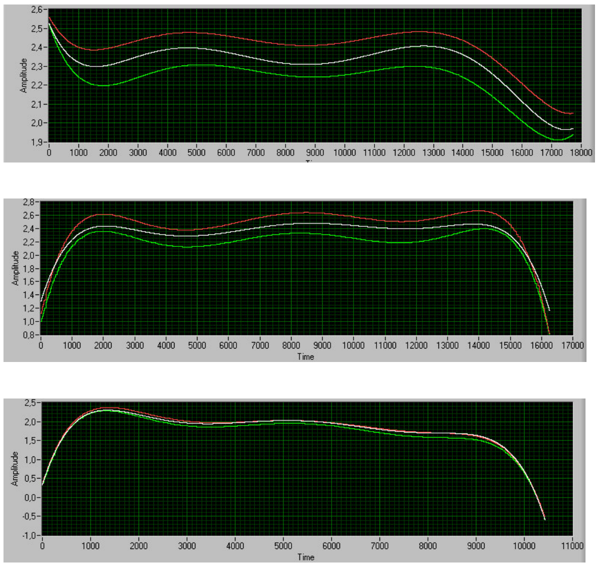
Pic.2

4. Measurements.

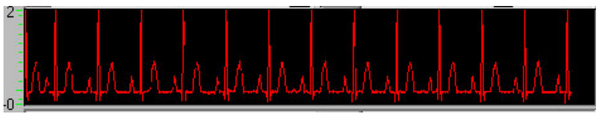
The Biomedical Signal Acquisition Equipment was tested in Stress Test Laboratory of the Cardiology Clinic of the County Clinical Hospital Sibiu on 35 patients. We observe that the patients monitoring during stress tests are improved because this instrument provide another 'free hand' for the personnel, and not only for that, the results are a very well response came from the users.

Some of the curves acquired from respiratory gases CO_2 concentration and from ECG are shown in pic.3, respectively in pic.4.

For evaluating this instrument we consider the ergonomic aspect of using, the accuracy of data, and the record correlations with existing software.



Pic.3



Pic.4

5. Conclusion.

This Biomedical Signal Acquisition Equipment is very useful for Clinical Stress Test Laboratories in order to be an daily instrument with easy to use features and a friendly user interface. Also, this Biomedical Signal Acquisition Equipment set an objective and reliable end point for stress tests, in Clinical Stress Test Laboratories, and a criteria for effort capabilities, used in Sport Test Laboratories in order to determine the degree of training the for top sportsmen.

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