Implementation of LabVIEW® for the Evaluation of Biosignals of Selected Cardiovascular Parameters

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Products Used:

- LabVIEW
- DAQ

Abstract

In a clinical pharmacological research laboratory the conventional recording (register stripes) of ECG, cardiac sound and carotid pulse of test persons was replaced by electronic storage in a personal computer in order to expand the previous manually evaluation by an interactive LabVIEW solution.

The Challenge

Registration, storing and filing of original biomedical data and their evaluation by medical staff in clinical research as an example for the acceptance of new measuring methods.

The Solution

LabVIEW, DAQ and the multifunction board Lab-PC+ create a fast available data acquisition system. A large panel of tools facilitates the data processing at high mathematical level.

Introduction

The assessment of the heart contractility is usually performed by simultaneous registration of curves of ECG, cardiac sound and carotid pulse for non-invasive measurement and registration of systolic time intervals.

Subsequently, these analogue measurement curves (register strips, original data) are used to manual estimate the systolic time intervals. These data are used to identify changes of the mechanical heart function, such as effects induced by drugs. Figure 1

We have this conventional manual estimation expanded by a computerised biosignal processing and evaluation.

The three analogue signals were digitised with 12 bit using a data acquisition program. The biosignal registration spans a period of 20 heart cycles. In this data package disturbed cycles can now be eliminated following an optical assessment by the physician. Based on three usable measured curves one resulting cycle was averaged (comparable with the signal-averaged electrocardiogram SAECG). The physician marks the points in the averaged cycle with the help of a pre fixed cursor which reflect the systolic time intervals. The calculated cardiovascular parameters are saved and can be used in EXCEL.

Why LabVIEW ?
LabVIEW provides a cost-effective solution both in medical and laboratory measuring technique. Applications are accepted in medical research by its graphic nature. See our second paper: Virtual Instruments create and control Virtual Valves.

Detailed structure
Equipment of medical engineering :
BIOSET 3000 -- ECG device with integrated measuring of heart sound and carotid pulse, analogue output, display, pen recorder, Fa. Hörmann Medizintechnik Zwönitz / Germany

Figure 1. Simultaneous registration of curves of ECG, cardiac sound and carotid pulse by U. Poller

Data transferring and storing
Personal computer :
- 120 MHz Pentium PCI / SCSI 16 Mbytes RAM
- 1 Gbyte hard disk
- 270 Mbytes Syquest removable hard disk
- Windows 3.11
- LabVIEW 4.0

The three analogue signals are adapted by isolating amplifiers (Analog Devices 5B Series) to the input parameters of the Lab-PC+.

In accordance with the safety recommendations in Germany this configuration must meet the following conditions:
- electric strength of the power supply for 5B-Module > 4 kV

- the stationary PC stands in a distance at least 5 meter from the test person

Every analogue signal is sampled with 12 bit and 1 kHz / channel. The data are saved immediately on the hard disk (Format Integer 16). The theoretical length of the recording only depends upon the capacity of the hard disk, because data are sampled in background-mode.

The real file length depends upon the heart rate and is approximately 60-240 Kbytes.

The original data are copied to the removable hard disk. It serves as a transportable medium to the CD-Recorder (Filing).

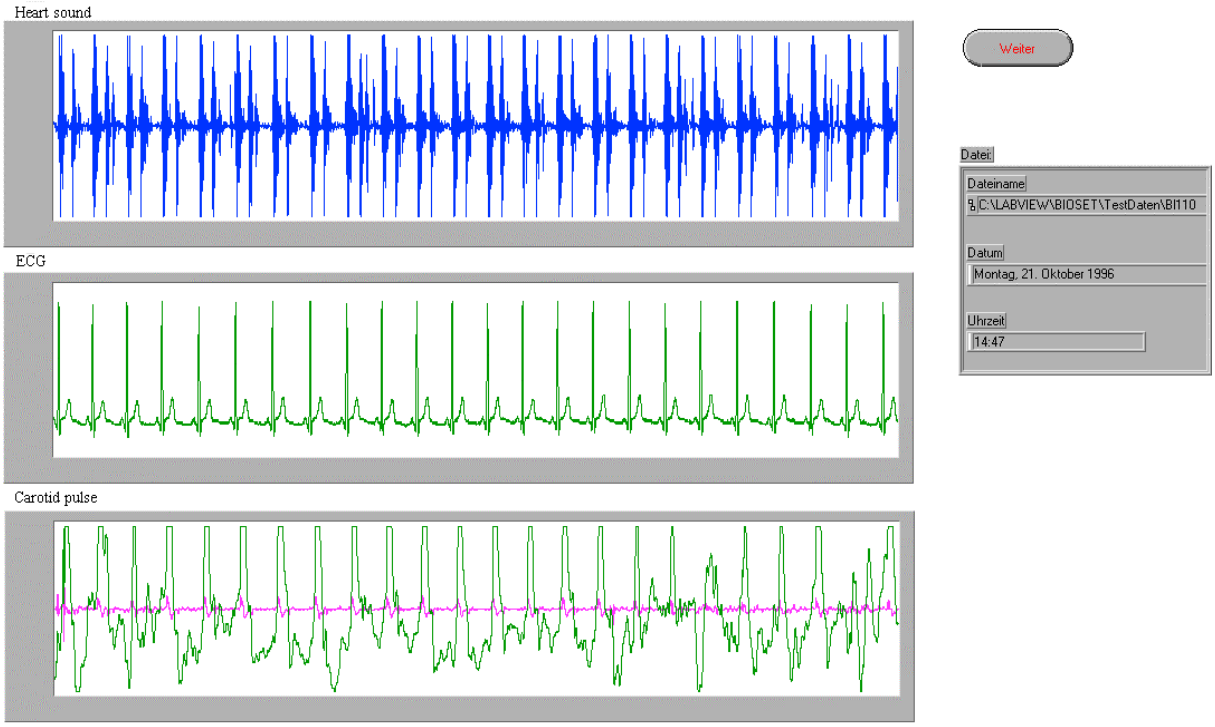

Figure 2. The Presentation of the original data in a virtual instrument

Data processing and evaluation:
The end of the recording causes the closing of the file and the immediate presentation of the original data in a virtual instrument (Graph). The physician assesses the quality of the recording as described above and starts the averaging. At the same time the averaged cycle appears in an additional virtual instrument. The mathematical functions used in this extensive calculation are part of the following LabVIEW-Libraries :

- Digital Signal Processing VIs
- Measurement VIs
- Curve Fitting VIs
- Probability and Statistic VIs
- Linear Algebra VIs

In the averaged cycle, created from 20 cardiac-actions, the cursors are pre fixed by software to the defined points on the curves. The physician examines the result and is able to correct it, if necessary. This interactive working method should be replaced by an automatically evaluation in the future.

Results

The system is working continuously for six month. The conventional recording was reduced from 20 to 5 cycles. The comparison of both estimation methods shows a good correlation.

Reference

Poller U, Nedelka G, Radke J, Pönicke K, Brodde O-E
Age dependent changes in cardiac muscarinic receptor function in healthy volunteers.
J Am Coll Cardiol 29 : p. 187-193 1997

Acknowledgements

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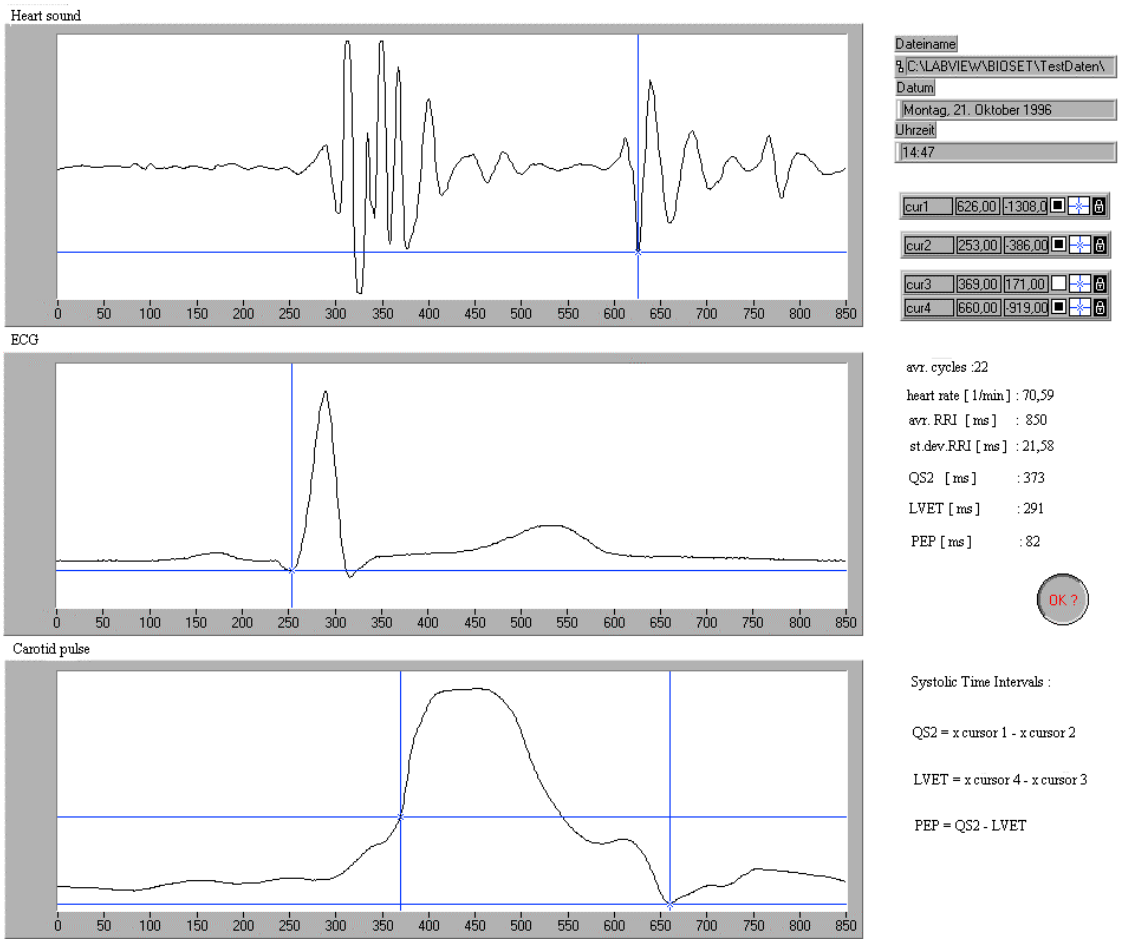

Figure 3. The averaged cycle with the pre fixed cursors

Author Biography

Holger Lehnich was born in 1959. Study Electronics on the University of Jena 1980-1985. 1985-1990 work for Industrial research and development of pacemakers in Halle since 1990 Martin-Luther-University Halle-Wittenberg, Medical Department Biomedical engineering

Georg Kaltenborn, Private docent engineer, was born in 1946. Study Information Technique 1965-1970 on Technical University of Ilmenau, Germany. 1970-1993 Institute of Clinical Biochemistry, Medical Dep. Halle research and development in clinical, biochemistrical instrumentation, measurement, automation and quality control. 1980 PhD degree and 1989 habilitation, both for Biomedical Technique. Since 1993 in the new Centre for Medical Basic Research with the general development direction biomedical measurement.

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