

MODULAR MEASURING SYSTEM „ADVANCED PDA“ DESIGNATED FOR SUPPORT OF THE MEDICAL AND BIOMEDICAL ENGINEERING RESEARCH

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Abstract: The basic function of presented system is the scanning of biological and technical signals. This system was originally designed for technical support of our own research projects (telemetry, monitoring and storage of biomedical signals). Due to satisfactory results, experiences and significance of this topic, „ADVANCED PDA“ project has overwhelmed the needs of our institute and it was decided to make it available for public in form of customer modular system. Measured signals are digitalized and processed by the central control unit, then passed on by selectable communication interface (metallic connection (RS232, USB), wireless interface (BlueTooth, WiFi, GSM, GPRS-ethernet) for displaying, archiving and further evaluation in given imaging unit (classical PC, notebook (OS WIN/Linux), PDA platform (PocketPC 2003)). The most advantageous feature of the system is its modularity. The whole chain is composed from preassembled modules via internal interfaces which represents very fast, effective and inexpensive solution. By simple software or hardware adjustments we can measure other quantities than those included by default modules. Modular measuring chain ADVANCED PDA is ready to be strong and affordable tool for all potential partners in research and industrial area. Its author's collective was granted with the Innovation 2004 Prize by the Innovative Enterprise Association of Czech Republic, personally delivered by the Czech vice-prime minister Ing. Martin Jahn, MBA.

Introduction

The „ADVANCED PDA“ project was developed at the Institute of Biomedical Engineering CVUT in Prague. Its basic function is the scanning of biological and technical signals. This system was originally designed for technical support of our own research projects (telemetry, monitoring and storage of

biomedical signals). Due to satisfactory results, experiences and significance of this topic, „ADVANCED PDA“ project has overwhelmed the needs of our institute and it was decided to make it available for public in form of customer modular system.

Methods

The system is able to acquire signals via input sensors at *several levels*:

Biological signals:

EKG, EEG, skin resistance, body temperature, blood pressure, actigraphy, myography, spirometry.

Physical and technical quantities:

Temperature, pressure, acceleration, pH, flow rate, electrical current and voltage, illumination, GPS positioning, angle.

Measurement, processing and visual representation

Measured signals are digitalized and processed by the central control unit, then passed on by selectable communication interface (metallic connection (RS232, USB), wireless interface (BlueTooth, WiFi, GSM, GPRS-ethernet) for displaying, archiving and further evaluation in given imaging unit (classical PC, notebook (OS WIN/Linux), PDA platform (PocketPC 2003)).

Modularity

The most advantageous feature of the system is its modularity. The whole chain is composed from preassembled modules via internal interfaces which represents very fast, effective and inexpensive solution. By simple software or hardware adjustments we can measure other quantities than those included by default modules.

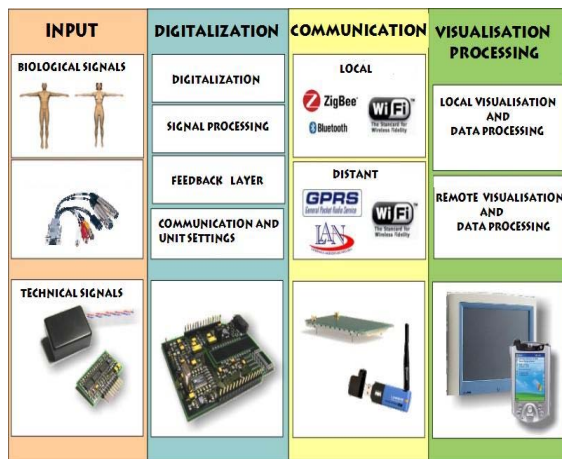


Figure 1: Basics scheme of the system Advanced PDA.

Software

Most components are available from our own development incl. all software tools. Selection of the appropriate connection interface ensures the maximum users comfort and opens the gate into modern world of communication. Also developed were the algorithms for digitalization and storing of data on the real time basis, its reliability, sturdiness, detection of the data flow interruption and other background computing options (fiber priority control, calculations of given attributes from the current data and its imaging).

Basics scheme of the whole system is described on Figure 1.

Results

There are listed some of typical realisations accomplished with the Advanced PDA system below.

List of accomplished applications:

- Viligant Car
- Equine ECG
- Scuba Diving Monitor
- Pulmonary Thermometer
- Applications in Civil Engineering
- Stimuli Sensing Unit
- RealTime signal acquisition box

RealTime signal acquisition box

Presented application project refers to formerly established one named „Sleeping driver, Vigilant car“, which was being solved within the framework of research project MSM 210000012 – Transdisciplinary research in biomedical engineering and, before that, under the „MSMT“ grant within the program „Support of the science and research at the undergraduate and graduate education system“ (250s) at UBMI (formerly CBMI) already in 1999.

The essential part of the project was the development of algorithms for digitalization and storing of data on the real time basis, its reliability, sturdiness, detection of the data flow interruption and other background

computing options (fiber priority control, calculations of given attributes from the current data and its imaging) for the needs of the „Sleeping driver, Vigilant car“ project and also for ECOM Ltd., a domestic manufacturer of the liquid chromatography equipment that is used for all scanning and processing of the analog input signals in testing and burn-in of the products.

Should all the analog input signals be monitored and processed in real time and the imaging and parallel computing available (for alarm settings and other industrial purposes) with the possibility to change configurations, keep the whole system mobile and small in size, the solution is the use of one board PC with the appropriate operational system. At the moment, as a result of the computing technology development there are available fairly inexpensive PDA computers (Personal Digital Assistant) (priced from as little as 7000 CZK), containing Intel StrongArm processor (400MHz), several tens of MB of the memory (extendable by memory cards), operating system PocketPC 2002 on the MS Windows CE basis (others also available) and with plenty of peripheries from net interfaces to GSM, GPS modules and miniature hard discs. Although PDAs are due to its „commercial“ technical parameters not widely usable in common industrial practice and due to Windows CE not even for the true real time operations, its low price and wide accessibility makes them ideal for the one-purpose or intelligent monitoring unit use in the prevailing „office“ environments such as laboratories and service workshops.

In bellow described „Sleeping driver, Vigilant car“ project we faced the problem how to detect the steering wheel movements that carry the information about the driver's fatigue, how to calculate in real times all the parameters referring to the lack of vigilance symptoms and how to display it and inform the driver about any possible related danger.

Thanks to all above mentioned advantages and due to an absence of any rotating mechanical parts (sensitive to vibrations in moving vehicle) we decided to use PDA. This innovative solution found already its industrial use targets, an interest with the prospect of long-term cooperation was expressed by ECOM Ltd. (see <http://www.ecomsro.cz>), Czech manufacturer of the liquid chromatography equipment that is used for all scanning and processing of the analog input signals in testing and burn-in of the products.

Within the project there was a PDA based equipment developed that is readily able to scan and store analog signals in real time. It is derived from previously developed system that contained a standard PC component (notebook). The essential aspect was to implement algorithms resolving processing on the real time basis and to adopt the final solution for an industrial practice.

The proposed solution should be considered perspective mainly due to decreasing prices and improving performance of PDA units. Further development of algorithms for such analog signal scanning is determined by necessity to construct a HW module with A/D converter that would enable scanning, digitalization, wireless transmission and storing signals in PDA in real time. Such module was developed, tuned and constructed at the initial stage of the project. Also developed were the algorithms for digitalization and storing of data on the real time basis, its reliability, sturdiness, detection of the data flow interruption and other background computing options (fiber priority control, calculations of given attributes from the current data and its imaging). Finally, the SW for the purposes of „Sleeping driver, Vigilant car“ project (as well as for the company „ECOM Ltd.“) was composed.

The results are to be presented not only at the Workshop 2005 (presentation of achievements by Czech Technical University in Prague) but it has also contributed to the final version of modular measurement chain „ADVANCED PDA“ assigned for the research support in medicine and biomedical engineering. Its author's collective (K. Hána, R. Fiala, J. Kašpar a P. Smrčka) was granted with the Innovation 2004 Prize by the Innovative Enterprise Association of Czech republic, personally delivered by the Czech vice-prime minister Ing. Martin Jahn, MBA.

With respect to the common financing of the project by ECOM Ltd. and practical impact of the project results we consider our work as very prospective as it provides a solid example of mutually beneficial cooperation in which the scientific results are both used as a basis for further research and development activities as well as usefully implemented in practice.

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Pulmonary Thermometer

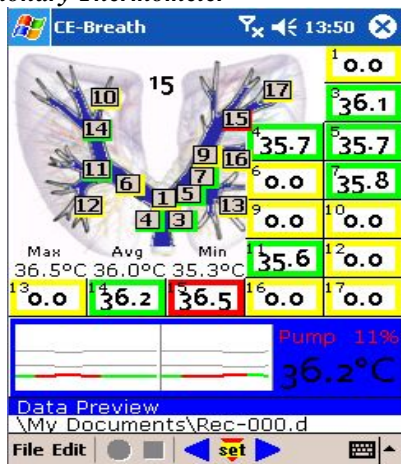


Figure 2: Acquisition software for temperature monitoring inside the lung.



Figure 3: Investigation for temperature measurement inside the lung.

System for the early noninvasive bronchial carcinoma detection is presented here. Temperature is monitored in the lung by thermistor with very fast response. Face of the acquisition software is on the figure 2. On the Figure 3 is depicted investigation by the medicine.

Equine ECG

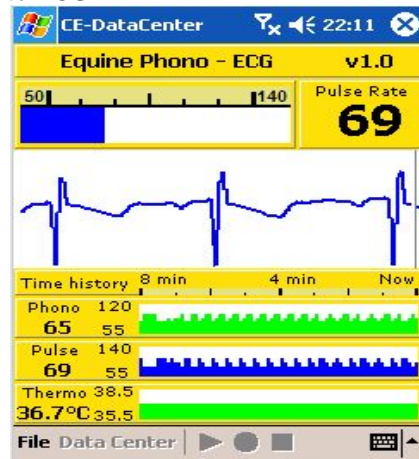


Figure 4: Software for ECG acquisition.

In the cooperation with Veterinary and Pharmaceutical University in Brno we developed special system for equine ECG acquisition. On the figure 4 you can see SW realization on the PocketPC platform and on the Figure 5 is shown an experiment of data acquiring.



Figure 5: ECG equine investigation with experimental APDA setup.

Vigilant Car

In the vigilant car project, some technical and biological signals are acquired using APDA system, to estimate fatigue state of the driver. From the Figure 6 you can obtain basic information on measured signals. Mathematical model for fatigue estimation is applied then.

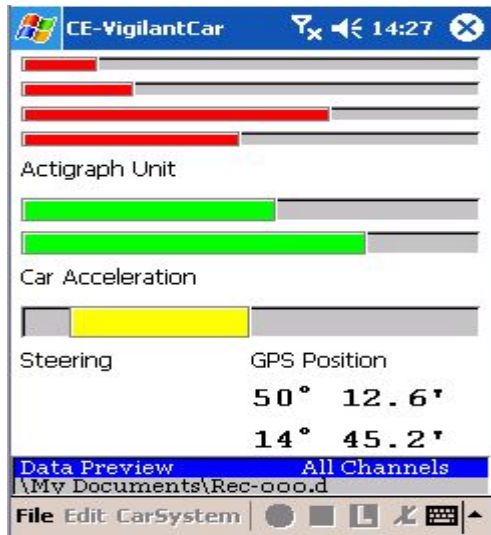


Figure 6: PocketPC program for data acquisition in the vigilant car project.

Scuba Diving Monitor

In the scuba diving project, the APDA system is used for monitoring biosignals on the diver, technical signals on the equipment and environmental quantities. These data are correlated then and results are carried out.

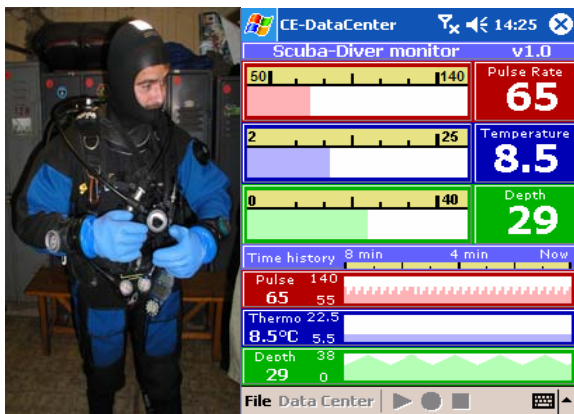


Figure 7: Scuba Diving Monitor realization.

On the Figure 7 is realization of the system with the acquisition software on the PDA.

Stimuli sensing unit

APDA system is used for monitoring response of the human body to psychological stimulation here. Prototype was developed in cooperation with parasitological

institute, UK Prague. On the Figure 8 you can see software realization with data processing.



Figure 8: Software for signal processing and acquisition in the stimuli sensing project.

Conclusions

Modular measuring chain ADVANCED PDA is ready to be strong and affordable tool for all potential partners in research and industrial area. Its author's collective was granted with the Innovation 2004 Prize by the Innovative Enterprise Association of Czech republic, personally delivered by the Czech vice-prime minister Ing. Martin Jahn, MBA.

Acknowledgement

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