TELEMETRY SYSTEM OF BIOLOGICAL PARAMETERS

J. Spišák, M. Penhaker

VŠB – Technical university of Ostrava, FEI, K455,17. listopadu 15, Ostrava – Poruba, 708 3, Czech republic
E-mail:marek.penhaker@vsb.cz, Phone: +420 5 9732 3510, Fax : +420 5 9 732 3138

Summary The mobile telemetry system of biological parameters serves for reading and wireless data transfer of measured values of selected biological parameters to an outlying computer. It concerns basically long time monitoring of vital function of car pilot.The goal of this projects is to propose mobile telemetry system for reading, wireless transfer and processing of biological parameters of car pilot during physical and psychical stress. It has to be made with respect to minimal consumption, weight and maximal device mobility. This system has to eliminate signal noise, which is created by biological artifacts and disturbances during the data transfer.

Abstrakt Cílem této práce je návrh mobilního telemetrického systému pro snímání, bezdrátový přenos a zpracování biologických parametrů pilota při fyzické a psychické zátěži s ohledem na minimální spotřebu, hmotnost, mobilitu a celkovou robustnost zařízení. Taktéž je kladen důraz na eliminaci rušivých signálů způsobujících artefakty v snímaných biologických parametrech a v přenášených datech. Teoretická část práce popisuje základní charakteristiky biologických parametrů a přístrojů pro mobilní použití jimiž jsou tyto parametry snímány a měřeny. Praktická část práce se zabývá návrhem a realizací zařízení pro připojení modulů měřících biologické parametry na vzdálený počítač a řešením vizualizačního SW.

1. INTRODUCTION

This work was created on the basis of need of scanning and telemetry transmission of biological parameters at car pilots at Eco Shell Marathon. Many sports events require the possibility of the scanning (both short-term and long-term ones) of biological parameters at sportsmen or F1 car pilots straight during the physical and psychical stress. By force of telemetry system, it is then actually possible to monitor basic vital functions activity like ECG, heartbeat and breathe frequency, blood oxidation, temperature. In addition, it is possible to monitor and judge to what degree the stress affects these basic vital functions e.g. while driving the F1 car when heightened concentration and pilot's increased reactions at the high speed are needed.

The next significant fact is that by monitoring of pilot's vital functions is in some measure possible to consider a quality of the car construction with respect to comfort and safety. By means of pilot's life functions distant monitoring it is possible to judge objectively pilot's abilities necessary for driving the formula and thereby to minimize the car accidence chance caused by sudden change of health (e.g. exhaustion, sickness, tiredness, cardiac arrest).

2. MATERIALS AND METHODS

On the chosen biological parameters, it is possible to monitor the basic life activities that directly reflect actual physical and psychical state of the pilot's state while driving the car in extreme situations. Next condition is not to disturb pilot while scanning the biological parameters. The pilot has to feel comfortably without even a small sensation that his body is connected to system of sensors. Similarly it must be secured the signal artifacts (motion artifacts, artifact caused by imperfect connection of a scan electrode and a skin, etc.) not to be transmitted into scanned signal owing to pilot's movement.

At the sensor selection an cable optimal length was respected not to occur an accidental separation of scanner electrode from the body or on the contrary the sensor cables not to be excessively long to get in the way while pilot's moving.

The following criterion for the choice of scanned biological parameters was an easy accessibility of our own sensors and modules for measurement scanned biological parameters and also its affordable price.

The system scans and processes an electrocardiogram, pulse rate, blood saturation by the oxygen (SpO2), plethysmography, body temperature and temperature of surroundings.

The telemetric chain consist of several functional blocs meant for scanning the biological signals from the pilot, signal processing and wireless transmition to a distance computer. The measuring instruments ChipOX and ECG100 read the biological parameters (SpO2, plethysmography, body temperature, temperature of surroundings, ECG and pulse rate), that are brought to inputs of communication module. The output of the communication module is linked to radio module meant to transmission all these parameters to a distant radio modem of receiver. The receiver is linked to computer that monitors scanned biological parameters. The completely telemetric chain uses communication interface RS232 that means the connection of apparatuses that read biological

parameters by the communication module and connection of communication module with sending radio module and subsequently connection of receiving radio module to computer through this interface.

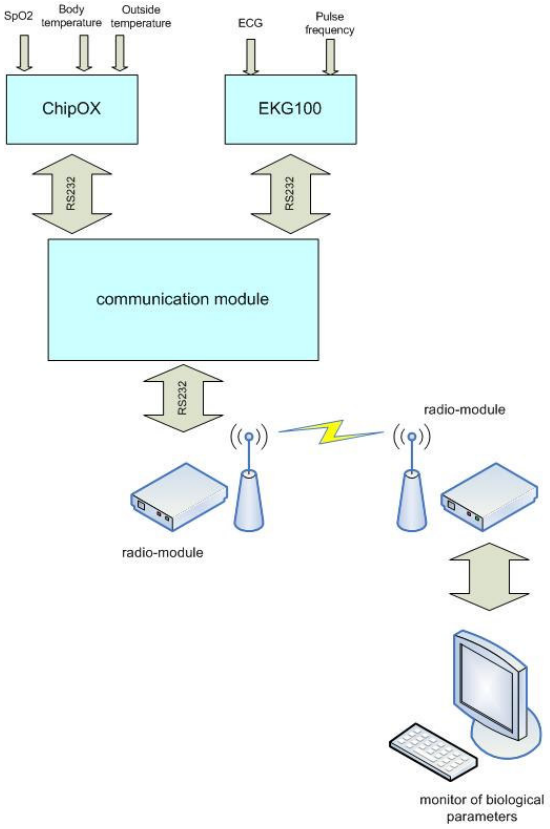

Fig. 1. Designed telemetry chain.

Communication module

Constituent component of telemetric chain

Plethysmograph ChipOX

Pletysmograph ChipOX measures saturation by oxygen (SpO2), plethysmogram, pulse rate, body temperature and temperature of surroundings. For body temperature and temperature of surroundings measurement were my own temperature sensor proposed and realized. The measurement of the rest bioparameters (SpO2, ...) was provided by finger or ear sensor.

The pletysmograph is powered from network adaptor or from the battery by DC voltage 6V. For wireless communication with surroundings is the instrument equipped with Bluetooth technology (that is for short distance communication), it is possible to connect the instrument to any radio module supporting the interface RS232 for longer distance data transmission.

Electrocardiograph ECG100

Electrocardiograph ECG100 is intended for scanning and measuring electrocardiogram (I, III Einthovens lead) with the assistance of stick electrodes. Power supply of the instrument is secured by DC voltage 9V from the network adaptor or battery. The instrument is provided, identically as a plehtysmograph, by ChipOX for the communication with the surroundings.

Temperature sensors

The temperature sensors were proposed and constructed for the body temperature and surrounding temperature scanning. Sensor's foundation is integrated circuit AD22103. The integrated circuit AD22103 by Analog Devices company is monolithic temperature sensor designed for supply voltage 3,3V that includes the temperature thermistor sensor and circuits for data processing on one chip. The output is voltage signal that is possible to bring on input A/D convener with no extra complicated modification. The realized temperature sensors are distinguished mainly by high sensitivity, quick response for temperature change and by sufficient accuracy.

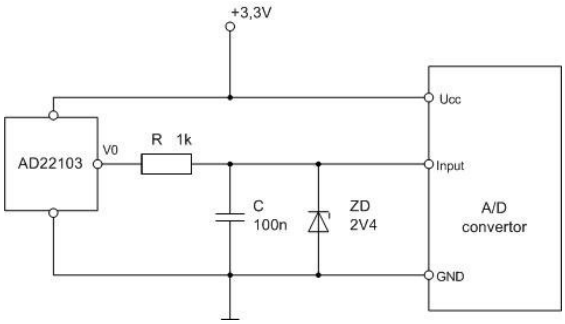

Fig. 2.Connection of temperature sensor to the A/D inverter.

The proposed communication module is an apparatus used for data collection and data transmission directly into computer with assistance of serial cable or into transmitter for wireless transmission into distant computer. The data represent measured quantity from plethysmograph and electrocardiograph.

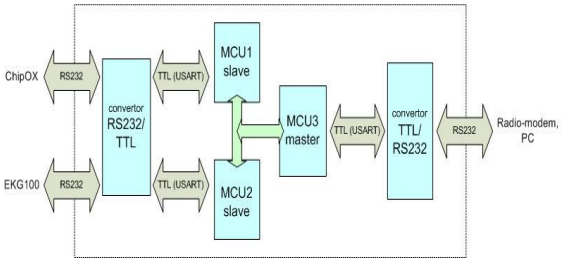

Fig. 3. Internal structure of communication module.

The module has two data inputs for connection to measuring instruments ChipOX and ECG100 and data input for connection of module to PC or transmitter for wireless communication. One of the main demands for this module is module was to all

the data inputs and outputs was designed for serial communication RS232. The purpose of communication module is to receive data from two measuring instruments and to send them through the serial cable or wirellessly to computer. The data that are the outcome of the module bring information about all measured biological parameters like ECG, pulse, plesthysmogram, SpO2 and temperature. The ground of the entire circuit arrangement is composed of three microprocessors from MCU1 to MCU3 from the data transmission view. The microprocessors secure an actual data transmission in the way that data from two inputs are suitably unified into one output. Since (Because) the microprocessors work at voltage level TTL by data communication, it is necessary to adapt both inputs and outputs into the same level, because the circumferences connected to terminal works usually in levels of RS232. The circuits MAX232 are used for this purpose.

Radio modems ADAM _4550 for wireless data transmission

The radio modems are used to its own wireless biological parameters transmission between the communication module and distant computer at the distance of 0,5 to 2 km. ADAM 4550 are types of radio modems that work at frequency of 2,4 GHz. Communication with module is set in serial line through the converter RS 232/RS 485 with transmission speed up to 115,2 Kbps. By using the directional antenna, it is possible to communicate for distance up to 20 km.

3. TREATMENT

The whole apparatus for scanning and telemetry transmission of biological parameters was tasted from the point of view its complete functionality with the use of radio modules both for wireless data transmission and also without it by connecting measuring instrument with communication module to computer through serial cable. The electrocardiograph ECG100 and plethysmograph ChipOX were plugged to inputs of communication module. As proofing electrocardiogram were used simulated signals from monitoring tester TESLA LCO120, which similarly generated the pulse rate. The plethysmogram and blood saturation by oxygen were practicably scanned by finger sensor that were connected to pletysmograph, ChipOX. During the trial period was the last scanned parameter the temperature of surroundings scanned by realized temperature sensor. The temperature detector was linked to one from analogue input of plethysmogram ChipOX. In addition to the first temperature detector, the second temperature sensor was also connected to perform an orientational comparative measurement.

4. RESULTS

The aim of this work was the proposal of a telemetric system for biological parameters measurement at F1 pilot for Eco Shell – Marathon. The telemetric system proposal lied in the selection of suitable biological parameters that preferably testified about an actual physical and psychical state of pilot while driving the car, furthermore in selection and design of biological parameters sensors, also proposal and implementation of communication module that is used for electrocardiograph and plethysmograph communication with distant computer.

5. CONCLUSION

The contribution of this work is nominated functional telemetric system that can be used to long time monitoring of chosen biological parameters of pilot at Eco Shell – Marathon. Such a monitoring system is important while pilot's basic vital functions monitoring, because it helps to reveal state of health changes on time. Pilot does not have to notice them in such a high speed because of higher claims to his attention. They could cause serious accident. It is also possible to use the proposed telemetry system for ballast testing in sports medicine to monitor sportsman's physical ballast through scanned biological parameters, e.g. by running.

Acknowledgement

This project was supported by the faculty internal project," Biomedical engineering systems".

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