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SYSTEM FOR MEASURING THE POTENTIAL OF BIOACTIVE POINTS ON THE HUMAN BODY SURFACE

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Measuring biopotentials in medicine is important in the diagnostic and therapeutic trials. Depending on the functional state of the organism, the electric potential of the skin changes in bioactive points under the influence of reflex mechanisms that come from internal organs. Conversely, stimulation of bioactive points on the surface of the skin affects the proper internal organs. For this purpose it has been designed an equipment for non-invasive monitoring and amplifying of biopotentials from characteristic bioactive points on the surface of the human body. Software for measurement, processing and display of biopotentials in bioactive points provides acquisition and signal processing, display, store and comparison of multiple sets of signals.

Keywords: bioactive points, biopotential, computer measurement.

Measuring biopotentials in bioactive points is very important in diagnostic and therapeutic terms [1—3]. According to the theory of gap junction, bioactive points differ in structure and function from the rest of the skin by increasing concentration of intercell conexon channels that connect the cytoplasm of the two cells and through which transport of ion electrical signals takes place. These channels consist of two conexons that are in contact along the intercell space [4—6]. Depending on the presence of calcium ions, pH factor within the cell, the presence of neurotransmitters, these ionic currents follow electromagnetic fields of small wavelength. Normally this current on the location of bioactive points varies from 25—30 μA [7—10]. These zones are characterized by increased conductivity, increased electrical capacitance, decreased electrical resistance of the skin, increased absorption of oxygen, increased temperature and painful palpatory reaction. Depending on the functional state of the organism, the electric potential of the skin changes under the influence of reflex mechanisms that come from internal organs in bioactive points. Conversely, stimulation of bioactive points on the surface of the skin affects the corresponding organs [11—13]. The importance of the voltage dependence in bio-physiological testing is not yet clear, so that all research have medical justification [14, 15]. This solution provides a contribution in that field.

Description of the system

In contact with the organism, electrodes show resistive-capacitive effects, and at the contact with skin, biochemical processes occur. That biochemical processes reduce the accuracy of measurements of biological signals. When electrodes are placed on the body surface and they proved the effect of electromotive force (emf) which makes electrolytic dissociation of tissue: frees the hydrogen and the electrodes corrode. For these experiments, the electrodes silver/silver-chloride (Electrolab, Belgrade) that can not be polarized were used as the reference electrode (Fig. 1). Presence of AgCl in these electrodes does not allow the creation of double layers. Silver-chloride electrolyte dissociating into the ions Ag^+ and Cl^- ions that move freely between the electrode and the electrolyte and prevent the formation of double layer, therefore these electrodes have low impedance and stable offset potential. On the other hand, they have photosensitive properties, so that it is possible to create a potential or offset potential changes in the presence of bright light.

For the signal detection from the surface of the skin, single use surface electrodes with factory layering gel were used (ECD, Florence, Italy). The presence of the gel is necessary because of the pores, hairs and other bumps on the skin that do not allow smooth surface electrodes to have close contact with the skin, therefore uneven and undefined air layer is formed between the electrode and the skin. Because of that hypoallergenic, adhesive pastes of low and negligible resistance and capacitance are applied. Electrodes are in fixed position in regard to the surface of the skin and the arms are in resting position during all tests.

Electrodes (Fig. 2) are connected by conductors with nickel-plated copper shell, which is connected to the ground of the amplifier in order to minimize interference. Signals were amplified 10 times by the instrumentation amplifier INA 114 (Fig. 3). Useful signal is further introduced into the AD converter. The signals are introduced into the computer and processed in LabVIEW 2010 application (Fig. 4). The front panel is shown in Fig. 5 . Four out of six available electrodes were used to monitor signals.

Fig. 1. Reference electrode

System consists of the hardware with six instrumentation amplifiers and two Ag-AgCl reference electrode, as well as the applications for data acquisition with six analog channels. The system has been laboratory tested and calibrated and then verified in real conditions.

Fig. 2. Electrodes and their conection

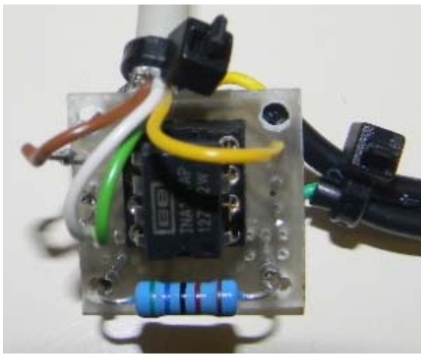

Fig. 3. Instrumentation amplifier

The software package is designed for the measurement, processing and display biopotentials at bioactive points. Also, the application itself allows selection of acquisition and signal processing, display and storage of the results and comparison of multiple sets of signals.

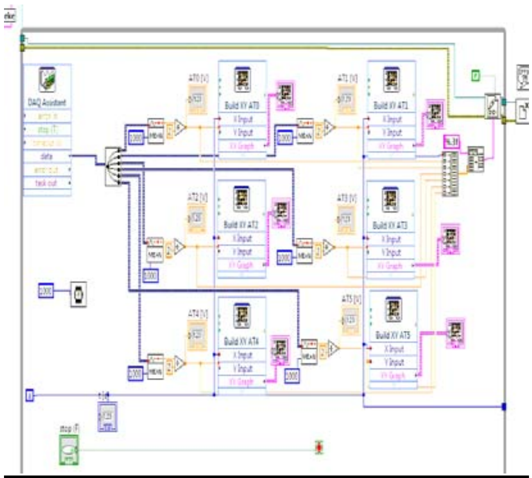

Fig. 4. LabView application

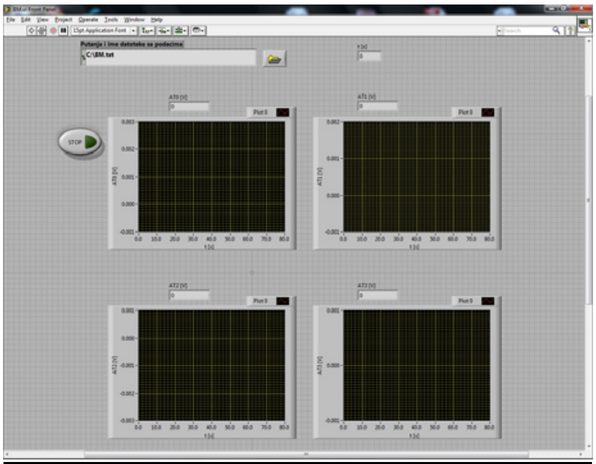

Fig. 5. Front panel

Diagram of the interface is shown in Fig. 6. Active signals that are observed are brought to the inputs A0 to A6, while R inputs are signals from the reference electrodes. The signals are processed and amplified in parts IA0 to IA6 that represent instrumentation amplifier INA 114. Such signals are further forwarded to the AD converter NI 6009 and after that through the USB connection to a computer, where a secondary processing and display of data are performed. The complete system is presented in Fig. 7

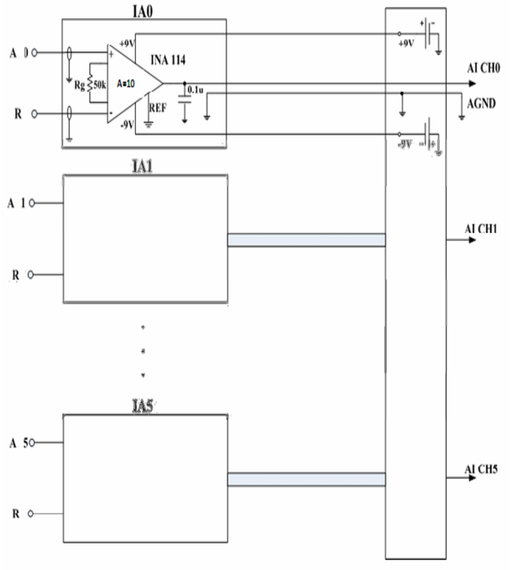

Fig. 6. Diagram of the measurement interface

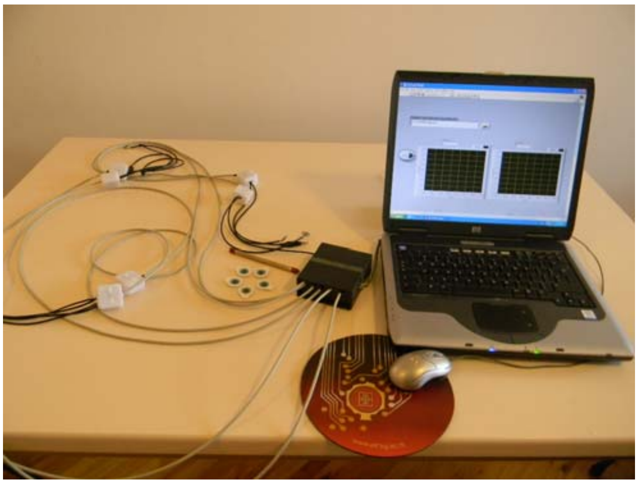

Fig. 7. System

Measurement results

By placing the described hardware and starting the application, it is possible to monitor and measure biopotentials in many points simultaneously. On Fig. 8, 9 the test results for two measuring points on the body is presented, the measurements were carried out both for left and right hands (four points) at rest (Fig. 8) and under stimulation (Fig. 9). To stimulate bioactive points, blue continuous laser was used, λ = 405 nm, power of 20 mW.

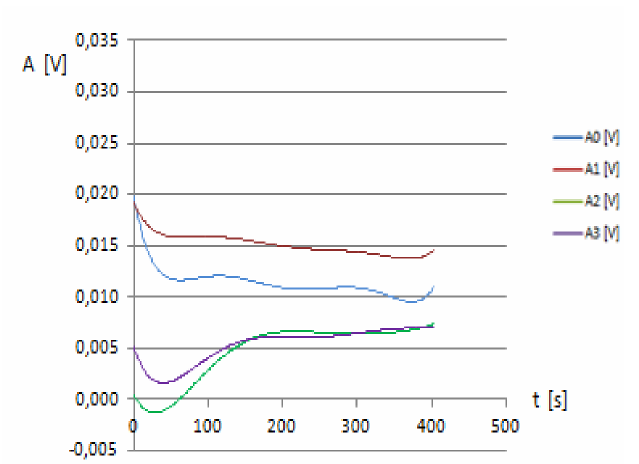

Fig. 8. Measurements of biopotentials at rest

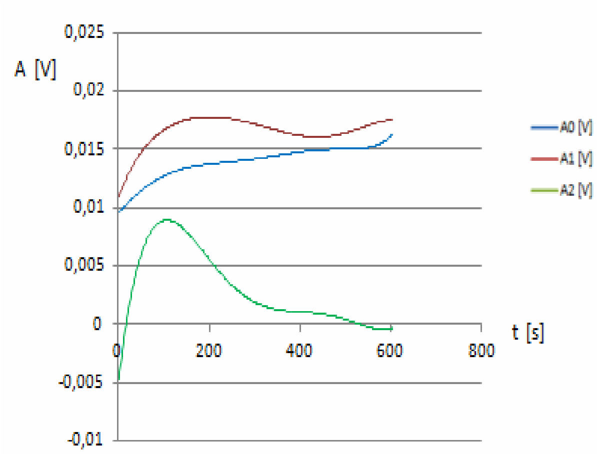

Fig. 9. Measurements of biopotentials at stimulation

Special hardware for monitoring of biopotentials at different bioactive points was made. That hardware consists of six instrumentation amplifiers, two Ag — AgCl reference electrodes and an application designed for data acquisition with six analog channels. System set up for monitoring biopotentials also contains, beside previously mentioned equipment, a commercial data logger, a PC and a desktop software. The system has been tested and calibrated in laboratory and then verified in real-life conditions. The results have shown that the system fully meets the specified requirements and can be compared with expensive commercial appliances.

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Система для измерения потенциала биологически активных точек на поверхности тела человека.

Измерения биопотенциалов в медицине играет важную роль в диагностических и терапевтических исследованиях. В зависимости от функционального состояния организма, электрический потенциал кожи изменяется в биологически активных точках. С другой стороны, стимуляция биологически активных точек на поверхности кожи влияет на сами внутренние органы. Для этого было разработано оборудование для неинвазивного мониторинга и усиления биопотенциалов соответствующих биологически активных точек на поверхности человеческого тела. Программное обеспечение для измерения, обработки и отображения биопотенциалов в биологически активных точках обеспечивает сбор и обработку сигналов, отображение, хранение и сравнение нескольких наборов сигналов.

Ключевые слова: *биологически активные точки, биопотенциалы, компьютерные измерения.*