About

Scientific-educational center “Biomedical Engineering” is a structural subdivision of the federal public budgetary educational institution of higher education “State University – Education-Science-Production Complex.”

The major aim is the growth of scientific school for the development of inspection methods and devices for biomedical engineering, science intensive production commercialization, improvement of the training personnel base for all technical professions, broadening of international cooperation in educational, know-how and research activity.

Primary activities

Scientific manpower development

Post-secondary technical training

Research engineering

Students scientific efforts

Advisory activity

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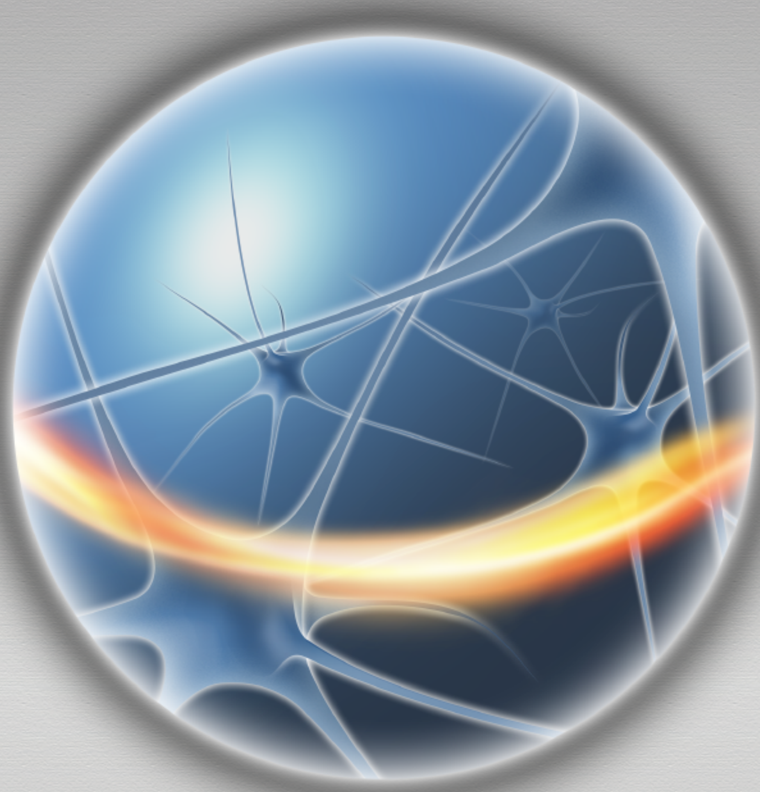


SCIENTIFIC-EDUCATIONAL CENTER

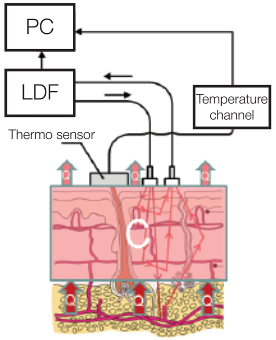
BIOMEDICAL ENGINEERING

of State University – Education-Science-Production Complex

Oryol, Russia

ГОСУДАРСТВЕННЫЙ УНПК УНИВЕРСИТЕТ

Method and device for diagnostics the functional state of peripheral vessels



The purpose of this research is a data correlation study of laser Doppler flowmetry (LDF) and cutaneous thermometry for occlusion test in patients with vibration disease (VD) or Raynaud's phenomenon (RP). It was noted that the dynamics of change in skin temperature of the palmar surface of fingers during occlusion and reactive hyperemia after occlusion corresponds qualitatively to the index of blood microcirculation, reflected by the temperature drop at the initial time after start of brachial artery occlusion and an increase above the initial level at the peak of hyperemia after occlusion. However, the derivative (rate) of temperature change over time is a little less than rate of change of perfusion, which is associated with features of the thermophysical characteristics of the skin. Thus, combined thermometry and LDF allow the investigation of changes in thermal parameters of patient's tissue during the progression of the VD/RP.

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Method for control functional status of microcirculatory-tissue systems during the cold pressor test

Using non-invasive optical methods of laser Doppler flowmetry (LDF), tissue reflectance oximetry (TRO) and pulse oximetry, we may investigate the dynamics of parameter changes of microcirculatory-tissue systems (MTS) when using cold pressor test (CPT). According to differences in the recovery rate of oxygen consumption during CPT, volunteers can be conditionally divided into two groups: displaying normal physiology and with a tendency to angiospasm and lack of functional recovery of the MTS. Use of the CPT for functional assessment of MTS allows us not only to estimate the reserve capabilities of the MTS, but also to identify – at a pre-clinical stage propensity to angiospasm, which has practical value in the clinic.

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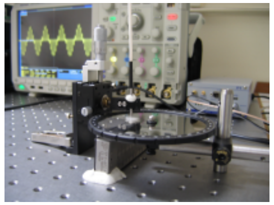
Key R&D policy

Metrological support of devices for laser doppler flowmetry



One of the most common methods of optical non-invasive diagnostics today is laser Doppler flowmetry (LDF). The LDF method is used for functional diagnosis of blood microcirculation, including diagnosis of diseases of the cardiovascular system. However, today the accuracy of the LDF method is rather low, and metrological support of LDF devices is virtually absent, which explains their limited use in clinical practice. This project proposes a prototype of hardware-software system for metrological support of LDF devices. It uses a piezoelectric actuator and Doppler light-diffusing layer to reproduce the desired dimension of the measurable value. This solution is capable of improving the utility of this class of medical devices.

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Methodological and instrumentation provision of fluorescence spectroscopy for medicine

The fluorescent spectroscopy (FS) provides effective and non-invasive optical diagnostics, primarily in medical areas such as oncology, transplantation, cosmetology and surgery. FS for medicine is a complicated technique that depends on the temperature, topological heterogeneity, different properties of each sample, etc. Therefore, the reliability of FS is affected by multiple factors, including the availability of data concerning the scattering and absorbing properties of specific tissues in specific conditions (for example, the contribution of skin melanin), light pollution at optical fibre tip and instrument errors such as excitation source instability, photodetector limitations, light filter precision, grating precision, CCD performance, etc. To achieve clinically significant and reliable results, issues of accuracy, convergence and dispersion measurement also need to be addressed.

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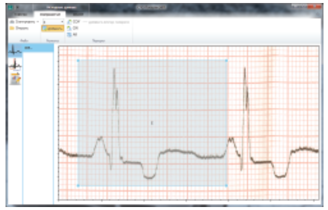
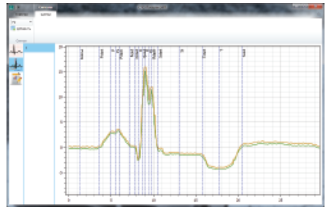
ECG devices metrological support and technical condition assessment

ECG is a well-known, wide spread and effective method of heart disease diagnosis. Nevertheless, legally defined procedures used for the technical condition assessment and metrological support of these devices are very complicated and routine. This project proposes an automated solution for ECG device verification. The basic idea is a semi-automatic analysis of the device using an ECG-like test input signal to elicit a response (ECG paper or digital data). Since the parameters of test signals are defined, result of comparison can be successfully used as an objective measure of technical condition and metrological performance. This solution can be used either as a rapid control system in medical institutions or as a tool in metrological services and service centers during maintenance and verification.





ECG signal quality assessment

Unfortunately, in most cases, the ECG signal is contaminated by different kind of disturbances: artifacts and noise. Source signal can be distorted so much that interpretation can be very difficult or even impossible. In addition, artifacts can simulate abnormal changes, which cause high levels of misinterpretation and false alarms. This project was inspired by PhysioNet/Computing in Cardiology Challenge 2011. The Proposed algorithm of an ECG signal quality assessment is based on empirical mode decomposition and machine learning. The proposed measures of quality, alongside the classification based on a host of decision trees, may be successfully implemented for distinguishing the nature of signals using a four-point scale.

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