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ON IMPROVEMENTS OF HEART RATE VARIABILITY TECHNOLOGY FOR EXPRESS DIAGNOSTICS OF OPERATOR'S STATE IN EXTREME CONDITIONS

Abstract

Heart rate variability (HRV) is used as a non-invasive informative marker of activity of the autonomic nervous system in wide range of medical care applications, especially for diagnostics of physiological states of body regulatory systems in extreme conditions, when registration hardware is highly restricted in size and available resources. In particular, the methodology is referred to an assessment of a functional state of different divisions of the autonomic nervous system. This information allows to estimate physiological reserve of the body and probationer's ability to carry out complex tasks in the specific environment. Space medicine (especially in Russia) is the main field where HRV analysis was successfully used for solving the tasks of continuous medical control of operators.

Currently, developments of advanced express diagnostics techniques for rapid support of operators in extreme conditions are of especial interest. Spectral analysis of heart period (HP) time series is considered to be the technique, most suitable for short-term analysis, and that is why spectra indexes of HRV are most commonly used in practice. HP signal is discrete, naturally irregularly sampled signal: a sequence of R-R interval values at time instances of R-pike detection. But majority of methods for spectra analysis needs regularly sampled time series for correct processing. There are different interpolation techniques, which allow transforming irregularly sampled data to regular equivalent. A lot of researchers emphasize that the choice of interpolation technique plays an essential role for final HRV indices' estimated values. But there is no generally accepted standard method for interpolation of HR series for HRV spectra analysis in literature. Comparison of efficiencies of different interpolation techniques was objectives of this research.

We have compared existing methods of HR interpolation techniques on simulated HR signals and on real data. Deep theoretical analysis of distortions for linear and spline piecewise continuous interpolation techniques allowed us to develop weighting functions for post-processing correction of HP spectra. Developed correction procedure makes efficiency of linear piecewise continuous interpolation technique superior to all other interpolation techniques for HP signal resampling. Achieved advances in HRV indices estimation procedure increase accuracy of operator's physiological states determination and improve the quality of Space medicine in general.