EQUATION IN FRACTIONAL DERIVATIVES FOR ECG DIAGNOSTICS

Gomozov, Y. P.[1], Seredin, V. V.[1], Ozirna, A. V.[2]
[1]*National Technical University «Kharkiv Polytechnic Institute», Kharkiv*
[2]*Center of Vocational and Technical Education No. 1, Kharkiv*

The human body is an electrically conductive environment, inside which the source of biopotentials is located - the heart muscle, so the difference in biopotentials can occur not only directly on the heart, but also on the surface layers of the body. This fact makes it possible to register biopotentials not only at the direct location of lead electrodes on the heart, but also on the surface of the body. A graphic record of the electrical potential created by the excitation of heart cells is called an electrocardiogram (ECG). With each beat, an electrical impulse (wave) passes through the heart. This wave causes the muscle to contract and pump blood away from the heart. ECG consists of different waves, intervals and complexes.

In general, a wide range of problems is considered in cardiology, among which the main one is the diagnosis of heart diseases and their forecasting. It is well known that the quality of this diagnosis strongly depends on the qualifications of the cardiologist who deciphers the electrocardiogram.

Therefore, they have been engaged in mathematical modeling and automation of medical diagnostics for quite some time. Automation of medical diagnostics requires large data sets. Since the use of ECGs from real patients is strictly regulated due to privacy issues, there is a need to generate artificial data that would allow obtaining large and balanced data sets without violating patient privacy. However, there are anonymous databases that allow you to make a diagnosis, but, unfortunately, do not allow you to make predictions. Currently, the main methods of forecasting and diagnosis by ECG are: application of neural networks to ECG; phaseography; forecasting according to HRV; application of Markov processes to ECG. All these methods have certain drawbacks. The rhythm of the heartbeat, although it looks regular and periodic, is chaotic in nature, that is, the heart needs a constant change in the time interval between successive heartbeats. Studies have shown that ECG signals are well modeled as fractal processes, and their properties can be characterized by fractal dimension.

Therefore, it is not by chance that works appeared (for example, [1,2]) in which analysis and forecasting according to the ECG is done with the help of equations in fractional derivatives. However, in our opinion, due to some reasons, the use of Jumarie's fractional derivatives in this case is not correct.

Using the ideas of bioinformatics and econophysics, we proposed a phenomenological model of diffusion-type ECG dynamics with Grunwald-Letnikov fractional derivatives.

References:

1. Srijan Sengupta, Uttam Ghosh, Susmita Sarkar and Shantanu Das. Application of Fractional Derivatives in Characterization of ECG graphs of Right Ventricular Hypertrophy Patients. arXiv:1711.02332v1 https://doi.org/10.48550/arXiv.1711.02332.

2. U. Ghosh, S. Sengupta, S. Sarkar and S. Das. Characterization of non-differentiable points of a function by Fractional derivative of Jumarie type. European Journal of Academic Essays 2015. 2(2): 70-86.