Method of identification of parameters of the human isometric effort stabilization.

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The study of maintenance of the human isometric effort is a topic problem of the movement physiology. According to the present views the trajectory of the process registered in an experiment is a sum of two components, namely, a slow and a fast components. The slow component reflects the process of arbitrary control by the value of the given effort. The fast component specifies the stabilization of the effort relative to its given value. Changes of the slow component have a spontaneous character and have no strongly marked temporary pattern. The pattern of the fast component, contrastingly, can be considered as nonstationary harmonic oscillations. Its nonstationarity is manifested in variations of all the three parameters: amplitude, frequency and damping coefficient. One of the problems connected with the analysis of maintenance of isometric effort is to identify current values of parameters of the stabilization and to reveal their temporary patterns.

We suggest the method identifying the stabilization parameters. It consists in solution of two tasks: 1) the partition of the registered trajectory into the slow and fast components; 2) the determination of current values of the stabilization parameters.

Solving the first task is based on two steps. First, the fragments are used, that shifted relative each other by one step of sampling of experimental data. Second, each fragment of the trajectory involving one or two periods of oscillations is approximated by means of the mathematical model describing the local behaviour of the slow and fast components of the registered trajectory. The slow component is described by a linear function and the fast component is specified by the right hand side of the differential equation of damping harmonic oscillations. The frequency and the damping coefficient are parameters of this equation. Parameter values corresponding to the middle of each fragment are identified by the described technique. On the basis of the obtained parameter values the slow and fast components corresponding to the middle of the fragment are calculated. The result of these calculations for all the consecutive fragments is the acquisition of the unknown components.

The aim of the second task is to precise current values of the frequency and damping coefficient and to determine the amplitude of the fast component. The solution of the task is reduced to determining parameters of the model describing the local behaviour of the fast component only. The structure of this model is defined as the right hand side of the differential equation of the damping harmonic oscillations. The use of this model enables us to precise values of the frequency and damping coefficient. To calculate the amplitudes we apply the trigonometric model involving the obtained current values of the frequency and damping coefficient.

The method was tested for 10 patients with Parkinson's disease. The isometric effort (in kg) held by the left or right hand was registered. The results have shown that the method suggested, contrastingly with the commonly accepted Fourier series method, allows us to reveal clearly various frequencies of oscillations of the stabilization of the isometric effort for this type of patients. We expect that the method can be useful for classification of patients with various movement disorders.

Fig. 1 Comparison of amplitude - frequency curves of the fast component of the isometric effort obtained by the suggested method and Fourier series.

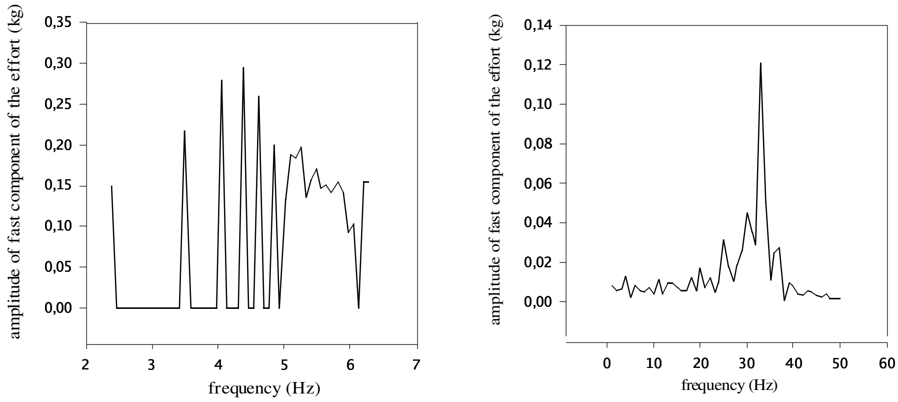

Figure 2 The registered isometric effort and two its components