NOVEL INFORMATION TECHNOLOGY FOR ANALYSIS AND INTERPRETATION OF A RHYTHMIC SIGNALS GENERATED BY BIOLOGICAL SYSTEMS

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The problem of computer processing of a rhythmic signals generated by biological system (for example, ECG, MCG and other) isn't a simple problem. We propose the novel informative technology for processing of rhythmic signals in the phase space.

It is assumed that observed signal $y(t) = \Phi[y_0(t), \zeta(t)] + h(t)$ is a result of distortions of periodic process $y(t)$ by the *internal* $\zeta(t)$ and the *external* $h(t)$ random perturbations. We suppose also that any i-th fragment on the m-th cycle of $y(t)$ be a result of operator transformation to corresponding fragments of $y_0(t)$:

$$y_m^{(i)}(t) = a_m y_0^{(i)}\left(\frac{t - \tau_m^{(i)}}{b_m^{(i)}}\right), \quad i = 1,\dots,K \qquad (1)$$

where $a_m, b_m^{(i)}$ are random parameters of perturbation (by amplitude and time) and $\tau_m^{(i)}$ is the parameter of time shift.

In this case, the stochastic model of observed signal might be obtained [1]:

$$y_m^{(i)}(t) = (1 + \xi_m) y_0^{(i)}(\theta) + h(t), \qquad (2)$$

where

$$\theta = \frac{t - (m-1)T_0 + t_0^{(i-1)}(1 + \delta_m^{(i)}) - \sum_{j=1}^{m-1}\sum_{i=1}^{K}(t_0^{(i)} - t_0^{(i-1)})\delta_j^{(i)} - \sum_{l=1}^{i-1}(t_0^{(l)} - t_0^{(l-1)})(1 + \delta_m^{(l)})}{1 + \delta_m^{(i)}} \qquad (3)$$

and ξ_m, $\delta_m^{(\,)}$ are sequences of a bounded random variables with zero average.

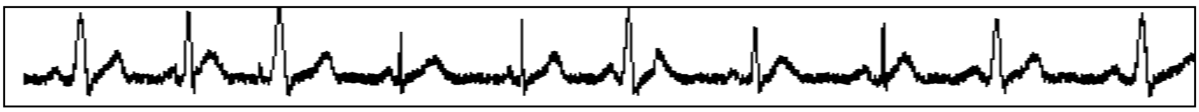

Figure 1. A rhythmic signal $y(t)$ generated by the model (1) - (3)
(on an example of ECG-signal)

The proposed informative technology consists from some separate stages (Figure 2). On the first step we use some original procedures which reduce the level of an external frequency [2] and random [3] interference $h(t)$ without appreciable change of useful signal's form. Next, we transform the filtering signal into the phase space and estimate the average trajectory using special procedures based on Hausdorff distances between every trajectory pairs. Finally, the inverse transformation gives the suitable estimation of non-observed periodical signal

$y_0(t)$ in the usual time domain [4]. Obtained estimation is used for morphological analysis and interpretation of the investigated biological process.

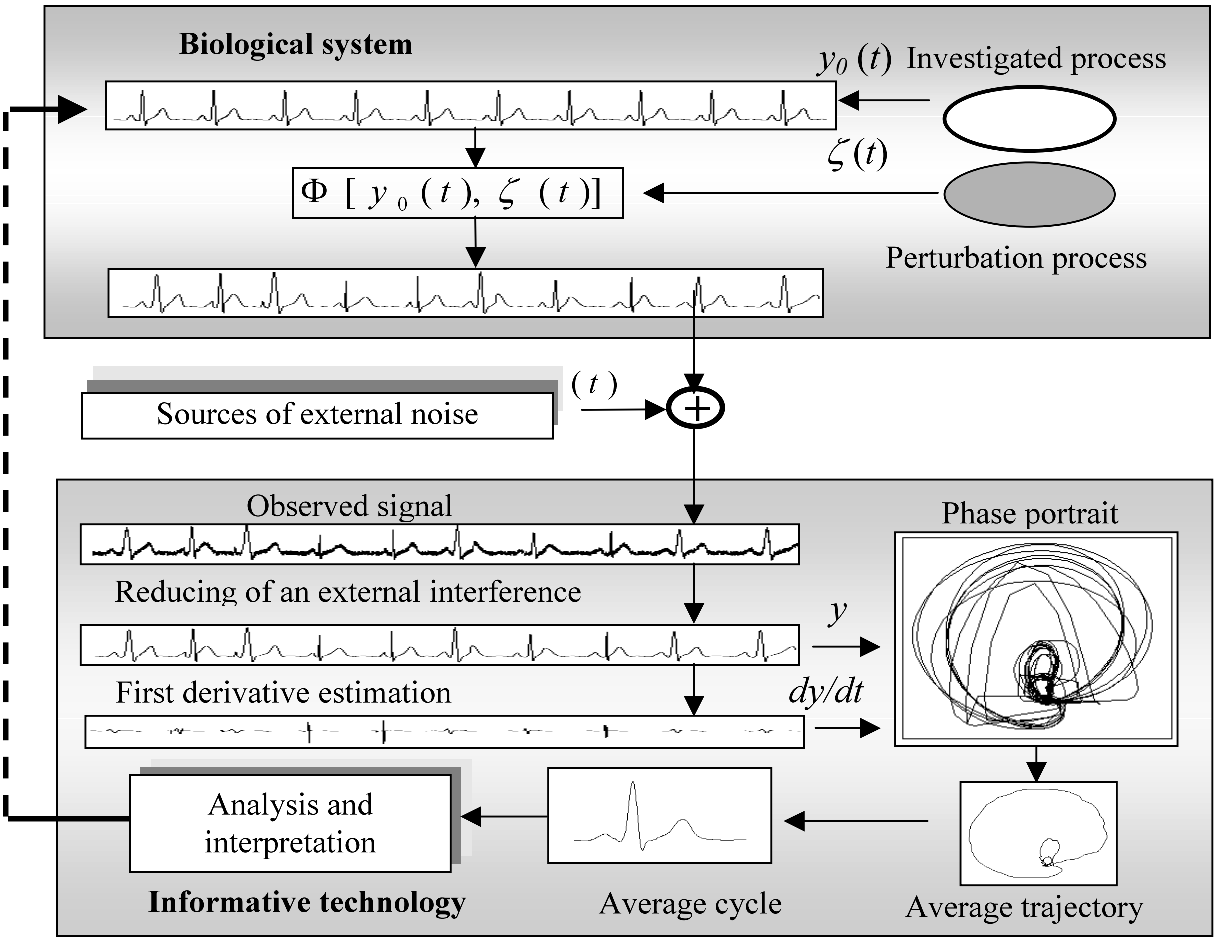

Figure 2. The informative technology architecture

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2. *Fainzilberg L.S.* Adaptive smoothing of a noise in informative technologies of physiological signals processing // Mathematical Machines and Systems. – 2002. – № 3. – P. 96–104. (On Russian).
3. *Fainzilberg L.S.* Restoration of a cyclic signal sample based on Hausdorff metric in a phase space // Kibernetica i sistemny analiz. –2003. – № 3. – P. 20-28. (On Russian).
4. *Fainzilberg L.S.* ECG Averaging Based on Hausdorff Metric // International Journal of Biomagnetism.– 2003. –Vol. 5. – № 1. – P. 236-237.