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A Method of Optimal Linear Systems for Following Filtration of Active Spectrum of Non-Stationery Process

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Abstract—It is shown a necessity of improve of known method of optimally matched filtering for following the spectrum of non-stationery processes. The essence of improvement lies in expansion of the conception of signals active spectrum, taking into account specificities of known following filters with self-tuning and application of known following filters with two integrators. It is proven that selecting of gain coefficients of three amplifies, which are contained in this filter, we can use them as separate section of band-pass filter for synthesis of optimal linear systems for following filtration the active spectrum itself for different signals type.

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INTRODUCTION

Creation of linear systems for electronics, radio engineering, communication and automated control in case of noise presence requires, first of all, synthesizing of optimal in some sense system transfer function. The solution of this problem is necessary for achieve of maximal signal-to-noise ratio.

For optimal signals filtration high-selective stationery band-pass filters can be used, as it was mentioned in [1, p.13.1]. Such frequency limitation of transmitted signals is used, for example, for stating of quality standards in telephony [2] and quality classes in radiobroadcasting [3]. But such filter does not match always the signal shape together with noise statistics. For example, in case of sounding of choir or symphony orchestra, where active (information) spectrum [4] occupies almost all dedicated frequency, its channel pass-band filter is the most closer to optimal filter. But, in case of active spectrum of sound signals is essentially less than stationery filter bandwidth it cannot be considered as enough matched filter. In the other case if there is a dialog between a man with deep voice and a woman with high-pitched voice, when active spectrum lies in lower and upper part of the spectrum, correspondingly, stationery band-pass filter is essentially unmatched.

Hence, both for the first mentioned case and for the second one signals types at upper and lower frequencies noise power exceeds a small spectral power of transmitted signals of such components, which are not in its active frequency. It is clear, that increase of signal to noise ratio requires application of following band-pass filters (FF).

Therefore, it is necessary to prove possibility of conditionally optimal systems for following linear filtration of exact active spectrum not only the second type signals, but also the other non-stationery processes.

MODIFICATION OF ACTIVE SPECTRUM BEHAVIOR

In paper [5] it is shown that in case of frequency restriction of arbitrary signals by following filters [5–8], which have restricted instantaneous lower $\omega_{lw}(t)$ and upper $\omega_{up}(t)$ frequencies, we can write following expressions for active half of current spectrum:

$$\Delta\omega(t) = [\omega_{up}(t) - \omega_{lw}(t)]/2 \tag{1}$$

and average instantaneous frequency of this band $2\Delta\omega(t)$:

$$\omega_0(t) = [\omega_{up}(t) + \omega_{lw}(t)]/2\,. \tag{2}$$