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DETECTION OF NOISE-LIKE SIGNALS BY THE FEATURES OF THEIR SPECTRA

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This work is about improving the energy detection method for noise-like signal detection by changing the approach to signal processing in the integrator in order to increase the speed of isolating the useful signal from the noise. In essence, a new method is proposed for detecting on a noise background, using the symmetry of the spectrum of NLS. The detection process was simulated. It showed the effectiveness of the proposed method in comparison with simple energy detection.

Wideband signals are widely used in the interference conditions, in CDMA, other communication systems, radio navigation, radar, as well as for the covert information and control signals transmission. They are of interest for the defense field, sphere of security and information protection. Therefore, the task of detecting these signals is urgent, and the fast of detection is often important. Unfortunately, traditional energy detection is not fast-response and requires long-term accumulation.

The energy spectrum of a phase-shift keyed (PSK) signal was considered, $\left|S_{PSK}(f)\right| = \sqrt{\sum_{i=1}^{n}\sum_{k=1}^{n} a_i a_k \cos((i-k)2\pi f t_0)}$. After taking into account the spectrum of a single pulse with duration t_0 and transferring it to the modulating frequency, the spectrum takes on the form shown in Fig. 1.

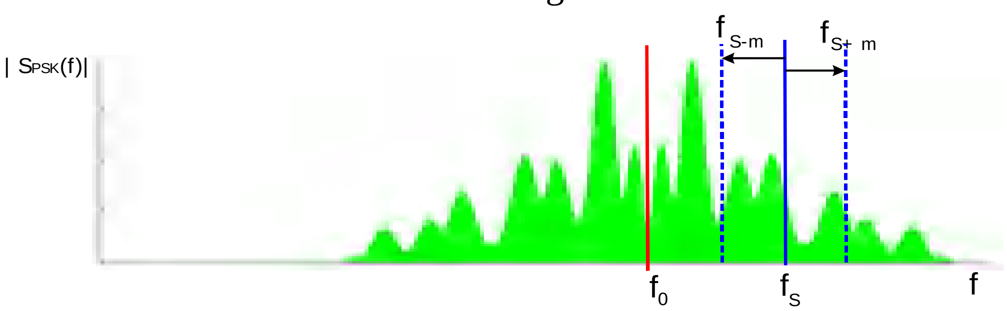

Fig. 1

As you can see, it is symmetrical about the center frequency (red line). This is not typical for noise and most of interference. It can be shown mathematically that the function of the pair wise products sum of the spectral values moduli (blue dotted lines), taken symmetrically about some arbitrarily chosen frequency (blue solid line),

$$A(f_S) = \sum_{m=0}^{M} \left|S(f_{S+m})\right|\left|S(f_{S-m})\right|, \qquad (1)$$

reaches its maximum when there $f_S = f_0$. That is, when the frequency f_S coincides with the symmetry center of this spectrum.

The first assumption was made: the property of the maximum of the function $A(f_S)$ is preserved even when white Gaussian noise is added to the noise-like PM signal, since it has a uniform spectral density. Then a second assumption was made – this property will make it possible to detect LNS on a noise background, and not only detect it, but also immediately determine its central frequency. Thus, a method for LNS detecting was proposed, which based on its spectrum symmetry. It consists in the fact that it is necessary to enumerate all values of f_S in interest band and find the function (1) maximum. However, there was a concern that noise exposure may “smooth out” the peak of this function, making it less noticeable.

To check the above assumptions, a mathematical model was developed that makes it possible to form a PSK signal with a different base, mix it with noise in a given ratio and carry out calculations in accordance with (1). The model was implemented in the MatLab environment. The simulation was performed for a constant modulating sequence with B = 13. At the same time, the information signal was continuously changing, which ensured the natural dynamics of the spectrum. Various SNR were also simulated. To evaluate the proposed method effectiveness, simulations were also performed for traditional energy detection.

The simulation results are shown in Fig. 2. It shows the results of0 energy accumulation in blue, and the proposed method in red. The dotted lines correspond to frequency bands where only noise is present, the solid lines to bands with noise and signal. As you can see, the method based on the spectrum symmetry begins to separate the signal from the noise earlier.

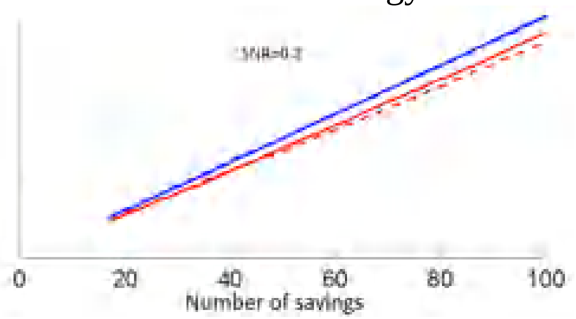

Fig. 2

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