

CUMULANT PROCESSING OF ULTRA WIDEBAND RADAR SIGNALS

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Abstract. A method for the estimation of the information parameters of ultra wideband radar signals based on the higher order statistics (HOS) is presented. It is shown that the application of the fourth order cumulants for parameter estimation of the resonant model allow to reduces the signal-to-noise ratio till the -12 dB.

Ultra wideband (UWB) radars include methods and systems for detection, parameters' measurement and targets' identification at application of signals, which spectrum has a ultra wide relative band.

In accordance with Baum's singularity expansion method [1] the electromagnetic radar target response can be decomposed into a finite sum of damped sinusoids and so the natural electromagnetic radiation of objects can be described by the resonant model. The model consists of parameters of two types: dependent on an energizing signal (polarization, form, direction of arrival) and the natural complex resonant frequencies of targets [2]. These frequencies are determined by basic geometrical sizes and shape of objects, practically do not depend on a aspect angle and can be used for identification of the radar targets. The natural portion of the response can be used for the aspect-independent active and passive radar target discrimination.

To make the comparative analysis of digital processing methods for the ultra wideband signals with application of the higher order cumulants we have selected resonance frequencies [3], appropriate to resonances of scale models of planes. The distinction in a spectrum of these models allows to make the conjecture of possibility to identify radar targets by using two pairs of models poles.

The higher order cumulants were used for the purpose of parameter estimation of the targets' resonant models. The model consisting of two damped sinusoids and additive Gaussian noise was chosen. Comparison estimation the HOS method with the traditional pencil-of-function method proved its high accuracy of the poles estimation.

The results of digital modeling show that the using of the fourth order cumulants method for parameter estimation of the resonant model leads to the increase of the estimation of poles' accuracy on 15-20 dB in comparison with traditional algorithms. It is shown that the application of the fourth order cumulants for parameter estimation of the resonant model allow to reduces the signal-to-noise ratio till the -12 dB. The fourth order statistics can be used as an effective tool for the estimation of resonant model parameters as well in the ultra wideband radar systems as in the others different applications of signals processing.

References

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