

# THE SIGNATURE IDENTIFICATION OF ULTRA WIDEBAND RADAR TARGETS

Yury Kuznetsov, Andrey Baev, Andrey Aleksandrov

Moscow Aviation Institute (State Technical University)  
125993, Moscow, Volokolamskoe Shosse, 4  
Tel.: (095) 158-40-47  
E-mail: mai\_k405@mtu-net.ru

**Abstract.** A method of signature identification for ultra wideband radars and the estimation of the information parameters of ultra wideband radar signals based on the higher order statistics (HOS) are presented. The sets of poles on a complex plane were offered to use as signatures of ultra wideband radar targets. It is shown that the application of the fourth order cumulants for parameter estimation of the resonant model allow to reduce the signal-to-noise ratio till the 0 dB.

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

It is shown that the application of the fourth order cumulants for parameter estimation of the resonant model allow to reduce the signal-to-noise ratio till the 0 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.

The identification of ultra wideband radar targets by using of fourth order cumulants was made by using objects' signatures. These signatures are the points in  $K$ -dimensional space, each axis of which is proportional to the true value of a pole on a complex  $z$ -plane for the expected target. The distance between an estimation of a point in space of signatures for the identified object and the signatures of objects stored in a databank, will be criterion for its identification. Such approach allows creating the automated system of ultra wideband radar target identification.

## References

1. S. Lawrence Marple, Jr., *Digital Spectral Analysis with Applications*, Moscow: "MIR", 1990.
2. Ю.В. Кузнецов, Щекатуров В.Ю., Баев А.Б., «Сравнительная характеристика алгоритмов оценки параметров резонансной модели объектов», *Вестник МАИ*, том 4, № 2, М.: МАИ, 1998 г.
3. Taylor, James D., *Introduction to Ultra-Wideband Radar Systems* / editor Taylor, James D., CRC Press, 1995.