Retrieval information from the UWB pulse signal using the Karhunen Loeve transform

Modris Greitans, Vladimir Aristov

Abstract – **In the article the results of the Karhunen-Loeve transform in the processing model of UWB pulse signals to retrieval information about the amplitude and phase changes.**

Keywords – **UWB pulse signal, Karhunen-Loeve .**

I. INTRODUCTION

Used in Radar processing algorithms [1] aim to identify in the reflected signal equivalent to the modulating voltage corresponding to the spatial variations in small targets, particularly the chest when breathing human. Along with the applicable methods of processing of the primary signal, such as spectral analysis, correlation analysis, the Doppler technique, phase analysis, and others are proposed to use conversion algorithm Karhunen-Loeve.

II. WORKING MODEL OF SIGNALS

The basis of Karhunen-Loeve transform is a rotation of the initial coordinate system dimension n, which are ensembles of discretized signal **x** , in the new coordinate system with vectors **y** with the number of samples m ($m \le n$) with a minimum mean square error of the transformation through the transformation matrix **W**, is formed from the eigenvectors of the covariance matrix of the training set [2].

$$\mathbf{y} = \mathbf{W}^{\tau}\,\mathbf{x} \qquad (1)$$

To investigate this area produced processing model of signal corresponding to changing of the amplitude and phase shift in the reflected signal. It is a model of UWB pulse reflection of the central frequency of 2 GHz as one target of simulating the movement of the chest of man and of the group of different remoted targets, one of which simulates the movement of the chest. The obtained simulation results show:

—when changing the amplitude of the reflected signal in units of time (Fig. 1b), and when its changing the delay within 40-150 ps (Fig. 1a) in the new coordinate system is sufficient m = 5-10 samples to display the signal compared to n = 256 counts in the original coordinate system, with the rms error not exceeding 10%;

—when changing the delay of the reflected signal in the range of 100 ps can be replaced by a new point in the two-dimensional coordinate system moving along an arc (Fig. 2a). This arc with a smaller oscillations of the target degenerates into a straight line;

—when changing of the amplitude of the reflected signal to a maximum of 3 times it can be replaced by a single sample in the new coordinate system, the value of which changes in law (Fig. 2b), which coincides with that of changes in the amplitude of the original signal;

— minor fluctuations of the target in group of fixed targets not clearly perceived by the operator to view the model of the reflected signal(Fig. 1c), clearly seen in the new coordinate system. Law of the trajectory motion of a point in the new (for example, a two-dimensional) coordinate system (Fig. 2c) coincides with that for the signal model corresponding to the oscillations of a single target.

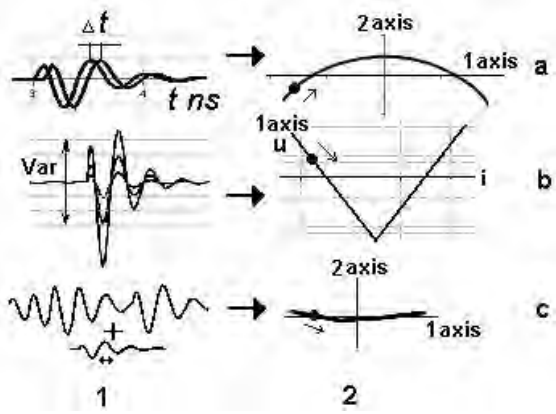

Fig. 1 Modeling results

For a preliminary assessment of the accuracy of the transformation and select the desired number of discrete samples in the new coordinate system, analyzed the eigenvalues λ of the covariance matrix of the training set. Typical distribution λ for ensembles of models of signals described above is shown in Fig. 2.

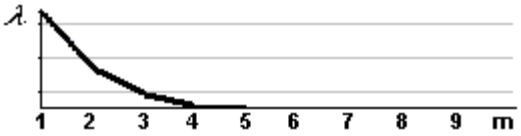

Fig. 2 Typical distribution eigenvalues

III. CONCLUSION

The results of processing model of UWB pulse signals confirm the potential and prospects of using Karhunen-Loeve transformation.

REFERENCES

[1] И.Я. Иммореев, С.В. Самков, "Сверхширокополосный радар для обнаружения и измерения параметров движущихся объектов", МАИ, http://www.uwbgroup.ru/pdf/03_cpcarus_id01.pdf

[2] R.D.Dony, Karhunen-Loeve Transform. The Transform and Data Compression Handbook. Ed. K.R.Rao and P.C.Yip. CRC Press LLC, 2001

Modris Greitans, Vladimir Aristov-Institute of Electronics and Computer Science. Dzerbenes str.14, LV-1006 Riga, Latvia
E-mail: modris_greitans@edi.lv vladimirs.aristovs@edi.lv