Radioelectronics and Communications Systems
Vol. 49, No. 2, pp. 37–42, 2006

Izvestiya VUZ. Radioelektronika
Vol. 49, No. 2, pp. 53–60, 2006
UDC 621.396:681.34

A METHOD FOR SIGNAL RECONSTRUCTION WITH THE USE OF NORMALIZED SPECTRUM

A. V. Totskii, P. Yu. Kostenko, I. V. Kurbatov,
Ya. T. Astola, and K. O. Yegiazaryan

Kharkov Aviation Institute, Ukraine

A new method is suggested for reconstruction of signals of unknown shape by their bispectral density. The new approach is based on application of smooth functions such as cosine and sine — instead of the discontinuous function of the "arctangent of bispectrum argument" type, traditionally accepted in phase measurements. The use of simulation permits to assess effectiveness of the suggested method of reconstruction of signals with the first genus discontinuities at different discretization intervals.

Reconstruction of signals by their bispectrum is often performed by the methods based on the common concept of direct or indirect usage of phase measurement results [1–6]. In [1–3], for example, reconstruction of signals is based on calculating the phase bispectrum in the explicit form. In [4] we find an approach consisting in extraction of phase information contained in the logarithmic bispectrum (bicepstrum), while in [5] — that embedded in the differential cepstrum. Another work is devoted to reconstruction of the phase of a transfer function with the aid of two adjacent sections in the phase bispectrum [6]. Note that, on the one hand, nondistorted reconstruction of the phase information is possible only under certain conditions and limitations, imposed on the processed signal properties and, on the other, the errors arising during the phase reconstruction may cause a considerable distortion at the output of the signal reconstruction system. Particularly, it may require a two-dimensional [1–3] or one-dimensional (such as the nonparametric method described in [4] or [6]) procedure of phase shift necessary for reconstructing the true values of phases. Effectiveness of the parametric method [4] depends on position of zeroes and poles of the z-transform of the processed signal about the circle of the unit radius on the z-plane. In the cases when the zeros and poles are located on this circle of unit radius, the cepstral coefficients cannot be determined, and the parametric method [4] does not work. Moreover, the parametric method necessitates additional a priori information in the form of the cepstrum of signal power, and a priori information about signal amplitude — to transform the processed signal into the class of the maximum/minimum-phase signals. However, such a priori information is often unavailable. The effectiveness of the iterative method of signal reconstruction [4] also depends strongly on certain conditions: in order to calculate the differences of cepstral coefficients we have to know the phase bispectrum. In other words, high convergence of the iterative method described in [4] is possible only in the case of some a priori information about the signal. In the method with calculation of the differential cepstrum [5], we have to impose strict limitations on differentiability of z-transform of the signal under processing: the transform must not have any zeroes and poles on the circle of unit radius in the z-plane.

Although the phase information may be of interest for a number of applications, it is not essential for treatment of the problems in concern with reconstruction of signals by their bispectrum. In this paper we propose a new approach to bispectral treatment of the problem of signal reconstruction, when the phase information in the explicit form is absent. As distinct from traditional approaches, where phase measurements are associated with the above-mentioned distortions and

Radioelectronics and Communications Systems
Vol. 49, No. 2, 2006

REFERENCES

1. H. Bartelt, A. V. Lohmann, and B. Wirnitzer, Applied Optics, Vol. 23, pp. 3121–3129, 1984.
2. G. Sundaramoorthy, M. R. Raghuveer, and S. A. Dianat, IEEE Trans. Acoustics, Speech, and Signal Processing, Vol. 38, No. 7, pp. 1297–1306, 1990.
3. M. G. Kang, K. T. Lay, and A. Katsaggelos, Optical Engineering, Vol. 30, No. 7, pp. 976–985, 1991.
4. A. P. Petropulu and C. L. Nikias, IEEE Transactions on Signal Processing, Vol. 40, No. 3, pp. 601–610, 1992.
5. S. Alshebeili and A. E. Cetin, IEEE Transactions on Geoscience and Remote Sensing, Vol. 28, No. 2, pp. 166–170, 1990.
6. A. P. Petropulu and H. Pozidis, IEEE Transactions on Signal Processing, Vol. 46, No. 2, pp. 527–530, 1998.
7. C. I. Nikias and M. R. Raghuveer, Proc. IEEE, Vol. 75, No. 7, pp. 869–891, 1987.

8 February 2005