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A METHOD FOR DETERMINATION OF ENERGY CENTER OF A SOLITARY PULSE

V. G. Andreyev and O. V. Pal'chik

Ryazan' State Radio-Engineering Academy, Russia

A new method is suggested for estimating the energy center of a solitary pulse. The method permits to diminish the estimate variance as compared to the same characteristic of the center-of-gravity method. The method is based on a recursive procedure of calculation of cylindrical convolution, which facilitates the implementation.

Many applied and theoretical problems require the knowledge of the energy center of a solitary pulse. In the explicit form this can be formulated, for example, in the problem of estimation of Doppler's phase, or in optical measurements. The choice of the method of search for the energy center reduces to a trade-off of permissible errors against required speed of the measuring system. Particularly, for triangulated measurers it may occur that the system becomes more critical to accuracy.

Since for actual signals we hardly can estimate exactly their center position, the results presented in this work were obtained on stochastic sequences u of length N, composed of solitary pulses s backgrounded by additive white noise n: $u = s + n$.

Consider the most well-known methods for determining the energy center and compare their characteristics.

Approximation with the use of the least-square method [1] permits to obtain the most accurate estimates. A disadvantage of this method is the need for using the threshold processing in the course of adaptation to the parameters (the center and width variations) of the pulse s. No universal recommendations exist for selecting the threshold, and the non-adaptive approach calls for considerable computational expenditures — due to high order of the approximating polynomial and the need for determination of the global minimum. The main computational load of the method is accounted for by inversion of the $n \times n$ matrix, where n is the order of the approximating polynomial. In the Gaussian elimination, for example, the procedure requires the number of multiplication (division) operations in proportion with n^3. The overall computational expenditures on the approximation are about $(n^3 + 2nN)$. Moreover, the algorithm requires no less than $2n^2$ words of random access memory.

The search for the energy center of a pulse s by **the method of center of gravity** may be regarded as determination of the geometric mean of the sequence u:

$$\hat{M} = \sum_{g=0}^{N-1} g \cdot u[g] / \sum_{g=0}^{N-1} u[g] \qquad (1)$$

where $u[g]$ are samples of the analyzed sequence u, and $\hat{M}$ is the estimate of the energy center for u.

This method is distinguished with its simple implementation and, with the use of contemporary hardware, works very fast: it takes only $(N + 1)$ multiplications (divisions), which makes it possible to use it in real time. The intermediate data

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