DIGITAL SIMULATION OF GROUP ESTIMATION OF AN ENERGY SPECTRUM ACCORDING TO THE ENTROPY-MINIMAX METHOD

V. V. Savchenko and D. N. Bashulin

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Estimation of the energy spectrum of a random time sequence $\{x(l)\}$ according to the entropy-minimax method (EMM) is implemented in a system of M linear decorrelators having different orders m = 1, 2, ..., M (see [1]). Its computation formula for a sample of size L is

$$G_{MM}^{(L)}(f) = 1/\left[\sum_{m=0}^{M} \lambda_m(L)\, K_m^{2(L)}(f)\right] \tag{1}$$

and uses the set of squares of the amplitude-frequency responses (AFR) of the decorrelators $K_m(f) = |K_m(jf)|$, m = 1...M determined on the analysis interval [1; L] jointly with the sequence of weighting coefficients $\{\lambda 12_m(L)\}$. In different versions of the selection of $\{\lambda_m(L)\}$, Eq. (1) yields different modifications of the estimate of the unknown energy spectrum. It has been demonstrated that the optimal version is the one corresponding to the system of equations

$$\int_{-\Delta F}^{\Delta F} K_m^{2(L)}(f)/\left[\sum_{i=0}^{M} \lambda_i(L)\, K_i^{2(L)}(f)\right] df = \sigma_m^2(L), \tag{2}$$

where $m = \overline{0, M}$, which is defined on the set of sampling variances $\{\alpha^2_m\}$ of the response $\{x_m(l)\}$ of the decorrelators having the different orders (the integration is performed within the limits of the passband of the analyzed process). Here $\sigma_0^2(L) = \sigma_0^2 = M\{x^2(l)\}$; $K_0^{(L)} = K_0 = 1$. The efficiency of the resulting spectrum estimate (1) will depend in this case on the efficiency with which the system of M decorrelators will be adjusted according to the criterion requiring the minimum mean squares of their responses $\sigma^2{}_m(L) = M\{x^2{}_m(l)\}$, $m = 1 \ldots M$.

Evidently, the implementation of the decorrelators according to a filter network having a lattice structure (see [2]) is the most promising. Its most obvious advantage over the parallel processing system considered in [1] lies in the significant economy in hardware and software. Moreover, one should take into account the good dynamic properties of lattice filters and their relative insensitivity to round-off errors. Therefore, there is legitimate interest in the possibilities of utilizing lattice filters in the problem of estimating an energy spectrum according to the EMM method. It is to an analysis of these possibilities that the present work has been devoted.

The dynamics of a lattice filter (LF) of m-the order in discrete time (l = 1, 2, ...) can be described by a system of recurrence equations of the form

$$\begin{cases} R_{m+1}^{(L)} = 2\sum_{l=m}^{L} e_m(l)\, b_m(l-1)/\sum_{l=m}^{L}[e_m^2(l) + b_m^2(l-1)]; \\ e_{m+1}(l) = e_m(l) - R_{m+1}^{(L)} b_m(l-1);\ \ l = 1 \ldots L; \\ b_{m+1}(l) = b_m(l-1) - R_{m+1}^{(L)} e_m(l);\ \ m = 0 \ldots M. \end{cases} \tag{3}$$

Here $e_0(l) = b_0(l) = x(l)$; $R^{(L)}{}_{m+1}$ is the partial correlation coefficient (PCC) of the process at the output of the m-the step of the LF. The PCC set $R^{(L)}{}_n$, $n = \overline{0, m}$ is used to determine the ensemble of m weighting coefficients of the m-the order optimal decorrelator

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