Radioelectronics and Communications Systems
Vol. 46, No. 1, pp. 48–50, 2003

Izvestiya VUZ. Radioelektronika
Vol. 46, No. 1, pp. 69–73, 2003
UDC 621.372

THE ROBUST ALGORITHMS FOR OPTIMIZATION OF NONRECURSIVE FILTER COEFFICIENTS BY THE COMBINED CRITERION OF MINIMUM MEAN-SQUARE ERROR

S. N. Kirillov and S. M. Shubin

Ryazan' State Radio-Engineering Academy, Russia

The authors report of development and tests of new robust algorithms for optimization of nonrecursive digital filters based on a combined criterion of minimum of the mean-square error. The latter contains information concerning variation of the synthesis inaccuracy. The algorithms suggested are shown to provide a decrease by 1.7 dB in the dynamic range of the error signal at the output of the filter under synthesis, and exhibit low sensitivity to inaccurately set initial parameters.

The methods of adaptive design of nonrecursive filters with the use of adaptive simulation are well known [1, 2]. One of such applications represents optimization of coefficients of nonrecursive filters with a prescribed complex-valued frequency response. According to this method, as can be seen in the block diagram of Fig. 1, in order to form the desired $d[k]$ and produced $y[k]$ responses, the inputs of a standard (SF) and adaptive (AF) filters are driven from a sine-wave generator by an input signal equal to a sum of sine signals $x[k] = \sum_{m=1}^{N} \sin 2\pi f_m k$, where f_m are normalized frequencies at which the requirements have been established.

The SF output signal $d[k] = \sum_{m=1}^{N} a_m \sin(2\pi f_m k + \theta_m)$, where a_m and θ_m are prescribed requirements to the amplitude-frequency (AFR) and phase-frequency (PFR) responses of the filter to be synthesized.

In the process of adaptation we minimize some parameter of the error signal, thus establishing AF coefficients in accordance with the requirements prescribed. Usually [1, 2] we employ the algorithms of optimization of nonrecursive filter coefficients by the criterion of minimum of the mean-square error (MSE). As has been shown in [2], the characteristics synthesized by this criterion show a good mean approximation to requirements imposed, but may have large overshoots. To improve the properties of the minimum MSE criterion, we may employ the combined criterion of MSE minimum making it possible to diminish the dynamic range (DR) of the error signal and the dynamic range of the proper numbers of the correlation matrix [3–5].

In the event of the combined criterion we minimize the working function

$$\Phi = E\left[\left\{(1-h)\, e[k] - h\,(e[k] - e[k-1])\right\}^2\right] \qquad (1)$$

where $E[\bullet]$ is the operation of averaging in time; $h = 0,..., 1$, is the weighting multiplier, and $e[k] = d[k] - y[k]$ is the error signal.

The purpose of this work is development and investigation of algorithms for optimization of nonrecursive filters based on the combined criterion of minimum MSE.

REFERENCES

1. V. Cappelini, A. J. Constantinidis, and P. Emiliani, Digital Filters and Their Application [Russian translation], Energoatomizdat, Moscow, 1983.
2. B. Weedrow and S. Stirns, Adaptive Processing of Signals [Russian translation], Radio i Svyaz', Moscow, 1989.
3. S. N. Kirillov and M. V. Stepanov, Radiotekhnika, No. 2, pp. 39–41, 1999.
4. S. N. Kirillov and M. V. Stepanov, Tsifrovaya Obrabotka Signalov, No. 1, pp. 27–32, 2000.
5. S. N. Kirillov and M. V. Stepanov, Izv. VUZ. Radioelektronika, Vol. 43, No. 3, pp. 21–26, 2000.

29 August 2000