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TWO EXAMPLES OF MULTIPLIERLESS PERFECT RECONSTRUCTION LATTICE FILTER BANK DESIGN

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This paper is devoted to solving of the task of multiplierless two-channel perfect reconstruction lattice filter banks [1-4]. A modified algorithm combining a variation of initial parameters (VIP) and a variation of coefficients (VC) are used. Two examples show that the refuse of a simplified selection of a spectral factor code (C) leads to substantial improvement of results.

Example 1. Filter bank requirements: the nominal edges are f_{1n}=0.18, f_{2n}=0.32, and the sampling frequency equal 1, the order of each filter is 2N-1=27, the mantissa of binary coefficients is $M \le 10$, the number of non-zero bits in the coefficients is $m \le 2$. The task 1: the minimum stopband attenuation is $\tilde{a}_0 \to \max$. The task 2: the total number of adders in the multiplierless filter is $\Sigma \to \min$, $\tilde{a}_0 \ge 45$ dB.

A value $\tilde{a}_0$=45.45 dB (more precisely 45.37 dB [4]) at M=10 and m=2 (Σ=56) is reached in [1]. Improved solutions for simplified selected C=33 are obtained in [4] by VIP+VC algorithm. In [1] an initial filter with continuous coefficients corresponds to C=0 and the designed multiplierless filter corresponds to C=32. Therefore it is interesting to find solutions by VIP+VC modified algorithm for C=32. The values $\tilde{a}_0$=48.59 dB, Σ=54, M=8 and $\tilde{a}_0$=45.49 dB, Σ=50, M=8 are obtained for this value C. Both solutions improve the result [1].

Designing by VIP+VC modified algorithm for C=0,1,…,127 and C=16383-0,1,…,127=$\underline{0}$,$\underline{1}$, …,$\underline{127}$ leads to many solutions exceeding results [1,4]. Two best of them are C=$\underline{102}$, $\tilde{a}_0$=53.35 dB, Σ=54, M=9 and C=$\underline{25}$, $\tilde{a}_0$=45.39 dB, Σ=46, M=4. For the second solution the found coefficients $\alpha_0,...,\alpha_{13}$ (on fig. 1b in [1,2]) are $1-2^{-4}$, 2^{-3}, 2, $-1-2^{-1}$, $-2-2^{-3}$, -2^{-4}, $-2^{-1}+2^{-4}$, $-1-2^{-4}$, $-2^{-2}-2^{-3}$, $-2^{2}+2^{-1}$, 2^{-4}, $2+2^{-2}$, -2^{-4}, $2+2^{-3}$. Interestingly, that this second solution is possible to reach by using the only VIP algorithm.

Example 2. The requirements: the nominal edges are some, $\tilde{a}_0 \ge 45.45$ dB, 2N-1=21, M=9, $m \le 3$ and $\Sigma \to \min$ [2]. A solution with Σ=56 and $\tilde{a}_0$=45.78 dB (more precisely 45.19 dB [3]) is achieved in [2]. VIP algorithm [3] leads to Σ=56 and $\tilde{a}_0$=45.01 dB. Here we use VIP+VC modified algorithm for a set of C. For solutions [2,3] all zero appropriated to a passband are inside the unit circle. In this case for the given filter order the code C=0 or C=1984-k64, k=0,1,..., 31. We shall be limited C=0 and C=1984. In the first case solution with Σ=56, $\tilde{a}_0$=45.16 dB and in the second case solution with Σ=56, $\tilde{a}_0$=45,66 dB are obtained. It is interesting that the coefficients $\alpha_0,...,\alpha_{10}$ for C=1984 distinguish from that were founded in [2] by the only coefficient. We have $\alpha_0=-2^2+2^{-6}$, and in [2] $\alpha_0=-2^2+2^{-5}$. Besides our value α_0 is included into a range of exhaustive search [2]. Apparently the misprint is accepted in [2].

Designing for C=1,2, …,32 lead to very big number of solutions with $\tilde{a}_0 \ge 45.45$ dB and $\Sigma \le 56$, two best of them are C=2, $\tilde{a}_0$=46.19 dB, Σ=48 and C=12, $\tilde{a}_0$=45.64 dB, Σ=46. For the second solution $\alpha_0,...,\alpha_{10}$ are 2^{-3}, $2^{-1}-2^{-9}$, $-2^{3}+2+2^{-3}$, $-1+2^{-2}+2^{-5}$, 2^{-4}, $-2^{-2}-2^{-5}-2^{-7}$, $-2^{-1}+2^{-6}$, $2^{2}-2^{-1}$, $1+2^{-3}+2^{-6}$, -2^{-1}, $-2^{-2}-2^{-3}$. In comparison to the solution at C= 1984 the number of adders is reduced from 56 to 46.

References

1. Lim Y.C., Yu Y. J. A width-recursive depth-first tree search approach for the design of discrete coefficient perfect reconstruction lattice filter bank. IEEE Trans. on CAS: II. 2003. Vol. 50. June. P. 257-266.
2. Yli-Kaakinen J., Saramaki T., Bregovic R. An algorithm for the design of multiplierless two-channel perfect reconstruction orthogonal lattice filter banks. ISCCSP. 2004. Mar. P. 415-418.
3. Mingazin A. Design of multiplierless perfect reconstruction lattice filter banks. Sowremennaya elektronika. 2007. Mar. P. 50-55.
4. Mingazin A. Improved design of multiplierless two-channel perfect reconstruction lattice filter banks. Sowremennaya elektronika. 2008. Mar. P.26-31.