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MULTIPLIERLESS TWO-CHANNEL PERFECT RECONSTRUCTION LATTICE FILTER BANK DESIGN USING SPECTRAL FACTOR SELECTION

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A two-channel perfect reconstruction lattice filter bank proposed in [1] is considered. We have assumed that involvement of a spectral factor selection into multiplierless lattice filter bank design algorithms can improve results. It is confirmed by the design example at nominal edges $f_{1n}=0.18$, $f_{2n}=0.32$ and the sampling frequency equal 1. We used two algorithms based on a variation of initial parameters (VIP) as [4]. The results [2-4] may be improved by using a special spectral factor. That is shown in Table1. Here 2N-1 is the order of each filter in the bank; C is the spectral factor code; M is the fractional part wordlength of coefficients; m is the number of non-zero bits in coefficients; f_1 and r are the passband edge and auxiliary parameter [4] for which the solution is obtained; $\tilde{a}_0$ - the minimum stopband attenuation; Σ - the total number of adders including the structure adders (first item) and adders (second item) replacing all pairs of multipliers on coefficients α_i in Fig.1b in [2,3].

Table 1

Algorithm	2N-1	C	M	m	f_1; r	$\tilde{a}_0$, dB	Σ
Simple rounding [2]	27	0	10	2	-	25.38	56=28+14×2
Tree search [2]					-	45.37*	56=28+14×2
Implicit enumeration [3]	21		9	≤ 3	-	45.19*	56=22+17×2
VIP [4]					0.18053; 3	45.01	56=22+17×2
VIP	27	0	10	≤ 2	0.1950; 0.1683	38.85	52=28+12×2
		33	8		0.1788; 0.1367	46.79	54=28+13×2
			7		0.1794; 0.1429	44.06	50=28+11×2
VIP + variation of coefficients (coordinate-wise search)		0	10		0.1780; 0.4398	40.98	50=28+11×2
		33			0.1788; 0.1367	48.10	56=28+14×2
					0.1800; 0.1481	47.81	54=28+13×2
			7		0.1786; 0.1377	46.08	50=28+11×2
					0.1810; 0.1600	44.38	44=28+8×2

In case C=0 the passband zeros of the transfer function are $R_6\exp(\pm j\varphi_6)$, $R_5\exp(\pm j\varphi_5)$,…, $R_1\exp(\pm j\varphi_1)$, R_0 and in case C=33 the zeros are $R_6\exp(\pm\varphi_6)$, $R_5^{-1}\exp(\pm\varphi_5)$, $R_4\exp(\pm\varphi_4)$,..., $R_1\exp(\pm\varphi_1)$, R_0^{-1}. Here R_i is the radius and φ_i is the angle of i-th zero in z-plane. In addition R_i<1, i=0,1,…,6 and $\varphi_1<\varphi_2<...<\varphi_6$. For the solution with $\tilde{a}_0$=48.10 dB the coefficients are $\alpha_0,...,\alpha_{13}$: $-2+2^{-3}$, $2^{-1}+2^{-7}$, $2^{-1}+2^{-5}$, $2^{-5}-2^{-8}$, $2^{-1}+2^{-6}$, 2^3-1, $-2^{-1}-2^{-7}$, $2^{-2}-2^{-6}$, $1-2^{-7}$, $-2^{-6}+2^{-8}$, $-2^{-3}+2^{-5}$, $2^{-3}+2^{-6}$, $-2^{-4}+2^{-6}$, $2^{-6}-2^{-10}$. For the solution with $\tilde{a}_0$=46.08 dB all coefficients are identical except $\alpha_3,\alpha_9,\alpha_{13}$: 2^{-5}, -2^{-6}, 2^{-6}. It is interesting that the solution with $\tilde{a}_0$==46.79 dB differs from the one with $\tilde{a}_0$=48.10 dB by the only coefficient $\alpha_{13}=2^{-6}$. The values $\tilde{a}_0$ marked with the badge * are reevaluated at 1000 points for the coefficients from [2,3].

References

1. Vaidyanathan P.P., Hoang P.Q. Lattice structures for optimal and robust implementation of two-channel perfect-reconstruction QMF banks. IEEE Trans. on ASSP. 1988. V. 36. Jan. P. 81-94.
2. 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.
3. 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.
4. Mingazin A. Design of multiplierless perfect reconstruction lattice filter banks. Sowremennaya elektronika. 2007. Mar. P. 50-55.