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New universal rotation-based fast computational structures for an efficient implementation of the DCT-IV/DST-IV and analysis/synthesis MDCT/MDST filter banks. (English)

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Summary: New universal rotation-based fast computational structures identical both for the discrete cosine/sine transform of type IV (DCT-IV/DST-IV) and the forward/backward modified discrete cosine/sine transform (MDCT/MDST) computation are described. They are the result of a systematic construction of a fast algorithm for an efficient implementation of the time domain aliasing cancellation (TDAC) analysis/synthesis MDCT/MDST filter banks employed in various audio compression schemes. New fast algorithms provide novelty computational structures based exclusively on the computation of Givens-Jacobi rotations, and thus, the need of any discrete sinusoidal unitary transform such as the discrete Fourier transform (DFT), DCT-IV/DST-IV or discrete cosine/sine transforms of type II (DCT-II/DST-II) of reduced size is completely eliminated, so simplifying the computational structure of the algorithms. The rotators and summators are used only as the basic computational modules (in a hardware implementation they are simple hardware blocks). The simple and regular Givens-Jacobi rotation-based fast computational structures valid for any N divisible by 4 (N being the length of data sequence) define new sparse matrix factorizations of the DCT-IV and MDCT matrices and in particular, generate an efficient implementation of the MDCT in MP3 audio coding standard. For a given $N = 2^n$ they can be easily reconfigurable for a specific audio coding scheme. Finally, since Givens-Jacobi rotation can be factored into a product of Gauss elementary matrices being unit lower and unit upper triangular matrices, the new fast rotation-based computational structures are suitable for an integer approximation of the DCT-IV/DST-IV (integer DCT-IV/DST-IV) and MDCT/MDST (integer MDCT/MDST) which are currently modern transform technologies for lossless audio coding.

MSC:

- 94A11 Application of orthogonal and other special functions
- 93E11 Filtering in stochastic control theory
- 65T50 Numerical methods for discrete and fast Fourier transforms

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Keywords:

modified discrete cosine transform; modified discrete sine transform; analysis and synthesis MDCT filter banks; modulated lapped transform; modulated complex lapped transform; fast computational structure; MPEG audio coding; integer MDCT; lossless audio coding

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