Discrete Cosine and Sine Transforms
General Properties, Fast Algorithms and Integer Approximations

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Discrete Cosine and Sine Transforms: General properties, Fast algorithms and Integer Approximations is the single comprehensive resource available on book market covering the various latest developments in DCTs and DSTs. The complete set of DCTs and DSTs, called the discrete trigonometric transforms, is presented including their definitions, general mathematical properties, relations to the optimal Karhunen-Loève transform (KLT), with the emphasis on fast algorithms (one-dimensional and two-dimensional) and integer approximations of DCTs and DSTs for their efficient implementations in the integer domain. DCTs and DSTs are real-valued transforms that map integer-valued signals to floating-point coefficients. Although the fast algorithms reduce the computational complexity significantly, they still need floating-point operations. To eliminate the floating-point operations, various methods of integer approximations have been proposed to construct and flexibly generate a family of integer DCTs and DSTs with arbitrary accuracy and performance. The integer transforms currently represent the modern transform technologies for lossless transform-based signal coding. The integer DCTs/DSTs with low-cost and low-powered implementation can replace the corresponding real-valued transforms in wireless and satellite communication systems as well as portable computing applications.

The book is essentially a detailed excursion on orthogonal/orthonormal DCT and DST matrices, their matrix factorizations and integer approximations. Definitions, principles, properties, signal flow graphs, derivations, proofs and many examples are provided for proper understanding of the strengths and shortcomings of the spectrum of DCTs and DSTs and the methods of constructing their integer versions.

Readership:
This book is suitable for scientists, researchers and engineers (research institutes, universities and companies). It is also suitable for graduate students in Electrical Engineering and Computer Science.

Key Features:
- Presentation of the complete set of DCTs and DSTs in context of the entire class of discrete unitary sinusoidal transforms: the origin, definitions, general mathematical properties, mutual relationships and relations to the optimal Karhunen-Loève transform (KLT).
- Unified treatment with the fast implementations of DCTs and DSTs: the fast rotation-based algorithms derived in the form of recursive sparse matrix factorizations of a transform matrix including one- and two-dimensional cases.
- Detailed presentation of various methods and design approaches to integer approximation of DCTs and DSTs utilizing the basic concepts of linear algebra, matrix theory and matrix computations leading to their efficient multiplierless real-time implementations, or in general reversible integer-to-integer implementations.
- Comprehensive list of additional references reflecting recent/latest developments in the efficient implementations of DCTs and DSTs mainly one-, two-, three- and multi-dimensional fast DCT/DST algorithms including the recent active research topics for the time period from 1990 up to now.

Contents:
DEFINITIONS AND GENERAL PROPERTIES OF DCTs AND DSTs - Definitions and general properties of integral Fourier cosine and Fourier sine transforms with some examples, the origin, definitions and general mathematical properties of DCTs and DSTs including convolution properties.

THE KARHUNEN-LOÉVE TRANSFORM (KLT) AND OPTIMAL DECORRELATION - KLT as a series representation of a given random signal, asymptotic equivalence of DCTs and DSTs to KLT, asymptotic equivalence and generation of discrete unitary transforms.

FAST DCT/DST ALGORITHMS - Definitions, properties of orthogonal/orthonormal DCT/DST matrices and relations among them, explicit forms of orthonormal DCT/DST matrices, fast rotation-based DCT/DST algorithms based on sparse matrix factorizations (DCT-I, SCT, DST-I, SST, DCT-II/DST-II, DCT-III/DST-III, DCT-IV/DST-IV), fast 2-D DCT/DST algorithms.

METHODS FOR INTEGER APPROXIMATION OF DCTs/DSTs - Plane rotation matrices: factorizations and notations, elementary rotation matrices, elementary transformations, QR, LU, LDU and PLU matrix factorizations, factorizations of Givens-Jacobi rotations and Householder reflections, various constructions of integer DCT/DST transforms: C-matrix transform, integer cosine/sine transforms, generalized Chen transform, BinDCT/IntDST and IntDCT/IntDST, other methods and approaches - lossless DCTs, invertible integer DCTs, reversible DCTs including late additions with comments.

APPENDICES - Vector spaces, the matrix eigenvalue problem, matrix decompositions, signal and its representation.

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