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

Vladimir Britanak, Patrick C. Yip, K. R Rao

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The Discrete Cosine Transform (DCT) is used in many applications by the scientific, engineering and research communities and in data compression in particular. Fast algorithms and applications of the DCT Type II (DCT-II) have become the heart of many established international image/video coding standards. Since then other forms of the DCT and Discrete Sine Transform (DST) have been investigated in detail.

This new edition presents the complete set of DCT and DST discrete trigonometric transforms, including their definitions, general mathematical properties, and relations to the optimal Karhunen-Loéve 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. To eliminate the floating-point operations, various methods of integer approximations have been proposed to construct and flexibly generate a family of integer DCT and DST transforms with arbitrary accuracy and performance. 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 aproximations.

It is hoped that the book will serve as a valuable reference for industry, academia and research institutes in developing integer DCTs and DSTs as well as an inspiration source for further advanced research.

Key Features
- Presentation of the complete set of DCTs and DSTs in context of entire class of discrete unitary sinusoidal transforms: the origin, definitions, general mathematical properties, mutual relationships and relations to the optimal Karhunen-Loéve 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.

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