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Design of Two-Channel Quadrature Mirror Filter Banks Using a Transformation Approach

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Abstract : Two-dimensional (2-D) quadrature mirror filter (QMF) banks have been widely considered for high-quality coding of image and video data at low bit rates. Without implementing subband coding, a 2-D QMF bank is required to have an exactly linear-phase response without magnitude distortion, i.e., the perfect reconstruction (PR) characteristics. The design problem of 2-D QMF banks with the PR characteristics has been considered in the literature for many years. This paper presents a transformation approach for designing 2-D two-channel QMF banks. Under a suitable one-dimensional (1-D) to two-dimensional (2-D) transformation with a specified decimation/interpolation matrix, the analysis and synthesis filters of the QMF bank are composed of 1-D causal and stable digital allpass filters (DAFs) and possess the 2-D doubly complementary half-band (DC-HB) property. This facilitates the design problem of the two-channel QMF banks by finding the real coefficients of the 1-D recursive DAFs. The design problem is formulated based on the minimax phase approximation for the 1-D DAFs. A novel objective function is then derived to obtain an optimization for 1-D minimax phase approximation. As a result, the problem of minimizing the objective function can be simply solved by using the well-known weighted least-squares (WLS) algorithm in the minimax (L∞) optimal sense. The novelty of the proposed design method is that the design procedure is very simple and the designed 2-D QMF bank achieves perfect magnitude response and possesses satisfactory phase response. Simulation results show that the proposed design method provides much better design performance and much less design complexity as compared with the existing techniques.

Keywords : Quincunx QMF bank, doubly complementary filter, digital allpass filter, WLS algorithm
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