

# 應用於多媒體信號處理的副頻帶濾波器組之設計(II)

Design of Subband Filter Banks for Multimedia Signal Processing (II)

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## 一. 中文摘要 :

本計劃已完成預期之研究工作-研發一項設計具有非均勻副頻帶特性的FIR濾波器組其FIR濾波器具有最小均方誤差止帶響應及具有最小尖波重建誤差之技術. 首先, 利用一近似法則, 我們推導此設計問題為一最佳化問題. 配合一有效的疊代方法來解決此設計問題. 電腦模擬實驗已驗證本計劃成果之有效性.

## 二. 英文摘要 :

This project has accomplished the research work for the design of the analysis and synthesis FIR filters of two-channel nonuniform division filter banks. We first formulate the design problem as an optimization problem based on an approximation scheme. An efficient iteration procedure is developed to update the filter coefficients during the iteration process. The effectiveness of the developed technique to solve the design problem

is illustrated through several design examples.

**Keywords:** Nonuniform-Division Filter Banks, Optimization.

## 三. 緣由與目的:

Due to the fact that multimedia information becomes a necessary part of modern life. Processing the speech or audio signals of multimedia information has been viewed as an important research work. However, conventional uniform subband decomposition is not an appropriate scheme to match the requirements for the subband coding of speech and audio signals. The most appropriate decomposition must consider the critical bands of the ear. It has been shown that these critical bands have nonuniform bandwidths and cannot be easily constructed by conventional tree structure based on two-channel QMF banks. Therefore, it is worth considering

the design problem of two-channel nonuniform-division filter (NDF) banks.

#### 四. 研究方法與成果：

研究方法—First, we present a new NDF banks and derive the associated formulas for the input/output relationship. According to these formulas, we then derive the problem formulation for optimally designing an NDF bank under the minimax and least-squares criteria. To solve the resulting optimization problem, an efficient design technique has been developed based on an appropriate approximation scheme and a novel approach for updating the filter coefficients.

研究成果—In this project, we have developed a new system structure for constructing an NDF bank and derived the formulas for relating the input/output relationship of the NDF bank. Next, an efficient technique has been presented for designing the proposed NDF bank. The effectiveness of the proposed design technique has been demonstrated by several computer simulation examples.

#### 五. 結論與討論：

We have finished the proposed research work during the one-year period. Utilizing an approximation scheme and an appropriate coefficient update formula, we have presented a method to design a two-channel nonuniform-division filter bank which is optimal in the minimax re-

construction error and least-squares stopband response sense. The optimal filter coefficients can be obtained by solving only linear equations. The effectiveness of the proposed method has been demonstrated by several computer simulation examples.

#### 六. 參考文獻：

- (1) K. Nayebi, T.P. Barnwell, and M.J.T. Smith, "Nonuniform filter banks: a reconstruction and design theory," IEEE Trans. on Signal Processing, vol. 41, Mar. 1993, pp.1114-1127.
- (2) S. Wada, "Design of nonuniform division multirate FIR filter banks," IEEE Trans. on Circuits and Systems II: Analog and Digital Signal Processing, vol. 42, Feb. 1995, pp.115-121.
- (3) J. Kovacevic and M. Vetterli, "Perfect reconstruction filter banks with rational sampling factors," IEEE Trans. on Signal Processing, vol. 41, June 1993, pp.2047-2066.
- (4) J. Princen, "The design of nonuniform modulated filter bank," IEEE Trans. on Signal Processing, vol. 43, Nov. 1995, pp.2550-2560.
- (5) T. Nagai, T. Futie, and M. Ikehara, "Direct design of nonuniform filter banks," Proc. of ICASSP, vol. 3, 1997, pp.2429-2432.
- (6) J.-H. Lee and S.-C. Huang, "Design of two-channel nonuniform-division maximally decimated filter banks using  $L_1$  criteria," IEE Proc. -Vision, Image and Signal Processing, vol. 143,

no. 2, Apr. 1996, pp.79-83.

(7) C.-K. Chen and J.-H. Lee. "Design of linear-phase quadrature mirror filters with powers-of-two coefficients," IEEE Trans. on Circuits and Systems II: Analog and Digital Signal Processing, vol. 41, July 1994, pp.445-455.

(8) J.-H. Lee and T.-C. Jung, "Linear-phase quadrature mirror filters with coefficients -1, 0, and +1," Signal Processing, vol. 56, 1997, pp.91-101.

(9) J.-H. Lee and D.-C. Tang, "Minimax design of two-channel nonuniform-division FIR filter banks," IEE Proc.-Vision, Image and Signal Processing, vol.145, no.2, pp.88-96, April 1998.