Optimal Cosine Modulated Nonuniform Linear Phase FIR Filter Bank Design via Stretching and Shifting Frequency Response of Protype Filter

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Abstract

•The frequency responses of all the analysis filters and the synthesis filters of the filter bank are derived based on both stretching and shifting the frequency response of the prototype filter.

•The design problem is formulated as a functional inequality constrained optimization problem.

•Our recently developed integration approach is employed for solving the optimization problem.

Introduction

•Filter banks decompose input signals into component signals in different frequency bands. Operations are then applied to these component signals.

•Nonuniform filter banks are the filter banks with different decimation factors in different subband channels.

•FIR filter banks are the filter banks with all the analysis filters and the synthesis filters being FIR.

•Linear phase filter banks are the filter banks with all the analysis filters and the synthesis filters being linear phase.

•Cosine modulated filter banks are the filter banks that all the analysis filters and the synthesis filters are the cosine modulations of a single prototype filter.

Problem Statement

•Existing cosine modulated nonuniform filter banks [1] do not guarantee that all the analysis filters and the synthesis filters are linear phase.

•The amplitude distortions of existing cosine modulated nonuniform filter banks as well as both the maximum passband ripple magnitudes and the maximum stopband ripple magnitudes of the analysis filters and the synthesis filters are very large particularly at the transition bands of the analysis filters and the synthesis filters of the corresponding cosine modulated uniform filter banks.

•The lengths of all the analysis filters and the synthesis filters of existing cosine modulated nonuniform filter banks are the same.

Solution Proposed

•The filter bank is designed based on both stretching and shifting the frequency response of a prototype filter. The design problem is formulated as an optimization problem and an integration approach [2] is applied for solving the problem.

Problem Formulation

•The total aliasing error of the filter bank is minimized subject to a specification on the maximum amplitude distortion of the filter bank as well as specifications on both the maximum passband ripple magnitude and the maximum stopband ripple magnitude of the prototype filter.

Results and Discussions

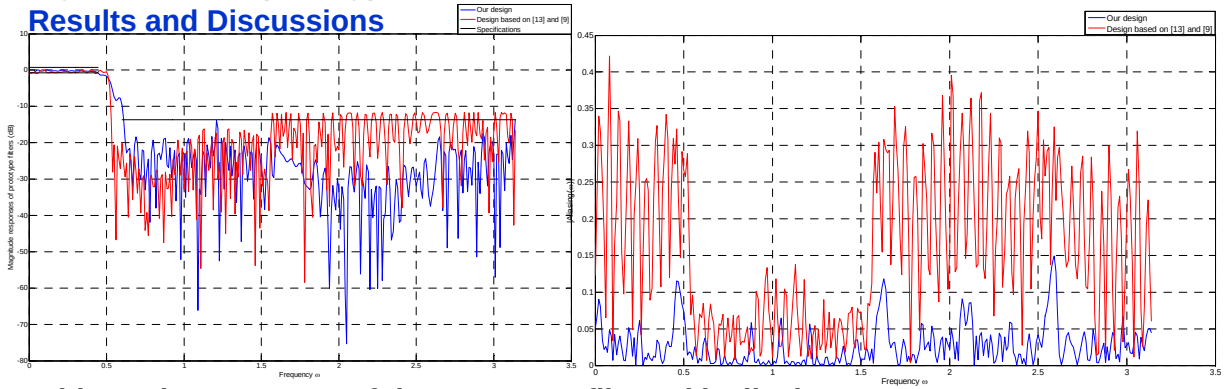

Table 1- a) Responses of the prototype filters. b) Aliasing errors.

Conclusions

•As the length of all the analysis filters and the synthesis filters are inversely proportional to the bandwidth of the filters.

•Our design could achieve a better performance on the maximum amplitude distortion of the filter bank as well as better performances on both the maximum passband ripple magnitude and the maximum stopband ripple magnitude of the prototype filter.

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