DIGITAL FILTERING USING AMPLITUDE CHANGE FUNCTIONS

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CERTIFICATE

This is to certify that the thesis entitled, 'DIGITAL FILTERING USING AMPLITUDE CHANGE FUNCTIONS', being submitted by E. Gopinathan, to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of Doctor of Philosophy, is a record of bonafide research work carried out by him under our supervision and guidance and in our opinion, it has reached the standard fulfilling the requirements of the regulations relating to the degree.

The results contained in this thesis have not been submitted to any other institute for the award of any degree or diploma.

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ABSTRACT

The performance of a symmetric nonrecursive filter can be sharpened or improved by the multiple use of the same filter. The method is based on an Amplitude Change Function (ACF) which is a polynomial relationship between the amplitude H of the prototype and H_0 of the transformed filter. This thesis is concerned with some new applications of the ACF. First, some new ACF's are presented for further improving the response of the sharpened filter; it is shown that by scaling and/or shifting the ACF, the passband and/or stopband performance can be further improved. Also, a New Chebyshev type ACF (NCACF) has been derived which does not require correction filters for its hardware implementation. Shifting and scaling the NCACF are shown to result in further improvement in the response.

A method for continuously varying the ACF, within certain limits, is also suggested in this thesis. This variable ACF is achieved by restricting its plot to pass through a predetermined point and then, varying this point such that the amplitude of H_0 lies between 0 and 1 for all values of H within the same limits. Expressions for finding the limits of variation are given. A modular hardware implementation scheme for different combinations of the order of tangencies of the ACF, keeping the order of transformation invariant is also suggested. The variable ACF can be used either to reduce the inband ripples or to continuously vary the cut-off frequency of the transformed filter.

The concept of ACF is further used for the frequency transformation of digital filters. Generalized expressions for transforming a lowpass filter into highpass, bandpass or bandstop filters are obtained. The response of the transformed filter can be further improved by shifting or by using the NCACF. Methods for varying the centre frequency keeping the bandwidth constant and vice-versa, for the bandpass/bandstop transformed filters are also suggested.

The various applications of the ACFs discussed for non-recursive filters are extended to recursive filters. An even order polynomial is used to relate the magnitudes of the prototype and transformed filters and the phase is taken care of by using appropriate number of allpass filters in all parallel branches. A brief discussion on the errors due to arithmatic operation in the transformed recursive filter is also carried out.

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