DIGITAL FILTERS

AND

CASCADE CONTROL COMPENSATORS

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ABSTRACT

The thesis contains new design procedures for digital filters and cascade control compensators. Fixed point binary representation of signals is considered, as is the sequential execution of a programmed device. The two's complement fixed point binary arithmetic has specific nonlinearities. Sequential program execution gives intrinsic timing properties which make certain filter structures relatively convenient to implement.

A versatile second order digital filter structure is proposed, a feature being that the notch depth is infinite at all sampling rates. New and convenient design procedures to compute the required coefficient values are developed. One procedure gives ideal magnitude equivalence with frequency warping, whilst another gives approximate magnitude equivalence without frequency warping. The thesis also contains a derivation from first principles for Bessel digital filters.

Then the effects of representing the signal using two's complement arithmetic are considered. Techniques are devised to avoid both small and large signal limit cycles. These techniques apply to filters where the input is not zero.

The thesis also contains new design techniques for sampled control systems which allow design evaluations to be made within the Laplace domain. One aspect is to extend compensation for frequency warping of the bilinear transform from the frequency axis to any point in the Laplace domain. Also a method for sequencing instructions so as to minimize computational delay is presented.