OPTIMAL PRE- AND POST-FILTERING IN NOISY SAMPLED-DATA SYSTEMS

by

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ABSTRACT

In this thesis we consider the problem of jointly optimizing the pre- and post-filters in a communications or storage system, with optimality considered in a weighted mean-square error sense. We adopt a system model that is general enough to be applicable to a wide variety of problems, such as broadcasting, tape recording, telemetry, and signal coding, among others. Our fundamental assumptions throughout this work are that the pre- and post-filters are linear and that all signal and noise spectra of interest are known.

We derive the optimal pre- and post-filters for three basic classes of systems, characterized by infinite impulse response (IIR), finite impulse response (FIR), and block filters. Whenever appropriate, we present filters with nearly optimal performance that can be efficiently implemented. We also derive analytic forms and a fast version for a recently introduced class of pre- and post-filters for block processing with overlapping basis functions, namely, “Lapped Orthogonal Transforms” (LOT’s). In all of these classes, for typical image processing and coding applications, we obtain improvements in the weighted r.m.s error over traditional systems on the order of 1 to 6 dB.

Some of the results of this work can be immediately used to improve existing digital signal coding systems. For example, the combination of pseudo-random noise quantization with appropriate filtering, and the use of a fast LOT, may lead to a reduction of more than 3 dB in the r.m.s error in a block coder, with a simultaneous whitening of the noise patterns and significant reduction of the so-called “blocking effects”.

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