Electronic System Group
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1. The Subject and Aims of Research

Recent research is devoted to the synthesis and implementation of digital filters, the applications of adaptive filters to real-time signal processing, and the design of digital up-converters and down-converters. The main objectives of our research are to develop new realization structures and pertinent design techniques for tracking the variations in signal characteristics and producing better system performance. In addition, we are interested in enhancing the efficiency of the system realization and achieving overall system robustness, which leads to research results of greater practical value.

2. Related Recent Research Topics

(a) Digital Filter Design Based upon Multiple Criteria: Conventional filter design technique is to realize deterministic filter specifications with minimum realization error, and the filter characteristics are incapable of adapting to the real-time characteristics of the input signal. When the filter is realized with common adaptive filter techniques, the filter characteristics are loosely governed by the adaptation algorithm, which often leads to undesired filter characteristics. Therefore, we develop new filter design methods based upon the constrained minimization formulation. The filter constantly gathers information concerning the characteristics of the input signal and the realized filter characteristics. At the same time, the filter uses the above information to determine the appropriate adjustments to the filter parameters. The filter realization and the filter characteristics adjustments are to be implemented with a high-performance DSP processor. We intend to develop separate algorithms for both FIR and IIR digital filters. With the development of such filter realization schemes, we not only achieve better filtering results under the condition that the characteristics of the input signal varies with time, but also may omit the procedure of filter design procedure altogether.

(b) Design and Realization of High-Order IIR filters: The difficulties of high-order IIR filter design arises from inadequate computational accuracy, numerous local minimum points in the error function, and the selections of the direction and step size of the filter parameter adjustment. The implementation of high-order IIR filters may have unresolved problems in the dynamic range adjustment, overflow error prevention, and limitation of the transient response. We have utilized the normalization of the error function and better Hessian estimate formula to achieve better filter synthesis results. We have also achieved even better results by regulating the step size in filter synthesis problems with radius constraints on poles. We are developing filter realization scheme with automatic dynamic range adjustment and overflow prevention. Additional functionality of coefficient fine tuning for fixed-point filter realization is under investigation.

(c) Wide-band Noise Canceling Systems: Previously, our research in this area are mainly concerned with the time delay estimate and filter order estimate for noise canceling problems and the development of fast algorithms for this purpose. Our future research is directed towards the development of a noise canceling headphones system. Based upon the system architecture of using one microphone in each of earpiece as the signal gathering devices, the unwanted wide-band noise can be removed by signals generated deliberately using the noise canceling algorithms. The frequency response degradations of the headphones can be compensated in. the same noise canceling system as well.