

Preface

Multirate signal processing has become a key topic enabling efficient techniques in many areas of modern engineering such as wireless and satellite communication systems, software and cognitive radio, and image and video processing, among others. The main advantage of multirate systems is rooted in the computational efficiency based on the ability to use different sampling rates simultaneously in the same system.

Despite numerous existing techniques on multirate signal processing for digital information processing and different promising future applications, there are only a few edited books which include some of the applications of multirate systems in different fields. The reason for proposing a new book in this area is to overcome a gap existing between numerous results published in journals and conferences and no recently edited books. The goal is to include recent important results and promising future applications of multirate systems.

The text is divided into eight chapters written by experts in the field.

In the first chapter, “Implementation Studies of Multirate Systems,” written by Y. Huang and C. Li, the implementation aspects of multirate systems are discussed. Two case studies are elaborated. The first study investigates the design challenge for high-speed and very high-bandwidth up-sampling filter for transmitter. The second study particularizes design challenge in wide frequency coverage for down-sampling filter for multi-standard radio receiver.

The next chapter, titled as “Advances in Multirate Filter Banks: A Research Survey,” written by A. Kumar, B. Kuldeep, I. Sharma, G. K. Singh, and H. N. Lee, advances a research survey on filter banks including a general review of filter bank theory and the state of the art in filter bank design. The elaboration of future advancement in the field of optimal filter bank design is also presented.

The third chapter, “Methods for Improving Magnitude Characteristic of Comb Decimation Filters,” written by G. Jovanovic Dolecek, presents some recent methods for improving the magnitude characteristic of comb decimation filters in stopband, in passband, as well as in both. First, the methods for aliasing rejection improvement, using comb zero rotation, based on exploring the characteristics of

symmetrical polynomials, are presented. In the following the methods for comb passband droop compensation in a wideband are presented, based on a trigonometrical approach, in which the magnitude responses of compensators are in sinusoidal forms. Finally, the method based on multiplierless corrector filters, for the improvement of comb magnitude characteristic in passband, as well as in folding bands, is elaborated. The methods are illustrated with examples and MATLAB scripts are provided for presented methods.

The following chapter, “Design of Multi-Channel Filter Bank Using Minor Component Analysis and Fractional Derivative Constraints,” written by B. Kuldeep, A. Kumar, G. K. Singh, and H. N. Lee, presents a new design technique for multichannel cosine-modulated filter banks, based on minor component analysis and fractional derivative constraints, using swarm optimization techniques. Problem formulation and proposed design methodology are elaborated and illustrated with examples.

Chapter 5, “Multiresolution Filter Banks for Pansharpening Application,” written by H. Hallabia, A. Kallel, and A. B. Hamida, tackles the image signal processing application. Two channel filter banks are adopted to fuse remotely sensed imagery, also called a pansharpening. This process consists in transferring the spatial content of panchromatic (PAN) image at finer resolution into an image at coarse resolution, e.g., multispectral (MS) or hyper-spectral (HS) image. Experimental results, including datasets, the selected pansharpening algorithms, and the quality assessment metrics, are included.

The next chapter, “Video Signal Processing,” written by Y. L. Huang, is devoted to video signal processing applications. The background knowledge, applications, and technical details of current multirate video systems are presented. First, the basic concept and knowledge of the video system are introduced. In addition, several examples of multirate video applications are shown. Afterward, the key techniques to achieve these applications from the fundamental frame rate conversion (FRC) and the advanced frame rate up-conversion (FRUC) are explained. The general flow diagram of the FRUC techniques is given, and the technical details are also discussed. Additionally, several evaluation methods are explained and the popular video datasets are shown. Finally, the requirement and recent researches of hardware implementation for FRUC techniques are discussed.

Chapter 7, “Multirate Systems in Cognitive Radio,” written by S. C. Prema and K. S. Dasgupta, elaborates the use of filter banks for spectrum sensing in cognitive radio (CR), including cosine-modulated filter banks and DFT filter banks. Multirate filter bank techniques can reduce computational complexity and improve spectral analysis in cognitive radio applications. For a fractional utilization of spectrum, the center frequency and spectral edges of the primary user can also be estimated using filter banks.

Chapter 8, “Design of Nonuniform Linear-Phase Transmultiplexer System for Communication,” written by A. Vishwakarma, A. Kumar, and H. N. Lee, presents an improved design technique for a nonuniform linear-phase transmultiplexer filter bank (FB) for communication system. The prototype filter is designed using different window functions that have high side-lobe falloff rate (SLFOR). Next,

the filter coefficients are optimized to satisfy perfect reconstruction (PR) condition. The performances of the method are evaluated in terms of fidelity parameters such as inter-symbol interference (ISI), interchannel or inter-carrier interference (ICI), signal to inter-symbol interference ratio (SISI), signal to interchannel interference ratio (SICI), and signal to total interference ratio (SI). The simulation results demonstrate that very low values of ICI and ISI can be obtained using various adjustable windows.

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