

# Advances in Digital Signal Processing: Multirate Systems with MATLAB Applications

Prof. Dr. Ljiljana Milić, Prof. Dr. Miroslav Lutovac, Msc. Jelena Čertić

Multirate signal processing techniques are widely used in many areas of modern engineering such as communications, image processing, digital audio, and multimedia. The main advantage of a multirate system is the substantial decrease of computational complexity, and consequently, the lowered power consumption in real-time operations, smaller chip area followed by the cost reduction. The computational efficiency of multirate algorithms is based on the ability to use simultaneously different sampling rates in the different parts of the system. Moreover, the multirate-based algorithms are used to solve some of the complex signal processing tasks that could not be solved otherwise, such as sampling rate conversions, signal decomposition and reconstruction, multiplexing and demultiplexing, computations of DSP transforms (cosine transform and wavelet transform, for example).

The objective of the seminar is threefold:

- Present an overview of the multirate signal processing techniques.
- Demonstrate the MATLAB applications in understanding multirate techniques, in solving practical design problems, and in developing efficient implementation structures.
- Demonstrate the solution of an efficient communication system based on the multirate signal processing approach.

## Contents:

1. Introduction: importance of multirate techniques and their applications
2. Sampling-rate alterations, computational savings, aliasing and imaging effects, MATLAB representations
3. Efficient realization structures based on polyphase decompositions with illustrations in MATLAB
4. Efficient multirate filters for sampling rate conversion, MATLAB examples
5. Solving complex filtering problems using the multirate approach, MATLAB examples
6. General interpolation problem, system integration
7. Filter bank structures and performances, perfect reconstruction and nearly perfect reconstruction filter banks, MATLAB examples
8. Signal decomposition and reconstructions, MATLAB illustrations
9. Application of multirate techniques in software radio solutions

## References (books)

- [1] R.E. Crochiere and L.R. Rabiner, Multirate digital signal processing, Englewood Cliffs, Prentice-Hall, 1983.
- [2] P.P. Vaidyanathan, Multirate systems and filter banks. Englewood Cliffs, NJ: Prentice Hall, 1993.
- [3] N. J. Fliege, Multirate digital signal processing, New York: John Wiley, 1994.
- [4] T. Hentchel, Sample rate conversion in software configurable radios, Morwood, MA: Artech House, 2002.
- [5] G. Jovanović-Doleček, (ed.), Multirate Systems: Design & Applications, Hershey, PA: Idea Group Publishing, 2002.
- [6] F. J. Harris, Multirate Signal Processing for Communication Systems, Upper Saddle River: Prentice Hall, 2004.
- [7] Lj. Milić, Multirate Filtering for Digital Signal Processing: MATLAB Applications, Hershey, PA: Information Science Reference, Jan. 2009, to appear.