EBCCSP 2015

June 17-19, 2015
KRAKÓW

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IEEE International Conference on
Event-based Control, Communications & Signal Processing

Call for Participation in Tutorial

The Linear Algebra of Nonuniform Sampling

Tutorial Presenter

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Aim and scope:

While Shannon sampling theorem has a simple justification by Fourier transform argument, nonuniform sampling poses some major mathematical difficulties. Although nonuniform sampling can be simply viewed as a linear transformation of bandlimited continuous-time signals into discrete-time signals, the infinite dimensionality of the problem together with the lack of time invariance in this linear approach has made its theory mostly reserved to applied mathematicians. The growing interest in event-based signal processing is now moving the theory of nonuniform sampling to the foreground.

The aim of this tutorial is not only to show what the fundamental results are on this topic, but also to intuitively motivate them from scratch. In this process, an objective will be to give engineers access to a more general view on signals that goes beyond the commonly known mathematics of signal processing, is inherited from *functional analysis* and *operator theory* in mathematics, and is necessary to understand the issues of reconstruction from nonuniform samples. We will start with the simple finite dimensional case of periodic signals, where sampling and reconstruction boil down to commonly known linear algebra based on matrix manipulations. From this simple context, it will be easy to see finite dimensional issues that can be extended to infinite dimensions, as well as identify issues that are specific to infinite dimensions. Attendees will be thus progressively introduced to difficult but necessary notions in infinite dimensional signal spaces such as *frames*. Equipped with a well-defined framework of analysis, we will then see how methodic answers can be given to a number of questions such as the problem of generalized sampling (the sampling of derivatives being just one example), the robustness of reconstruction to sample errors, sampling and reconstruction under analog circuit constraints, and sliding-window processing for real-time reconstruction implementations (time-varying FIR filter type).

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