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Tutorial on: Compressed Sensing: From Theory to Practice

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Abstract:
Most natural and man-made signals exhibit a structure which allows us to describe them with a relatively small number of parameters, i.e., there exist an efficient low-dimensional ("sparse") description in an appropriate domain (e.g., Fourier).
The recent and rapidly growing field of research known as Compressed Sensing or Compressive Sampling is revolutionizing the way we sample in many applications in that it makes it possible to compress such signals without the need to know the sparsity domain explicitly. This allows us de facto to acquire these signals at sampling rates that are significantly lower than the Nyquist rate without any loss of information.
The proposed tutorial is divided into two parts. The first part reviews the basic principles of Compressed Sensing. The fundamental concepts are given via intuitive geometrically inspired explanations that are suitable also for non-specialists.
The theory explained in the first part of the tutorial can be better grasped by seeing it applied in concrete examples. With this aim, the second part of the tutorial is devoted to application areas of Compressed Sensing. In particular, we discuss the detection of harmful interferers for Global Navigation Satellite Systems (GNSS) based on a sub-Nyquist power spectrum. Moreover, we show the application of Compressed Sensing to spectrum sensing for Cognitive Radio systems where the sparsity of spontaneous transmissions in frequency, time, and space (direction of arrival) is exploited to reduce the number of measurements that have to be taken.