In recent years, numerous disciplines including telecommunications, medical imaging, computational biology, and neuroscience benefited from increasing applications of high dimensional datasets. This calls for efficient ways of data capturing and data processing. Compressive sensing (CS), which is introduced as an efficient sampling (data capturing) method, is addressing this need. It is well-known that the signals, which belong to an ambient high-dimensional space, have much smaller dimensionality in an appropriate domain. CS taps into this principle and dramatically reduces the number of samples that is required to be captured to avoid any distortion in the information content of the data. This reduction in the required number of samples enables many new applications that were previously infeasible using classical sampling techniques.

Most CS-based approaches take advantage of the inherent low-dimensionality in many datasets. They try to determine a sparse representation of the data, in an appropriately chosen basis using only a few significant elements. These approaches make no extra assumptions regarding possible relationships among the significant elements of that basis. In this dissertation, different ways of incorporating the knowledge about such relationships are integrated into the data sampling and the processing schemes.

We first consider the recovery of temporally correlated sparse signals and show that using the time correlation model, the recovery performance can be significantly improved. Next, we modify the sampling process of sparse signals to incorporate the signal structure in a more efficient way. In the image processing application, we show that exploiting the structure information in both signal sampling and signal recovery improves the efficiency of the algorithm. In addition, we show that region-of-interest information can be included in the CS sampling and recovery steps to provide a much better quality for the region-of-interest area compared the rest of the image or video.

In spectrum sensing applications, CS can dramatically improve the sensing efficiency by facilitating the coordination among spectrum sensors. A cluster-based spectrum sensing with coordination among spectrum sensors is proposed for geographically disperse cognitive radio networks. Further, CS has been exploited in this problem for simultaneous sensing and localization. Having access to this information dramatically facilitates the implementation of advanced communication technologies as required by 5G communication networks.

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The public is welcome to attend.