ABSTRACT

Signal acquisition at Nyquist rate assures high fidelity reconstruction of the analog signal from the acquired discrete samples. Acquisition of high frequency signals require high Nyquist rates. Temporal sampling is achieved with analog-to-digital converters, but it is difficult to design these converters with extremely high sampling rate. Spatial sampling is achieved with antenna arrays, but large number of antennas for acquisition may be expensive. This has led to an interest in sub-Nyquist techniques. Moreover, some applications are only interested in the second order statistics of the signal. This is where co-prime arrays and samplers play an important role, and are considered in this thesis. The work here focuses on temporal (time-domain) signals.

Most of the literature reveals that co-prime based schemes have large latency. An attempt is made to change this notion. The difference set of the prototype co-prime array is studied in detail. The closed-form expression for the weight function is derived for the entire and continuous difference range. The weight function is of importance since it governs the accuracy and latency of the estimate. In addition, the difference set of the prototype co-prime array is studied under perturbed conditions. Two estimation strategies, blind and non-blind are described. Its computational complexity is also derived. The proposed non-blind estimation technique has larger number of contributors for estimation.

The fundamentals of the co-prime sensing based correlogram method for spectral estimation are developed. Closed-form expressions for the bias window and variance are derived. A discussion on co-prime parameter selection is also considered. The closed-form expressions derived here will provide the necessary foundation to investigate the variants of correlogram with window functions from a low latency perspective. The combined set for correlogram estimation is also compared with the cross difference set, multiplicative processor, min processor, DFT filter bank, and compressive sensing.

The difference set and correlogram theory for prototype co-prime array with multiple periods is also developed. In addition, fully sub-Nyquist and partial sub-Nyquist scenarios for cross-correlation estimation are proposed. Applications such as time-delay, range, velocity, acceleration, and cross-spectrum estimation are considered. The theory of cross spectrum and window functions is also considered.