Revisiting Array Signal Processing Through the Lens of Riemannian Geometry

Ronen Talmon, EE, Technion

Abstract. Array signal processing is a key area in signal processing, used in numerous classical and modern applications such as radar, sonar, wireless communication, acoustics, robotics, smart cities, and autonomous vehicles. A critical component of many array processing methods is the spatial correlation matrix of the array-received signals, which holds important spatial information. Typically, these matrices are used based on their positive-definite structure for beamforming, spectral analysis, and optimization. However, most methods treat these matrices as if they are in a simple Euclidean space, not taking advantage of the proven fact that they actually lie on a more complex Riemannian manifold.

In this talk, I will introduce a new approach that uses the Riemannian geometry of positive-definite matrices. This approach provides powerful new tools for array signal processing, addressing longstanding challenges in the field. I will present methods for direction of arrival (DoA) estimation and signal enhancement that work well in adverse conditions that include multipath channels, high noise levels, and interfering signals. These methods and results demonstrate how using Riemannian geometry can improve performance and foster opportunities in signal processing.