**Spatial Channel Estimation and Tracking**

**PIs**: Profs. Shasha, Rangan, Erkip

**Students:** George Wong (Undergrad, Shasha), Parisa Amir Eliasi (PhD, Rangan), Parisa Hassanzadeh (PhD, Erkip), Shu Sun (PhD, Rappaport)

**Introduction of Team:** George has completed his third year as a Courant undergrad and is currently Dennis Shasha’s advisee. He has a strong foundation in software and some knowledge of wireless physics from his initial work with NYU WIRELESS including the development of the database and work in the initial measurements. Parisa Amir Eliasi is a third year PhD student with Prof. Rangan and has a solid basis in compressed sensing from her work in low-rank matrix completion problems for MRI. Parisa Hassanzadeh is a Provost Fellowship recipient and will be starting her second year as a PhD student with Prof. Erkip. Shu Sun is a second year PhD student with Prof. Rappaport and began work in beamforming.

**Affiliate sponsors with direct interest**: Since spatial channel estimation is fundamental to virtual every aspect of the mmW system design, we expect interest from virtually all affiliates.

**Overview Research Statement**: The project will consider modeling and algorithms for estimating and tracking spatial structures of channels and the effect of spatial channel estimation on beamforming.

**Research Thrusts and Improvements for NYU WIRELESS:** Millimeter wave systems fundamentally rely on directional transmissions with high-dimensional antenna arrays for obtaining suitable range and to obtain gains from spatial diversity and spatial multiplexing. The research will consider two related problems for spatial processing for these systems:

* High-dimensional spatial channel estimation. The goal here is to develop novel algorithms that can exploit the low-rank spatial structure of the channel, potentially leveraging ideas from low-rank matrix completion in compressed sensing. Hardware constraints will be considered in that we will consider both analog beamforming (when the mobile can only look in one direction at a time) and low-rate digital beamforming (when the mobile can look at all antenna outputs, but with high quantization noise). This work will be performed by the Parisa Amir Eliasi and Parisa Hassanzadeh.
* Directional search and tracking algorithm. Leveraging the channel estimation methods, this work will consider the problem of how to perform initial cell search and tracking of the channel for mobility. We intend to develop a simple statistical model for the large-scale parameters possibly including birth-death processes for abrupt changes.
* Assessment in beamforming and SDMA. This part, to be conducted by Shu Sun, will evaluate the effect of channel estimation errors in beamforming and SDMA.

**Existing support and additional justification for the Project**: The PhD students are currently supported by an NSF.

**Justification for this project:** Almost all components of the mmW system design depend on estimation of the spatial structure of the channel. Hence, understanding of this component will be vital to all the higher layer system design. The work can also support the prototype development where we will need to implement these features. The modeling for temporal variations can also guide the measurement campaigns