

## **ECE Monthly Faculty Colloquium**

**Date/time:** 16 March 2023, Thursday, 5 PM to 6 PM

**Venue:** Golden Jubilee Hall (GJH), ECE, IISc

**Speaker:** A. Chockalingam, ECE, IISc

### **Title:**

OTFS 2.0 (Zak-OTFS) - A Waveform for Communication and Radar Sensing in 6G and Beyond

### **Abstract:**

6G presents an opportunity to reflect on the fundamentals of wireless communication, as it becomes more and more difficult to estimate channels in high-mobility/high-Doppler environments when information signaling and signal processing are carried out in the traditional time-frequency (TF) domain. Also, the convergence of communication and radar sensing in 6G and beyond (inspired by the developments in intelligent transportation systems) has focused research attention on the design of waveforms that support both applications. This talk will focus on orthogonal time frequency space (OTFS) waveform which is emerging as a promising waveform for this purpose.

Information signaling and signal processing in OTFS are carried out in the delay-Doppler (DD) domain because of which OTFS outperforms traditional TF domain based multicarrier waveforms popularly used in the previous generations. A basic function in OTFS signaling is DD domain-to-time domain transformation at the transmitter and vice versa at the receiver. Last five years of OTFS research has focused on an approach where the above transformation is carried out in two steps, viz., DD domain-to-TF domain conversion using inverse symplectic finite Fourier transform (ISFFT) followed by TF domain-to-time domain conversion using Heisenberg transform, and corresponding inverse transforms at the receiver. We call this scheme OTFS 1.0. Alternately, this transformation can be carried out in a single step, viz., DD domain-to-time domain conversion using inverse Zak transform at the transmitter and time domain-to-DD domain conversion using Zak transform at the receiver. We call this scheme OTFS 2.0 (a.k.a. Zak-OTFS).

This talk will dwell on what and why of OTFS 2.0. Briefly put, OTFS 2.0 a) provides a formal mathematical framework (Zak theory) that explains why OTFS works well, b) is more robust to large channel spreads compared to OTFS 1.0, and c) has a lower complexity compared to OTFS 1.0. Research in OTFS 2.0 is wide open and we expect the next five years of OTFS research to be centered around OTFS 2.0, leading to its possible adoption in 6G standards.

\* This talk is based on recent research work carried out in collaboration with Ronny Hadani (inventor of OTFS), UT Austin, Saif K Mohammed, IIT Delhi, and Robert Calderbank, Duke University.

### **Speaker bio:**

A. Chockalingam received the B.E. (Honors) degree in ECE from P.S.G. College of Technology, Coimbatore in 1984 and the M. Tech degree in E & ECE from IIT, Kharagpur in 1985. In 1993, he obtained the Ph.D. degree in ECE from IISc, Bangalore. From Dec.1993 to May 1996, he was a Postdoctoral Fellow and an Assistant Project Scientist with the Department of ECE, UC San Diego. From May 1996 to Dec. 1998, he was with Qualcomm, San Diego, as a Staff Engineer/Manager. Currently, he is a Professor in the Department of ECE, IISc, Bangalore.