Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

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Inventors

Ahmed Alkhateeb

Shuaifeng Jiang

Contact

Physical Sciences Team

Orthogonal Time Frequency Space (OTFS) Channel Estimation for Massive MIMO Systems

Orthogonal time frequency space (OTFS) modulation has the potential to enable robust communications in highly mobile scenarios. This is due to multiplexing information-bearing data into nearly-constant channels in the delay-Doppler domain instead of the time-frequency domain, which makes communication more resilient to fast changes in the channel. Realizing these gains in massive MIMO systems is challenging due to high downlink pilot overhead which scales with maximum delay spread and maximum Doppler spread of the channel and with the number of antennas at the transmitter.

In massive MIMO-OTFS systems, the channels typically experience 3D sparsity in the delay, Doppler, and angle dimensions. Prior work used different compressive sensing approaches to reduce the downlink pilot overhead in estimating the OTFS massive MIMO channels. These approaches still suffered from high channel acquisition overhead for large-scale MIMO systems, especially in scenarios with large delay and Doppler spreads. To overcome these challenges and enable the benefits of OTFS gains in massive MIMO systems, this technology introduces an approach that leverages sensing data (e.g., position, direction, velocity, etc.) collected by radar, LiDAR, and/or other sensors.

Researchers at Arizona State University have developed a system that focuses on the challenge of high overhead associated with orthogonal time frequency space (OTFS) channel estimation in highly-mobile scenarios and massive MIMO systems. By harnessing sensing data collected by radar, LiDAR, and/or other sensors, this system acquires crucial delay, Doppler, and angle information related to mobile users and scatterers in the environment. By leveraging this sensing data, this system significantly reduces the signaling overhead for systems with large antenna arrays, such as those in 5G and beyond. With a primary focus on enabling robust communication in highly-mobile applications like augmented/virtual reality and autonomous vehicles/drones, this system enhances communication resilience to fast channel changes, unleashing the potential gains of OTFS modulation in massive MIMO systems. Its impact lies in supporting reliable, high data-rate wireless communication in dynamic environments, contributing to the advancement of future communication systems and facilitating the widespread adoption of innovative mobile technologies.

Related publication: Sensing Aided OTFS Channel Estimation for Massive MIMO Systems

Potential Applications:

- In future 5G/6G, private networks, and WiFi communication systems to

enable highly mobile applications, such as, e.g.,

- autonomous vehicles/drones
- augmented/virtual reality
- industry 4.0 navigating robots

Benefits and Advantages:

- Utilize sensing data (e.g., collected by radar, LiDAR, camera, position sensors, etc.) to reduce critical signaling overhead in massive MIMO systems
  - More than 50% reduction in pilot/channel acquisition overhead without any degradation in channel estimation NMSE
- Reliable support for highly mobile applications
- Enhanced communication resilience in dynamic environments