Abstract

Orthogonal Time Frequency Space modulation (OTFS) has emerged as a promising candidate for reliable communication in doubly spread wireless environments. Unlike traditional multicarrier systems that operate in the time-frequency domain, OTFS modulates information in the delay-Doppler domain, providing robustness against doubly selective channels. This thesis investigates two critical aspects of OTFS-based communication systems: low-complexity channel estimation and efficient multiple-access techniques.

First, we develop a low-complexity channel estimation algorithm for single-antenna Multi-Carrier OTFS systems employing practical rectangular pulse. The developed method is designed to accurately estimate channel with fractional delays and Doppler shifts by employing two key properties of OTFS modulation: (i) the fine resolution in the delay-Doppler domain that enables separation of individual paths, and (ii) the separability of the effective delay-Doppler domain channel expression into individual delay domain and Doppler domain terms. These features are utilized to formulate an iterative estimation procedure that individually estimates the delay, Doppler shift, and complex gain associated with each multipath component. Unlike existing approaches, the developed method avoids matrix inversion, resulting in significantly reduced computational complexity. Simulation results demonstrate that the algorithm achieves better normalized mean square error performance compared to several existing techniques.

Second, we present a multiple-access technique for Zak-OTFS systems, that supports uplink communication from multiple users having diverse channel characteristics over a shared time-frequency resource, ensuring compatibility with existing communication frameworks. The developed method employs modified transmit and receive filters in the native delay-Doppler domain of Zak-OTFS to allocate users distinct, non-overlapping time-frequency regions without requiring any guard bands. Analytical evaluation of the resulting time-domain signal confirms that each user's transmission remains confined within its assigned time-frequency region. Numerical results further demonstrate that the developed method effectively suppresses multi-user interference for *sinc* and *root raised cosine filter*, achieving bit error rate and normalized mean square error performance comparable to single-user systems, even under severe Doppler spreads.

The techniques presented in this thesis contribute toward the realization of OTFS systems in next generation networks by addressing the key challenges of channel estimation and multiple access in doubly spread wireless environments.