Invited Talk: Pseudorandom Sequences for Grant-Free Access in Massive Machine-Type Communications

Nam Yul Yu

Gwangju Institute of Science and Technology (GIST), Gwangju, South Korea

Abstract. Massive machine-type communications (mMTC) is an important use case of 5G and beyond wireless technology for concretizing the Internet of Things (IoT). In mMTC, grant-free access is a key enabler for connecting wireless devices with low latency and low signaling overhead. In uplink grant-free access, user-specific, non-orthogonal sequences are uniquely assigned to devices for non-orthogonal multiple access (NOMA), where each active device attempts to access a base station (BS) using its own sequence. Then, a BS receiver has to identify active devices, estimate channel profiles, and detect transmitted data, through the superimposed sequences from active devices. Exploiting the sparse activity, the principle of compressed sensing (CS) has been widely used to perform joint activity detection, channel estimation, and data detection for uplink grant-free access in mMTC.

In this talk, some applications of pseudorandom sequences for uplink grant-free access in mMTC are introduced. First of all, Golay complementary sequences are used for spreading sequences in uplink grant-free NOMA. From the properties of Golay complementary sequences, the spreading sequences provide low peak-to-average power ratio (PAPR) for multicarrier transmission. Also, a theoretical connection to Reed-Muller codes shows that the spreading sequences guarantee theoretically bounded low coherence for the spreading matrix. Second, a design framework is presented for non-orthogonal signature sequences, where the design principle relies on unimodular masking sequences represented by characters over finite fields. The Weil bounds on character sums are leveraged to show that the signature sequence matrix has theoretically bounded low coherence. Simulation results demonstrate that the spreading and the signature sequences achieve excellent performance of joint activity detection, channel estimation, and data detection for uplink grant-free access in mMTC. Thanks to the algebraic structure, the non-orthogonal sequences enjoy the benefits of small phases and small storage space in practical implementations. Finally, potential applications of pseudorandom sequences for mMTC will be discussed as a future research topic.