1. The Subject and Aims of Research
Wireless communications, smart grid and convex optimization and its applications

2. Recent Research Topics

- **Transmit Beamforming Designs for Multi-User Interference Channels:**
  Multiuser interference channels, including multi-cellular and ad-hoc wireless networks, are important and challenging research topics of wireless communications in recent years. We are focusing on two challenging aspects – robust beamforming designs under imperfect channel state information (CSI) and distributed optimization methods. The former is inspired by the fact that it is often difficult to acquire accurate CSI in multi-cellular/ad-hoc environments; while the latter is desirable from the network design perspective since it removes the need of a control center coordinating the network. We have developed several worst-case robust and chance constrained robust beamforming designs and their distributed optimization methods.

- **Physical-Layer Information Security:** Physical-layer secrecy is an emerging topic in wireless communications. It studies physical-layer coding/signal processing approaches to preventing the secret messages, sent from a transmitter to a legitimate receiver, from overhearing by nearby eavesdroppers. We have proposed several signal processing techniques, including novel training schemes for discriminatory channel estimation, and secure beamforming and artificial noise designs for enhancing the information security and the secret transmission rates.
Real-Time Demand Response for Grid Power Balancing: Power balancing is one of the most important issues for a power grid system. However, it is challenging to achieve real-time power balancing when green and renewable energy resources, such as wind and solar powers, are mixed in the generation side. This is because these green energies are difficult to dispatch and are intermittent in nature compared to the conventional fossil fuel based generators. Demand response (DR) techniques, which aim at smartly controlling the electricity usage in the power demand side, have been regarded as one of the promising approaches to achieving real-time power balancing. We have developed several efficient DR algorithms for large-scale Plug-in (Hybrid) Electric Vehicles (PHEV) charging and electricity management for residential neighborhood.


