The University of Queensland - IIT Delhi Academy of Research Joint PhD Project

Project title	**Full Duplex Antenna Systems**
Project code	**UQIDAR 00228**
Project description	Most modern transceivers use separate time or frequency slots for transmit (Tx) and receive (Rx) signals – operating in half duplex mode. However, simultaneous transmit and receive (STAR) or full-duplex operation can theoretically facilitate doubling of system's spectral efficiency. Some other potential applications include long-range continuous-wave (CW) radars, bidirectional relays, simultaneous spectrum jamming and sensing in electronic warfare etc. The major bottleneck in operation of a full-duplex transceiver is the large self-interference (SI) signal, or the signal that leaks directly from the Tx to Rx chain. Low power applications may require more than 100 dB of SI cancellation for STAR operation. SI cancellation is carried out simultaneously in three stages of transceiver chain, viz. antenna, analog and digital domains. We propose to explore the antenna and propagation aspects of full-duplex system design. Specifically, in contrast to oft-presented multiple antenna solutions in literature, we aim to work on monostatic or shared-antenna designs. Monostatic solutions offer compact solutions, without the handicap of phase and amplitude imbalance effects. Over the four years of UQ-IITD programme, we plan to tackle four challenges of full-duplex antenna design. Below are the design aims with their driving imperatives: 1) Wideband self-isolated antennas: Larger data rates require wide bandwidth solutions. Since most existing designs depend on destructive interference of the SI signal. The requirement mandates a strict constraint on phase and amplitude characteristics, which is difficult to maintain across a wide-frequency band. Again, the addition of over-the-shelf components does not only increase the price of the transceiver, but also calls into question its frequency scalability. This research will aim at proposing and exploring different techniques to extend the bandwidth of full-duplex antennas. 2) Wideband circularly polarized self-isolated antennas: Linear polarization puts a limit on the orientation of two transceiver systems with respect to each other. Misalignment can cause radio dead-spots. Dropping of signal becomes a severe issue when the wave propagates in atmosphere (Faraday effect) or is responsible for multi-path effect. As circular–polarization (CP) does not require any alignment (as long as the direction of wave is in antenna's main beam) with the additional benefits of preventing phase-reversed reflections of multi-path systems, we aim to investigate different techniques for designing self-isolated CP antennas. 3) Wideband non-planar full-duplexing antenna systems: Planar structures are lossy and have a limited power-handling capacity. We will explore 3D structures such as waveguide or dielectric resonator to design antenna systems with large power-handling capacity. It is also noted that these solutions need to be kept in small-form factor for applications in satellite communications or unmanned aerial vehicles. 4) Integration of non-reciprocal devices: While non-reciprocal components like circulators add to the size of the antenna, the

	possibility of SI cancellation by on-antenna integrated non-reciprocal devices will be investigated.
Project outcomes	We propose to deliver antenna systems for full-duplex applications in both planar and non-planar forms. The plug-and-play components will have wideband (> 10%) self-interference cancellation of more than 40 dB in both linear and circular polarizations. All systems will have a single radiating unit with or without non-reciprocal devices integrated with them.
Advisory team	**UQ Principal Supervisor** **Dr Nghia Nguyen-Trong** Information Technology and Electrical Engineering n.nguyentrong@uq.edu.au https://researchers.uq.edu.au/researcher/17883 **IITD PrincipalSupervisor** **Assistant Professor Kirti Dhwaj** Applied Research in Electronics kdhwaj@iitd.ac.in http://care.iitd.ac.in/People/Faculty/Kirti%20Dhwaj.htm
Type of student	Applications are open to: I or q students who meet eligibility criteria.
Discipline background of student	Ideally, this project requires students with a background in: Electrical Engineering, Electronic Engineering, Physics, RF Engineering
Ideal candidate	**Essential Capabilities:** Calculus, Electromagnetic Theory. **Desirable Capabilities:** EM CAD (HFSS, CST, etc.),programming, Circuit simulator. **Expected qualifications (Courses/Degrees etc.):** Bachelors, Masters.
Application process	Apply online by the due date: https://www.uqidar.org/students/how-to-apply/