Preface

Full-duplex operation for wireless communications can potentially double the spectral efficiency, compared to half-duplex operation, by using the same wireless resource to transmit and receive at the cost of a large power difference between the high-power self-interference (SI) from its own transmitted signal and the low-power intended signal received from the other distant transceiver. The SI can be gradually reduced by a combination of radio-frequency (RF) and baseband cancellation stages. Each stage requires the estimation of the different distortions that the SI endures such as the SI channel and the transceiver nonlinearities. This book deals with the development of SI-cancellation techniques that are well adapted to the full-duplex operation.

First, we recognize the sparseness of the SI channel and exploit it to develop a compressed-sensing (CS) based SI channel estimator. The obtained estimate is used to reduce the SI at the RF prior to the receiver low-noise amplifier and analog-to-digital converter to avoid overloading them. To further reduce the SI, a subspace-based algorithm is developed to jointly estimate the residual SI channel, the intended channel between the two transceivers, and the transmitter nonlinearities for the baseband cancellation stage. Including the unknown received intended signal in the estimation process represents the main advantage of the proposed algorithm compared to previous data-aided estimators that assume the intended signal as additive noise. By using the second-order statistics of the received signal, it is possible to obtain the noise subspace and then to estimate the different coefficients without knowing the intended signal. Depending on the number of transmit and receive antennas, we propose to use either the received signal or a combination of the received signal and its complex conjugate. Also, we develop a semi-blind maximum likelihood (ML) estimator that combines the known pilot and unknown data symbols from the intended transceiver to formulate the likelihood function. A closed-form expression of the ML solution is first derived, and an iterative procedure is developed to further improve the estimation performance at moderate to high signal-to-noise ratio. Simulations show significant improvement in SI-cancellation gain compared to the data-aided estimators.

Moreover, we present two new SI-cancellation methods using active signal injection (ASI) for full-duplex MIMO-OFDM systems. The ASI approach adds an appropriate cancelling signal to each transmitted signal such that the combined signals from the transmitting antennas attenuate the SI at the receive antennas. In the first method, the SI-pre-cancelling signal uses some reserved subcarriers which do not carry data. In the second method, the constellation points are dynamically extended within the constellation boundary in order to minimize the received SI. Thus, the SI-pre-cancelling signal does not affect the data-bearing signal. Simulation results show that the proposed methods considerably reduce the SI at a modest computational complexity.

This book aims to provide researchers and engineers in wireless communications, an understanding of the challenges and practical solutions to implement a full-duplex system.

This work was partially supported by the Natural Sciences and Engineering Research Council (NSERC) and Huawei Technologies Canada.

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Springer

http://www.springer.com/978-3-319-57689-3

Full-Duplex Wireless Communications Systems
Self-Interference Cancellation
Le-Ngoc, T.; Masmoudi, A.
2017, XII, 164 p. 59 illus., 51 illus. in color., Hardcover
ISBN: 978-3-319-57689-3