PhD THESIS ABSTRACT

"SELF-INTERFERENCE CANCELLATION APPROACHES FOR IN-BAND FULL DUPLEX COMMUNICATIONS USING SDR PLATFORMS"

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Because of the current high demand for spectral resources leading to spectrum scarcity, it is necessary to develop new technologies to improve spectral efficiency. . The IBFD (In-Band Full-Duplex) operating mode represents one of the most promising solutions for avoiding the current spectrum congestion, but it suffers from the high level of self-interference (SI) due to simultaneous transmission and reception in the same frequency band.

Actually, the SI signal completely overwhelms the Signal of Interest (SoI). Without the development of Self-Interference Cancellation (SIC) methods, the SI is so heavy that the detection and reception of the SoI becomes practically impossible. The main goal of this thesis is to characterize the SI signal, and to propose effective digital SIC techniques. Given the complexity of the analytical model required for an accurate IBFD simulation, experimental validations are imperative for evaluating the performance of the proposed SIC techniques. Hence, this PhD thesis aims to validate the proposed techniques for digital SIC in a realistic framework.

SIC methods based on adaptive filtering are first proposed to cancel not only the linear component of SI, but also the component caused by the I/Q channel imbalance. Indeed, the I/Q mixer-induced SI term represents the dominant SI component, especially for mass-market IBFD transceivers that typically feature IMRR levels around 25 dB. The assessment of the proposed linear and widely-linear adaptive filtering SIC methods is carried out in real-world conditions, using an experimental USRP platform that enables the software-based adjustment of the IMRR value associated with the Tx path's I/Q mixer.

Neural networks (NNs) are then introduced to deal with the non-linear components of SI. A complex-valued (CV) version of these networks is also implemented, to better exploit the phase information for SIC. Given the fact that the CV-NNs are not fully supported, either by Tensorflow or by PyTorchy library, our research work has been mainly dedicated to the development of NN-specific loss, activation and optimizer functions compatible with complex values. These functions have been integrated into classical Feed-Forward Neural Network (FFNN) and Recurrent Neural Network (RNN). In addition, advanced recursive NN structures that incorporate Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU) memory cells, known for their ability to achieve better results in time-series prediction and estimation scenarios, have been also considered.

Based on the CV-NNs capability of managing the phase information, a NN approach that estimates the SI signal based on the transmitted signal and its conjugated version, similar to the widely-linear adaptive filtering SIC method, has been proposed. Furthermore, the most promising RV and CV NN SIC architectures are experimentally assessed in a standalone configuration or in conjunction with the Recursive Least Square (RLS) adaptive filter.