Coupled Transmit Signal and Noise Cancellation at the RF Front End in Simultaneous Transmit/Receive System

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Current wireless systems employ a variety of techniques to meet the ever-increasing spectrum demands. These include schemes such as time-division duplexing (TDD), and frequency-division duplexing (FDD). In addition to these techniques, simultaneous transmit and receive (STAR), also referred to as in-band full-duplex (IBFD), offers potential to effectively double spectral efficiency. Such a system has the potential to reduce the spectrum utilization by half. However, implementation of STAR systems is hindered by the high power transmitted signals that couple into the receiver. In essence, there is higher self-interference in the band of interest, thus crippling receiver performance and preventing consistent reception.

Typically, high power interference is caused by direct and reflected/echo/multipath coupling. The transmitted signal, harmonics from the power amplifier (PA), and noise from the transmit chain are among those that cause the highest portion of interference. To realize a practical STAR system, the high power interferer must be suppressed below the noise floor of the receiver. Typically more than 100dB in isolation is required for STAR. In the case of an array, implementing such high level of isolation over a wide bandwidth and across all antenna elements is challenging. This is due to the transmit signal and uncorrelated noise that couples from Tx to Rx elements.

With above in mind, a novel STAR architecture was recently proposed with four stages of cancellation to achieve a greater measure of self-interference cancellation (SIC) over a wider bandwidth. A large isolation is also achieved at the antenna domain by exploiting polarity. At the back-end stage, cancellation is achieved using FIR filters placed right after the antenna. Additional cancellation is achieved at the analog baseband stage, and at the digital back-end. Overall, a 100dB reduction in SI is projected across a bandwidth of 1GHz. At the conference, we will show the cancellation of high power coupled transmit signals and noise at the RF stage. Specifically, the coupled transmit signal and harmonics are cancelled by implementing a FIR filter with transfer function conjugate of the antenna response. The coupled transmit noise is cancelled using a feed-forward loop-back RF filter. At the meeting, we will present the analysis, design, and simulation of the adaptive RF-SIC filter to achieve the noted SI cancellation to achieve realistic STAR across 1GHz of bandwidth.