Wideband Coupled Transmit Noise Suppression in Simultaneous Transmit/Receive Systems

Satheesh Bojja-Venkatakrishnan*, Elias A. Alwan and John L. Volakis
Department of Electrical and Computer Engineering,
Florida International University, Miami, FL
e-mail: sbojjave@fiu.edu

Simultaneous transmit and receive (STAR) systems, also referred to as in-band full-duplex (IBFD) systems, are highly attractive in combatting spectrum congestion. Such systems have the potential to effectively double spectral efficiency, by transmitting and receiving at the same frequency. In other words, STAR reduces the spectrum utilization by 50% as compared to conventional frequency division duplexing (FDD) techniques that require twice the bandwidth for the same application.

The challenge with STAR systems is to remove signals that are coupled into the receiver from the co-located transmitter. This self-interference signal needs to be suppressed for successful STAR implementation. It must actually be suppressed below the noise floor of the receiver. But this is challenging because the coupled signal includes the transmit chain noise and non-linearities from power amplifiers (PA) on top of the original message signal. In the case of an array, signals couple from multiple transmit antenna elements into a single receive element making the cancellation even more difficult. Implementing such a high level of isolation across a wide bandwidth in an array environment is even more challenging.

With above in mind, we present a novel STAR architecture operating in an array environment using four stages of cancellation to achieve a greater measure of self-interference cancellation (SIC) over a wider bandwidth. To achieve over 100dB isolation, the antenna itself is designed to give 30dB over 3GHz in bandwidth at the first stage. At the RF stage or 2^{nd} stage, cancellation is achieved using a FIR filter bank placed right after the antenna. One way to cancel the transmit noise is to directly sample it from its source and then subtract the filtered version for direct cancellation. Specifically, the designed RF filter bank, processes a replica of the transmit signal and its noise components from all the transmit chains to provide an additional 30dB isolation. An added 20dB isolation is achieved at each stage of analog baseband (3^{rd} stage) and the digital back-end (4^{th} stage). These four stages provide for a combined suppression of 100dB across 1GHz bandwidth. At the conference, we will show the cancellation of high power coupled transmit signals and noise at the first 2 stages. Specifically, we will present the design, and implementation of the adaptive RF filter to achieve the noted cancellation of uncorrelated transmit noise and signal.