Ultra-Wideband RF Filter for Self-Interference Cancellation in STAR Systems

Stephen J. Watt*, Elias A. Alwan, and John L. Volakis
ElectroScience Laboratory, The Ohio State University,
1330 Kinnear Road, Columbus, OH 43212

Spectrum congestion has prompted efforts to improve spectral efficiency and interference mitigation for wireless communication systems. In this context, simultaneous transmit and receive (STAR) or full-duplex systems offer the potential to double data rates and cut spectrum requirements in half. However, there is an inherent issue of self-interference from the transmitter to the receiver. This interference reduces signal-to-noise ratio (SNR) and saturates the receiver hardware.

Previous self-interference cancellation techniques [Bharadia et al., SIGCOMM, 2013] using multi-tap radio frequency (RF) filters have already been considered by emulating the coupled transmitted signal in the receiver chain. Although practically demonstrated, these self-interference cancellation techniques have narrow bandwidths less than 100 MHz. Therefore, they are not suited for ultra-wideband communications, including software radios. The latter are becoming more popular and are the reason for this research.

Recently, we proposed an RF filter structure with variable tap delays and variable tap coefficients to achieve wideband self-interference cancellation for STAR. Each of the filter taps are optimized synergistically to achieve a magnitude and phase response that approximates the antenna coupling response. This RF filter structure achieved 1 GHz cancellation bandwidth using a four-tap analog filter [Watt et al., APS/URSI, 2015].

The design by Watt et al. [APS/URSI, 2015] was found to provide for increased design flexibility suitable for scanning antenna arrays. In this paper, we detail the proposed RF filter design and evaluate its cancellation performance as part of a wideband STAR system in the context of scanning arrays. Specifically, we apply a cascaded two-port network approach using ABCD-parameters, Y-parameters, and S-parameters. Doing so, we demonstrate an optimized RF filter. At the conference, we will provide an analytical formula showing the bandwidth performance of the proposed RF filter under different interference processes. Additionally, we investigate the trade-offs among the number of taps, bandwidth performance, and filter circuit physical size.