Wideband Phased Array of Spiral Antennas for Simultaneous Transmit and Receive (STAR)

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As available radio frequency (RF) spectrum diminishes, methods of increasing spectral efficiency, such as simultaneous transmit and receive (STAR), are gaining interest. STAR allows systems to concurrently transmit as well as receive over the entire bandwidth of a channel, allowing for increased channel capacity. However, transmit/receive (Tx/Rx) coupling leads to self-interference that must be suppressed. Several approaches to cancel self-interference include the following: (1) Tx/Rx antennas with high isolation, (2) RF and analog filtering, and (3) digital filtering. In this paper, we focus on suppressing Tx/Rx antenna coupling across a large bandwidth. We aim to achieve port-to-port isolation using an array of collocated Tx/Rx antennas with scanning capability.

Others have demonstrated STAR, but scanning was only achieved at very narrow bandwidths. For example, a patch antenna array used narrowband filters to cancel coupling between adjacent elements (Wegener, IEEE MTT-S International Microwave Symposium, 2014). A circular array of Tx elements with progressive phase shifting at the feeds produced destructive interference at a single Rx element in the middle (K. E. Kolodziej, et. al., IEEE Antennas and Propagation Society International Symposium, 2012; W. F. Moulder, et. al., IEEE Antennas and Propagation Society International Symposium, 243-244, 2014). Wideband STAR was demonstrated, but only for a single element four-arm spiral antenna (Etellisi, et. al., IEEE Transactions on Antennas and Propagation, 64, 6-15, 2016).

In this paper, we propose an array of four-arm slot spiral antennas for use in STAR systems. To our knowledge, this is the first wideband array with beam steering for STAR. Spiral antennas were selected because they are inherently wideband and produce excellent circularly polarized radiation. In each spiral, two arms are used for transmitting and the other two are employed for receive. Notably, isolation is achieved through the symmetry and inherent polarization orthogonality of the transmit and receive arm pairs. The array of four-arm slot spirals is backed by a ground plane. Each spiral slot arm is terminated by a resistor placed at the end of the arm (B. A. Kramer, et. al., IEEE Transactions on Antennas and Propagation, 53, 2005). An infinite balun provides the required balanced feeding for each Tx and Rx arm pair. The spiral element's diameter was selected for increased gain while maintaining the critical $\lambda_{HIGH}/2$ element spacing to avoid grating lobes. For the designed array, the port-to-port Tx/Rx isolation at boresight was greater than 40dB with VSWR < 3 across 2.8-4GHz. While scanning to 30°, the isolation remained greater than 29dB. A prototype is currently being fabricated and results will be shown at the conference.