Parametric Study of Single-Antenna UWB Beamforming by Time-Reversal

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In this presentation, we investigate the effects of antenna parameters on single-antenna ultra-wideband (UWB) beamforming by time-reversal. We have recently demonstrated that a compact reverberation cavity with distributed apertures can be used as a single-feed antenna to achieve beamforming of short, ultra-wideband pulses by means of time-reversal techniques (S. K. Hong, V. Mendez, W. S. Wall and R. Liao IEEE Antennas Wireless Propag. Lett, 13, 794-797, 2014).

To achieve this beamforming, we obtain the individual impulse response (IR) between each aperture and the cavity feed. A relative time-delay is then applied to each of the time-reversed IRs. When the delayed time-reversed IRs are combined and retransmitted through the cavity feed, a short pulse is reconstructed at each of the apertures with the corresponding time-delay, thereby allowing beam-steered short pulses to form in the far-field. This approach allows for all of the necessary information for beamforming embedded in a single waveform, and it eliminates the need of a complex feed network with active delay-lines, which significantly simplifies UWB beamforming.

Due to the complex and wave-chaotic condition inside the reverberant cavity, the TR reconstruction of short pulses and beamforming performance may vary depending on the cavity antenna configuration. In this presentation we consider the abovementioned TR cavity antenna to perform a parametric study in terms of aperture size and cavity scattering conditions to evaluate the beamforming performance towards finding an optimal configuration. The beamforming performance is evaluated by examining the time-domain far-field pattern and the reconstructed pulse quality in terms of peak to noise ratio. Numerical and analytical simulations are utilized in this study.