

A SMILE Array Using a Single ADC for Digital Beamforming

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The Spatial Multiplexing of Local Elements (SMILE) technique (J. D. Fredrick, Y. Wang and T. Itoh, *IEEE Trans. on Microwave Theory and Techniques*, vol. 50, no. 12, pp. 3052-3058, 2002. D. S. Goshi, Y. Wang and T. Itoh, *IEEE Trans. on Microwave Theory and Techniques*, vol. 52, no. 12, pp. 2732-2738, 2004.) uses a switch network to combine the multiple data streams from the different antenna elements into one data stream, which requires only one RF receiver. The original SMILE scheme array uses parallel ADCs after de-multiplexing. We have explored a novel approach of using a single ADC before de-multiplexing and being processed in digital domain. An arbitrary waveform generator (Tektronic AWG520) was used to generate a 4-channel RF signal that mimics a real multi-channel signal from a 4-element uniform linear array. The AWG also generates digital sequence to control a 4-channel switch network in the analog multiplexer (MUX). The 4-channel RF switch network is realized with three high speed SPDT switches that connects different RF channels to the receiver sequentially in real-time. The commercial off the shelf (COTS) part from Mini-circuits can be switched at approximately 8 MHz with low insertion loss of about 1.5dB at 2GHz. Switches with higher switching speed can be developed with MMICs that will be able to handle a larger bandwidth in an integrated setting. The output signal of the MUX was sent to a single RF channel with a single LNA and mixer for down-conversion. This RF channel is followed by a high speed Gage CSE8482 digitizer sampled at 25MS/s. The Matlab demultiplexing and beamforming were processed for the filtered and digitized baseband multi-channel signals. Advanced algorithms have been tested for data recovery. Both Matlab simulation and lab testing results will be presented.