Analytical and Experimental Evaluation of a Novel Wideband Transceiver with On-Site Coding

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There is significant interest to integrate a variety of high speed communications using a single multi-functional front-end (transceiver) matched to an ultra-wideband (UWB) aperture. The availability of small UWB conformal apertures can provide a new paradigm in the way we collect and process information. However, utilization of this bandwidth imposes several requirements on the aperture, starting with a wideband feed network and the ability to scan down to low angles over the entire purported bandwidth (at least down to 70°). Concurrently, a scalable and power-efficient digital back-end is needed to realize digital beam-forming for cognitive sensing. A perennial challenge is the tradeoff between size, gain, and bandwidth. That is, the design of low profile, power-efficient, wideband conformal transceivers is desirable for conformal integration on small platforms.

Recently, a novel transceiver architecture with on-site coding was proposed for cognitive sensing [Alwan et al., IEEE ICWITS, 2012]. The architecture features agile beam forming, jamming mitigation, and MIMO communications. The new architecture departs from traditional digital beamforming approaches. Specifically, a single ADC is assigned to a group of array elements instead of having one ADC per element. To facilitate this approach, code division multiplexing (CDM) is applied to each received antenna signal prior to combining them for digitization using a single ADC. Thus, faithful signal recovery is possible at the digital baseband via decoding. The proposed architecture significantly reduces the number of ADCs and I/O channels leading to drastic improvement in size, weight, area, power and cost of the system with minimal impact on receiver signal-to-noise ratios (SNR).

In this paper, a detailed systematic evaluation of the proposed on-site coding receiver is conducted. We examine the trade-offs using non-ideal components (e.g. filters), including finite resolution ADCs and their impact on the system's noise floor. It is concluded that the bit error rate (BER) shows minimal SNR degradation using filters of order 4 and ADCs with 10 bit resolution along with Walsh-Hadamard (WH) codes to realize on-site coding. We also present a two-channel implementation with components off-the-shelf (COTS) assuming a modulated binary phase shift keying (BPSK) input signal and WH codes of length 8. Measurements show full signal recovery with minimal degradation.