Experimental Evaluation of Detection Performance of a MIMO Radar Testbed

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This paper reports on experimental evaluation of multiple input, multiple output (MIMO) radar detection performance using a developed MIMO radar testbed. The experimental setup represents a 2 × 2 MIMO (including a single input, single output (SISO)) configuration, using a M-sequence with an order of 6 as baseband signal, generated using an arbitrary waveform generator (AWG) with 2.5 GSample/s, and occupying 500 MHz of bandwidth. This signal is modulated using binary phase shift keying (BPSK) and up-converted to 3.5 GHz frequency band. The received signal is acquired using a downconverter and a digital storage oscilloscope (DSO) as time domain data, and processed offline. Threshold processing is carried out after matched filter processing. Furthermore, in order to change the signal to noise ratio (SNR), noise power is added with a noise source at the receiver input. Experiments were conducted in a radio anechoic chamber to exclude the effects of multipath.

Upon estimating the detection performance of the system, we adopted three types of processing: MIMO, re-phased netted radar (RPNR), and distributed radar network (DRN) processing. The MIMO processing implements a non-coherent approach where the decision is made using the signal's power alone. In contrast, the RPNR performs a coherent approach, taking into account the signal's power and phase information. In addition, the received signals phase is re-aligned to maximize the SNR. The DRN implements a non-coherent threshold processing on each individual receiver and combines the results to obtain the detection decision. In each processing, the threshold was selected to fix the probability of false alarm at 10^{-6}.

The three schemes were experimentally examined and their detection performances were found better than the SISO. At 80% probability of detection, the RPNR, the MIMO and the DRN marked 9, 8, and 6 dB of improvement in SNR, respectively, compared to the SISO. Although the RPNR yielded the best performance, the MIMO performed nearly with lower complexity since it utilized a non-coherent approach. The experimental data were also reproduced closely by numerical simulation.