Effects of Bandwidth on Joint Estimation Performance of Direction-of-Departure and Direction-of-Arrival in Ultra-Wideband MIMO Radar

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In direction estimation applications, several angle estimation algorithms in multiple-input multiple-output (MIMO) radars were proposed, including joint estimation of direction-of-departure (DOD) and direction-of-arrival (DOA). Nevertheless, these reports were mainly based on narrowband signal assumption. Target localization using the narrowband signal, however, was unstable due to radar cross section fluctuation. The authors proposed a joint DOD and DOA estimation in an ultra-wideband (UWB) MIMO radar system (Pasya et al., IEEE Radio Wireless Symposium 2014, to be published). The proposed scheme utilized a two-way MUSIC algorithm to estimate the respective DOD and DOA at each frequency component. Among these angle estimations, wideband DOD and DOA were then estimated by majority decisions. This report studies the effects of signal bandwidth on the performance of the proposed angle estimation scheme.

This study considered a 4×4 MIMO radar using a uniform linear array configuration, with antenna spacing of 15 mm (corresponds to a half wavelength at 10 GHz of frequency). Numerical simulations were done when the system was detecting 2 targets located at (ϕ_1, θ_1) = (10˚, -28˚) and (ϕ_2, θ_2) = (-10˚, -10˚), where ϕ and θ are the departing and arriving angle, respectively. Signal to noise ratio was 15 dB and the number of snapshot was 100. It was found that the performance of angle estimation using the proposed scheme varies according to the bandwidth chosen. Estimation using full-band UWB (3.1 to 10.6 GHz) signal yielded the most accurate estimation, with errors up to 1˚ and 3˚ in the DOD and DOA, respectively. These errors were attributed to outliers occurred at lower frequencies, corresponding to shifts in the MUSIC spectrum due to the fixed antenna spacing used at the antenna arrays. Estimation using narrower bandwidth, for example, 3.1 to 3.2 GHz (bandwidth = 100 MHz) resulted in poorer performance. The estimation errors in the DOD and DOA were 7˚ and 5˚, respectively. On the other hand, selection of high frequencies above 10 GHz reduced the estimation error.

Experimental evaluation will be carried out and presented at the conference as validation of the simulated results.