INVESTIGATING BEAMFORMING GAINS OF FREQUENCY DIVERSE INTELLIGENTLY DISTRIBUTED ADHOC POLYMORPHIC ANTENNA ARRAYS

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Distributed arrays have many advanced tracking capabilities and can exploit extended bandwidth using spatial characteristics. Typical applications of this utilize stretch processing or spatial time adaptive processing (STAP) with wideband linear frequency modulated (LFM) waveforms. An alternative of obtaining a large bandwidth and fine range resolution without requiring intrapulse frequency modulations is a stepped frequency waveform which is commonly used in single antenna elements. The most common stepped frequency waveform employs a linear frequency stepping pattern, where the RF of each pulse is increased by Δf from the proceeding pulse.

In this work a much different approach is taken such that a non-linear frequency increment, Δf, is applied across a randomly distributed antenna array for multidimensional processing gains. This novel method of beam-forming and beam-steering applies both frequency diversity and spatial aperiodicity to greatly increase bandwidth capabilities with unique range characteristics. An advantage of periodic frequency diverse arrays (FDA) are that the frequency increment of equal amplitude applied to individual radiators provide an additional degree of freedom for beam-steering as a function of range relieving the requirement for elemental phase shifters. Moreover, removing the periodicity in the array architecture and forming an aperiodic aperture eliminates grating lobes. Even though this comes at the cost of increased sidelobe levels, the benefits of greater bandwidth capabilities will be shown to enable the resolution of non-coherent targets in the spatial processing domain. The combined result of frequency diversity with aperiodicity leads to a high resolution, scan invariant beam with steerability in range and angle. Such a beam provides the capability of unique radar applications such as amplitude monopulse scanning, which keeps a target in the null of the difference beam by using a sum beam on transmit and a difference beam on receive, and cognitive beamwidth control, which uses the surface apertures of the array to provide greater object recognition and resolution capability.