

CHARACTERIZATION OF NEAR FIELD SCATTERING

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Surface wave radar is an emerging coastal and exclusive economic zone surveillance technology. Surface-wave radar systems used in this role are located at a land-sea boundary and use surface wave propagation and the conductivity of sea water to detect and track targets across water beyond the line-of-sight radar horizon. Detection and tracking of small vessels can be achieved at ranges in excess of 200 km where optical horizon may be no more than 20 km. These radars operate in the congested lower HF (approximately 3-10 MHz) section of the electromagnetic spectrum. The systems with which we have experience use floodlight transmission and an array of receiver sensors. A mix of classical digital beamforming, space-time adaptive Processing, and high resolution angle algorithms are often used to determine target direction.

A typical surface-wave radar receiving array may consist of between 8 and 64 sensors and can be 500m or 1km in total length. It is typically sited on a coastal beach which may or may not provide a uniform transition from land to sea. For example, the coast may in fact be a bay in which case the land sea boundaries beyond either end of the array may cause near-field scattering and distort the wave-front arriving at the array. There may be other locally sited structures, such as buildings and fences, which can be the source of local scatter. This makes achieving very low sidelobe spatial beams with a classical beamformer a difficult problem and can render the receiver system vulnerable to interference through beam sidelobes (possibly via skywave propagation).

The near-field scatters, produced by these mechanisms, are correlated with the desired direct far-field radar return from targets (and clutter). This scatter is typically approximately 20-40dB weaker than the direct signal. Without mitigation it is possible to achieve classical beam sidelobes of 30-35 dB, however in general the remaining components of the receiving system can sustain substantially higher performance. A method is required that can mitigate the effect of local scatter so that the radar system can realize the inherent sidelobe capability as set by the radar equipment.

We introduce the quadratic sensor angle distribution (SAD) for near-field source characterization. The SAD is a joint-variable distribution and a dual in sensor number and angle to Cohen's class of time-frequency distributions. It provides the power at every angle for each sensor in the array. In this distribution, a near-field sources has a different angle for each sensor. We use a known test source to illuminate the local scatterer distribution we wish to characterize. The high-power test source can be removed via orthogonal projection so as to reveal the less powerful local scatter. It is shown that the eigen-decomposition of the quadratic representation of SAD lends itself to source representation via multiple subarray beamforming.