Enhanced Angular Resolution for DOA Estimation by Using Luneburg Lens Antenna with a Waveguide Array Basement

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Benefit from the recent technological advancements in realizing materials with desired electrical properties, a Luneburg lens antenna, which has the capability of all-angle-scan regardless of the operating frequency, as well as excellent focusing characteristics, can be fabricated at a relatively low cost, and this has attracted a lot of attentions in radar community. Specifically, Xin *et al.* (M. Liang, X. Yu, *et al. IEEE International Microwave Symposium (IMS) Digest (MTT)*, June 2012, pp. 1-3) fabricated a Luneburg lens antenna with five conformal detectors located on its curved surface and employed the correlation method for the Direction-Of-Arrival (DOA) estimation. In this paper, we investigate a framework of DOA estimation by using a Luneburg lens antenna with a waveguide array as the basement, and also present a hybrid approach which combines the waveguide mode extraction and signal processing techniques for improving the angular resolution of the lens antenna. The hybrid method involves sampling the electric field at specified positions when the lens is operating in the receiving mode, and extracting the weights of possible propagating modes in each waveguide. Following this, we correlate the weights with the known ones that have been derived by either simulated or measured signals from single targets located at different looking angles, to make an initial estimate of the angular regions of possible DOAs. We then apply an algorithm based on the Singular Value Decomposition (SVD) of the simulated or measured data matrix to estimate the incident angles. Numerical results show that the proposed framework, used in conjunction with the hybrid approach, can achieve higher resolution over the conventional 3dB-beamwidth limit of the lens antenna. Furthermore, it is capable of locating targets with different scattering cross-sections and achieving an angular resolution as fine as 2^o, for a Luneburg lens antenna with an aperture size of 6.35λ and a Signal-to-Noise Ratio (SNR) of 30dB.

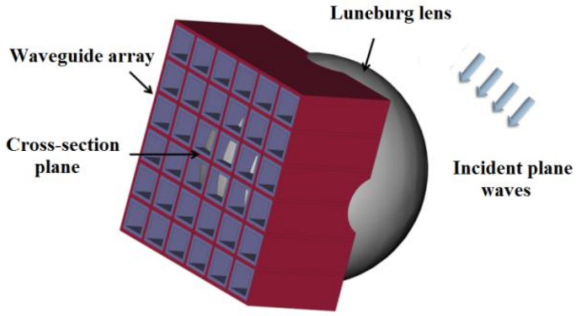

Fig. 1 Luneburg lens with a waveguide array basement.

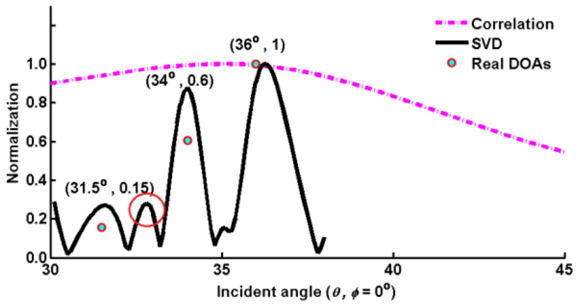

Fig. 2 Recovered DOAs by using the proposed method.