Abstract  The presence of a signal source and a receiver near a reflecting surface is a common scenario in many radar and communication systems; for instance, low-angle radar tracking systems and terrestrial radio links. Under this condition, the received signal can be modeled as the sum of fields arriving through the direct path and then scattered from the surface. A major challenge in multipath propagation at a low-grazing angle is that the angular separation between direct and reflected paths is smaller than the beamwidth of the receiver antenna array; hence, the reflected signal cannot be spatially filtered. Most of the previous work in this area has considered scalar-sensor arrays, which cannot resolve very close source arrival paths nor provide a good estimation of position (range and altitude).

In this paper, we propose to use diversely polarized sensor arrays to overcome the above difficulties and improve the estimation of all the source parameters, i.e., direction of arrival, range, altitude, and polarization, when the receiver array and the source are near a reflecting surface.

We present a general polarimetric signal model that takes into account the interference of the direct field with the field reflected by smooth and rough surfaces. Using the Cramér-Rao bound (CRB) and mean-square angular error (MSAE) bound, we analyze the performance of different array configurations, which include an electromagnetic vector sensor (EMVS), a distributed electromagnetic component sensor array (DEMCSA), and a distributed electric dipole array (DEDA). Using numerical examples, we show significant advantages of using the proposed diversely polarized arrays compared with the conventional scalar-sensor arrays.