Improved Scanning of Wideband Arrays using a Reconfigurable Surface

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Wideband phased arrays have become critical components of many high performance radar and wireless communications systems. In addition to operating over a large bandwidth, electrically scanned arrays often must also operate over large scan volumes. Although many wideband array technologies are capable of scanning to $\pm 45^\circ$ from broadside, this is insufficient for some applications for which scanning to $\pm 60^\circ$ or even $\pm 70^\circ$ may be required. However, the problem of achieving such wide scan angles while also maintaining a large instantaneous bandwidth is quite challenging. This is in part due to the large variations in the impedance of the array when scanning.

We have previously shown that when an array is placed above a conducting ground plane, the resulting reactance will fundamentally limit the realizable bandwidth of the array. In this sense, the array can be viewed as a matching network to the reactive load presented by the ground plane. As the array scans to large angles ($> 45^\circ$) in various directions, the impedance of this load varies greatly. However, a traditional array provides only a static impedance match for all such conditions. Because the array must compromise and balance performance over the entire scan volume, the impedance bandwidth will therefore be sub-optimal at any given scan angle, relative to the theoretical limits.

However, if the array can be reconfigured while scanning to different angles, the impedance match may be "fine-tuned" for the corresponding scan-impedance. In this way, a reconfigurable array can achieve greater bandwidth over a larger scan volume, and can perform much closer to the theoretical limits. We have implemented such an array by placing a reconfigurable surface below the radiating elements of a tightly coupled dipole array (TCDA). The reconfigurable surface contains varactor diodes which are easily re-biased for various scan conditions, and compensate for the varying scan-impedance of the array. Initial simulated results of the reconfigurable TCDA design indicate that it is capable of 6.25:1 bandwidth while scanning to $\pm 60^\circ$ in all directions, and 5.4:1 bandwidth while scanning to $\pm 70^\circ$ in all directions. Such performance is significantly superior to that which is possible by a standard static TCDA.