Direction of Arrival Estimation Enhancement for Closely Spaced Electrically Small Antenna Array

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Direction of arrival (DOA) of a microwave signal is important for many commercial and military applications. Accurate DOA estimation technique with small system size is highly desirable. Electrically small antenna array with small spacing between any two adjacent antennas is attractive because of the compact size of thewhole system. The challenge is how to achieve high accuracy of DOA estimation under this circumstance.

DOA technique using two antennas with a head like lossy scatterer in between them has been reported (H. Xin and J. Ding, IEEE AP-S Intl Symp. Dig., 1-4, 2008; R. Zhou, H. Zhang and H. Xin, IEEE Trans. Ant. Prop., vol. 59, No. 7, 2011). Also inspired by Human auditory system, here a new technique utilizing a scatterer of high dielectric constant in between electrically small antennas to achieve enhanced DOA estimation performance is demonstrated. Two electrically small antennas are placed with a small spacing (spacing << half wavelength) so that the total size of the structure is reduced. However, the corresponding phase difference between the received signals at the two antennas would be very small ($\sim\frac{2\pi d\sin(\theta)}{\lambda_0}$ with $d-$ spacing, $\theta-$ incident angle relative to boresight and λ_0- free space wavelength) due to the space limitation. In order to increase the direction finding sensitivity, a high dielectric constant block is added in between the two antennas. The larger the permittivity of the added material is, the higher the direction finding sensitivity can be achieved.

The DOA estimation is achieved with maximum likelihood of pre-saved complex voltage difference (magnitude and phase difference) between the two antenna ports. The received signal to noise ratio (SNR) is very important in addition to the direction finding sensitivity. Additional matching network for the system is studied. Finally the DOA performance of the proposed method will be compared with other existing technique.