Radio-frequency Source Estimation Using Field Distribution Measured on Metamaterial Absorber Surface

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Abstract— A thin metamaterial absorber has been used as a sensor array to measure the 2-d distribution of radio-frequency (RF) wave field incident and absorbed on its surface. The absorber is designed so that the incident wave is absorbed by a metasurface which is matched with the incident wave impedance. Absorption is achieved by lumped resistors interconnecting a 2-d dense array of mushroom-type square patches formed on a grounded dielectric substrate. The resistors inserted between the adjacent patches arranged in the row (x) and column (y) directions on the surface absorb the incident x- and y-polarizations, respectively, at the resonance frequency of the metasurface. In this case the x- and y-resistors act as small dipole sensors which output the voltages proportional to the x- and y-components of electric field of the incident wave, with their effective lengths given as a unit cell size. By monitoring the voltages on the array of the lumped resistors, 2-d amplitude and phase distributions of electric field are obtained on the absorber surface.

The field distribution measured on the absorber surface is then used to extract the information on its sources. As the sensor array absorbs the incident wave with tiny reflection, it acts as an almost ideal antenna array which does not disturb the incident field distribution, where no mutual coupling between the array elements can be taken into account. At the same time the detailed field distributions are obtained with the spatial resolution much smaller than the wavelength of the incident wave, due to the electrically dense sensor (resistor) arrangement. Such an accurate and detailed field distribution is expected to give a useful information to localize the angle-of-arrivals of far-field sources, as well as the locations of near-field sources.

In this study, as an example of such a source localization technique, we apply the MUSIC algorithm to estimate the locations of near-field sources. The performance of the technique is evaluated with simulations. Preliminary results show that the technique is effective to localize the RF (a few GHz) sources which are located about one meter away from a square-shaped absorber of several tens of centimeters per side.