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Magnetic field distribution measurement with a metasurface structure

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Metasurface structures have been used as radio-frequency (RF) absorbers. A mushroom-type metasurface was used for monitoring 2-d distributions of RF fields incident on the absorber surface, where a dense matrix of square metal patches was constructed on a grounded dielectric substrate, and absorption was achieved by lumped resistors interconnecting the surface patches at the resonance frequency [1]. Each pair of adjacent square patches worked as a short dipole sensor terminated with a lumped resistor matched with the incident wave impedance. By monitoring the voltages on the individual resistors, the electric field distribution of the incident wave illuminating the absorber surface was obtained. Since the lumped resistors were inserted between the square patches in the x- and y-directions on the absorber surface (the xy-plane), the x- and y-components of incident electric field polarizations were independently measured. Effectiveness of the technique was evaluated and validated by theoretical (numerical) calculations using plane-wave expansion of a near-field spherical wave on the absorber surface [2]. Such obtained field distributions should give useful information for in-situ and real-time localization of radiating RF sources.

In this study, we develop a new metasurface capable of measuring the magnetic field distribution of an incident RF wave. A unit cell includes three sets of metal loop structures orthogonal to each other, to pick up the x- and y-components (on the surface) and the z-component (perpendicular to the surface) of a magnetic field vector. Each loop has a small gap terminated by a resistor, the induced voltage on which is monitored to detect the magnetic field perpendicular to the loop plane. A 2-d matrix of unit cells are arranged on a dielectric substrate, so that a magnetic vector distribution can be measured on the new metasurface. In the presentation we will discuss the performance of the new metasurface in measuring the magnetic field of incident plane waves as well as near-field spherical waves. Scattering of the incident magnetic field due to the metal loop structures are evaluated to examine the accuracy of measurement using the theoretical (numerical) calculations, compared with simulations and experiments.

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2. S. Yagitani, R. Kanaura, M. Ozaki, and T. Imachi, “Numerical analysis and visualization of spherical waves absorbed by a thin metamaterial absorber,” Proc. ICEAA 2017, September 2017, pp.808-809, doi:10.1109/ICEAA.2017.8065372.