Single-Radar Image System Designed by Active Transmission Metasurfaces

Yun Bo Li [(1)], Lian Lin Li [(2)], and Tie Jun Cui* [(1)]
(1) State Key Laboratory of Millimeter Waves, Department of Radio Engineering
Southeast University, Nanjing 210096, People' Republic of China.
"http://radio.seu.edu.cn/"
*tjcui@seu.edu.cn
(2) School of Electronics Engineering and Computer Science
Peking University, Beijing 100871, People' Republic of China.

In recent years, the single-radar or the single-pixel image technology has greatly developed. Due to the excellent ability of controlling the electromagnetic wave by metamaterials/metasurfaces, the spatial filters (masks) which are the important parts of the single-radar image system can be easily realized by the metasurfaces. In our work, we present the active transmission metasurfaces to achieve the single-radar image under the microwave band with the high signal-to-noise ratio compared to the former works based on the theory of leaky-wave.

According to the theory of the single-radar image system, we generate the multiple measurement modes by using the transmission array metasurfaces which are tuned by the switching diodes. The metasurfaces are composed of two-layer cascaded transmission array, which can produce the performances of the high transmissivity and the considerable phase shifting. After receiving the backward scattered wave, we use two methods to process the signals. One is that we directly use the inverse matrix to reconstruct the object when the numbers of the image element and the measurement are equal. The other is that we use the compressed sensing technology to recover the object when the measurement number is less than the one of the image element and the OMP (Orthogonal matching pursuit) method is selected as the restructuring algorithm.

In our design, we propose a new method to randomly control each image pixel. We employ the FPGA to randomly support the binary voltage synchronously to the row and column of the transmission array. And the random codes 0 and 1 which are served to FPGA are generated by the Labview software on the PC. The new single-radar image system using this controlling scheme can drastically decrease the design cost and the complexity, so that it has the huge application prospect in microwave image domain.