Numerical Investigation of the Effects of Half-Space Background on Radar Signatures of Small Consumer Drones

Xin Qi* (1), Zaiping Nie(1), Xiaofeng Que(1), and Yue Wang(1)
(1) University of Electronic Science and Technology of China, Chengdu, China

Recent developments and popularity of small consumer drones have attracted much attention and resulted in a largely increasing in the number of drones controlled by civilian users. Characteristics of low price and easy operation are promising for its potential applications in various areas, such as aerial photography, search and rescue in disasters, surveillance in public security and package delivery. But in the meantime, demands for systems capable of detecting and identifying these small platforms with lower altitude and slower speed are increasing significantly, to avoid hostile use in unsafe acts, i.e., flight safety issues caused by recreational use have been reported severely. Radar system is believed to be a potential way to detect and classify these small drones, and some preliminary researches have been conducted concerning about analysis of radar cross section (RCS) in a free space and classification by micro-Doppler signatures.

In this paper, the effects of half-space background have been investigated firstly in RCS analysis of small consumer drones. Variations of reflections as a function of variables such as polarization and frequency are explored for free space and half space respectively. Scattering data are calculated by an efficient and accurate integral equation method (IEM), expedited by the multilevel fast multiple algorithm (MLFMA). In addition, a two-level discrete complex image method (DCIM-2L) has been applied to speed up the calculations of Sommerfeld integrals existing in the conventional half-space Green's functions. Furthermore, the two-dimensional (2-D) inverse synthetic aperture radar (ISAR) images are also provided to explore the influence of half-space background on radar signatures of these small drones. According to the 2-D Fourier transform, a 2-D ISAR image can be obtained by post-processing the wide-band and wide-angle mono-static scattering data which are calculated accurately and efficiently by the proposed novel method based on characteristic mode theory (CMT).