RCS measurement of small drones for future airport surveillance radar

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Since Airport Surface Detection Equipment (ASDE) detects reflective objects from a 2-D radar maps, it is difficult to detect objects moving on airport surface while reducing false positives due to grass and tree. It is also important to extract small flying objects such as small unmanned aircraft system (sUAS) which are not permitted to penetrate to airport. The purpose of this study is to develop a multi-static based new radar system around airport using 24 GHz in the K-band. This frequency band has higher resolution and is suitable for detecting small moving objects. In order to determine the system performance, the radar cross section (RCS) of the sUAS must be estimated. In this paper, RCS measurements of sUAS were performed as an initial experiment, and results of RCS measurements for sUAS present. Measurements were performed in our anechoic chamber where the attitude of sUAS was varied. Results show that reflected powers were small when the tilt angle was large.

Key Words: ASDE, sUAS, RCS

1. Introduction

Since Airport Surface Detection Equipment (ASDE) detects reflective objects from a 2-D radar map, it is difficult to detect flying small objects such as small unmanned aircraft system (sUAS) while reducing false positives due to grass and trees. In the future, a new airport surveillance system will be needed to prevent unauthorized sUAS from entering airports.[1)]

This study investigates the advancement of ASDE using 24 GHz in the K-band, which has been adopted in Japan. The K-band has higher resolution than the X-band used in ASDE in other countries and is suitable for detecting sUAS. The objective of this research is to develop a new multi-static type ASDE, and thus estimation of the K-band radar cross section (RCS) for sUAS is necessary to determine the performance of the system. In this paper, we present the initial results of the RCS measurement of sUAS with K-band.

2. Experimental Setup

Figure 1 shows the configuration of the measurement. The Network Analyzer was placed in a radio anechoic chamber. The transmitting antenna was connected to Port 1 and the receiving antenna was connected to Port 2 via an amplifier, and the antennas were placed side by side 10 m away from a turn table. The sUAS was placed on the turn table, and the received power from Port 1 to Port 2 was measured every 1 degree of azimuth angle, and the measurement was repeated for ±180 degree as shown in the upper left of Fig. 2. Measurements were taken at different tilt angles to simulate the sUAS in flight as shown in the upper right of Fig. 2.

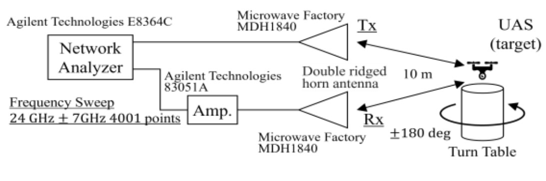

Fig. 1 Experimental setup.

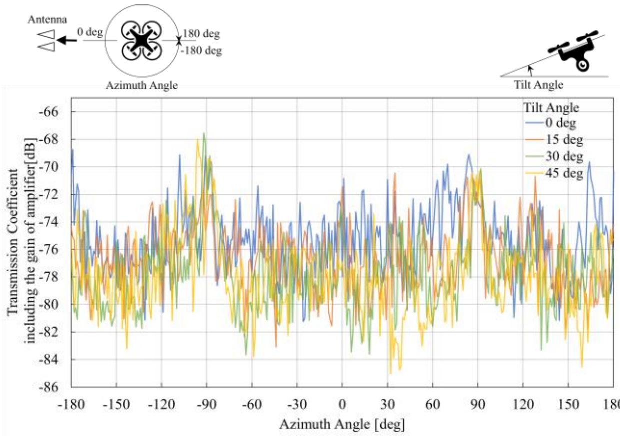

Fig. 2 Comparison of Reflection Intensity for DJI phantom 4.

After the measurement, the data in the frequency domain obtained at each azimuth angle was transformed to the time domain using the inverse Fourier transform, and the peak value around 70 ns was recorded.

3. Result and Discussion

Figure 2 shows the measurement results using the DJI Phantom4. There are four curves with the tilt angle 0, 15, 30, and 45 degrees, respectively. It is demonstrated that the larger tilt angle becomes, the smaller reflected power is. Therefore, lower detection rate could be observed in case of larger tilt angle depending on positional relation of transmitter and receiver or higher moving speed. This characteristic should be considered to determine radar specification.

References

1) J. Wang, Y. Liu and H. Song, "Counter-Unmanned Aircraft System(s) (C-UAS): State of the Art, Challenges, and Future Trends," in IEEE Aerospace and Electronic Systems Magazine, vol. 36, no. 3, pp. 4-29, 1 March 2021.