ABSTRACTS (MASTER THESIS)

Study on real-time aircraft clutter suppression using the MU radar

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The MU radar is the large VHF-band atmospheric radar to observe the lower, middle, and upper atmospheres in the Shigaraki MU Observatory. Strong clutter echoes from mountains or aircrafts sometimes cause problem of estimating wind velocity with atmospheric radars. In this study, we evaluated three methods of 1-constrained NC-DCMP (Norm-Constrained and Directionally Constrained Minimization of Power), 2-constrained NC-DCMP, and 2-step NC-DCMP, which are effective to suppress aircraft clutters [1]. The latter two requires the information of aircraft directions. We proposed a method to limit the scope of searching the directions using ADS-B Automatic Dependent Surveillance-Broadcast) system.

First, the latitude, longitude, altitude, and velocity of aircrafts were decoded from 112 bit messages of ADS-B. In order to use their information with adaptive signal processing, they were converted to ENU coordinate, which is the orthogonal coordinate system with the MU radar as the origin. Moreover, we use MV filter to predict and complement the aircraft position because ADS-B information is intermittent [2].

Finally, we applied 1-constrained NC-DCMP, 2-constrained NC-DCMP, and 2-step NC-DCMP to the observation data of the MU radar, and evaluate the suppression performance for aircraft clutters. We indicated the correlation between 1-constrained NC-DCMP suppression performance for aircraft clutters and the average sight velocity of aircrafts by ADS-B. Suppression performance of 1-constrained NC-DCMP is worse when the Doppler velocity is faster. Moreover, if we use the optimized directions of aircraft clutters with 1st step of 2-step NC-DCMP, which is the procedure of subtracting reproduced aircraft clutters from the received signal, the suppression performance of 2-step NC-DCMP is improved about 5 dB more than that of 1-constrained NC-DCMP, which is the conventional method.

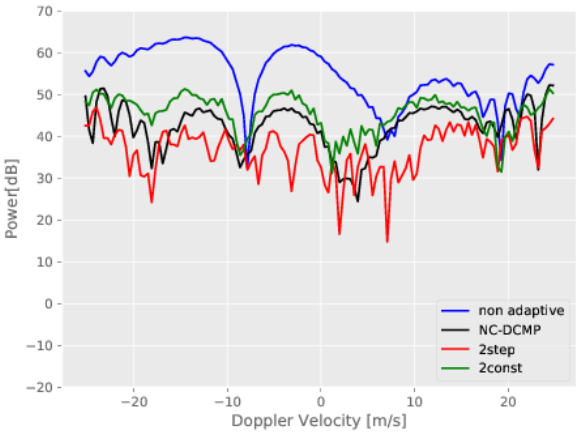

Figure 1. Comparison of three aircraft suppression methods with ADS-B.

References

[1] T. Hashimoto, K. Nishimura, M. Tsutsumi, K. Sato, and T. Sato, “A user parameter-free diagonal-loading scheme for clutter rejection on radar wind profiles”, Journal of Atmospheric and Oceanic Technology, vol.34, no.5, pp.1139-1153, 2017.

[2] A. Dutle, M. Moscato, L. Titolo, and C. Munoz, “A formal analysis of the compact position reporting algorithm”, Working Conference on Verified Software: Theories, Tools, and Experiments, pp.19-34, Springer, 2017.