ABSTRACTS (MASTER THESIS)

Study on Shape Estimation of Space Debris Using MU Radar

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It is widely known that regular observation of space debris in low earth orbit is one of the most important task for realization of sustainable space exploration. The aim of this study is to develop a method of estimating the shape of space debris with a ground-based station, the MU radar, which is not used for debris observation but for atmospheric observation because of low range resolution.

In previous study, Single Range Doppler Interferometry(SRDI) method was proposed, which can roughly image the shape of space debris using a fluctuating doppler spectrogram caused by the spin motion of space debris by means of numerical simulation [1]. Therefore, we examined the SRDI method by means of numerical simulation and observation. We used the pseudo wigner-ville distribution(PWVD) method to get a fluctuating doppler spectrogram which can be obtained from time-frequency analysis. In numerical simulation, space debris was expressed by many point targets and wire grid model. We confirm accuracy and validity of SRDI method. As a result of observation, the size of errors between the estimated size and the real size of space debris were within 0.5 m. As to the spacecraft adapter whose real diameter was 119.4 ~ 166.6 cm, we estimated its size at 40 ~ 140 cm.

In addition, We focused on Radar Cross Section(RCS) fluctuation. The RCS fluctuation of a perfectly conductive ellipsoid can be calculated analytically, so we assumed the debris to be an ellipsoid and fitted a curve to observed data in order to extract information about the shape of debris. By using this method, the spacecraft adapter already mentioned was estimated to be an elliptic plane whose major axis is 127 cm and minor axis is 98 cm. In this method, it is estimate that Spacecraft adapter whose diameter is 119.4 ~ 166.6 cm at elliptic plate whose major axis is 1.27 cm and minor axis is 0.98 cm. Moreover, taking this method together with the SRDI method made it possible to obtain not only information about the shape of debris but also the spin rate and the posture.

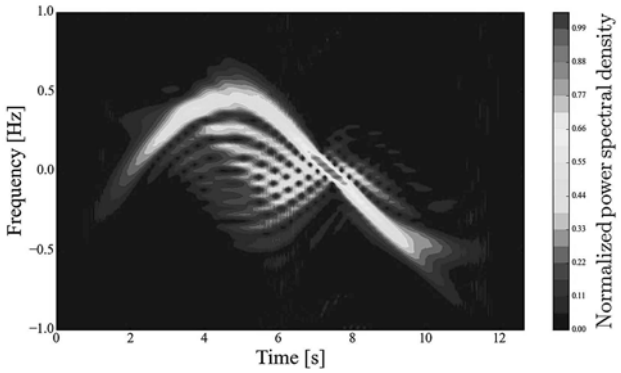

Figure 1. Calculation result of the time-frequency analysis of a space debris signal using PWVD

References

[1] T. Sato,, “Shape Estimation of Space Debris Using Single-Range Doppler In-terferometry”, *IEEE TGARS*, vol. 37., no.2, pp. 1000 -1005, 1999.