ABSTRACTS (MASTER THESIS)

Improvement of Space Debris Shape Estimation Technique Using MU Radar

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Space debris is considered as obstacles for space exploration, and we have to expand and improve observation method for space debris to reduce the risk of its collision with active spacecraft. In previous researches, the Single Range Doppler Interferometry (SRDI) method was proposed and used. This method requires only a fluctuating Doppler spectrogram caused by the spin motion of debris to estimate its shape. A spectrogram is a visual representation of the spectrum of frequencies in signal as they vary with time. In this thesis, we proposed an improved method of shape estimation of space debris with ground-based observatories.

We introduced Smoothed Pseudo Wigner Distribution (SPWD) for the SRDI method to obtain higher resolution of spectrogram. We confirmed the accuracy of SRDI method using numerical simulation and we also adapted the method with actual data of space debris observed by MU radar. FDTD (Finite-Difference Time-Domain) method is used as a numerical simulation method for radar system observation. We could obtain the correct 2D images characterizing the original shape of space debris when we suppose debris as a set of few discrete points by using SRDI shape estimation. The results of the numerical simulation also shows that, to estimate the shape of rigid body, the accuracy of the estimation needs to be improved. It is because spectrogram cannot distinguish spin motion echo from the echo of targets center. SRDI method was also evaluated by adapting actual observation of space debris which is known its shape. Through the analysis of actual data, we discovered that orbit motion spectral occurs in spectrogram and has negative effect for extracting spin motion spectral. To solve this problem, we proposed an analytic formula of orbit motion spectral and developed elimination method of this spectral. By using this improved SRDI method, we could obtain an image which characterize actual space debris.