
ABSTRACTS (MASTER THESIS)

Study on 3D shape estimation of space debris using MU radar

**(Graduate School of Engineering,
Laboratory of Space Systems and Astronautics, RISH, Kyoto University)**

Naruomi Ikeda

Recently, the amount of space debris has been rapidly increasing, and this is becoming an obstacle for space exploration. Many organizations are observing space debris and storing such data, however, there was a collision between an active satellite and satellite debris in 2009 regardless of these efforts. This indicates that the present observation network is not sufficient to completely avoid space accidents, and we need to improve and expand the observation network. The aim of this study is to develop a method of estimating the three dimensional shape of space debris using the Middle and Upper atmosphere (MU) RADAR, which is a major observation facility in the Shigaraki MU Observatory of the Research Institute for Sustainable Humanosphere (RISH), Kyoto University. Since atmosphere radar is already in use around the world, by applying this method, we can expand the observation network for space debris without constructing a new observation facility. However, atmosphere radar has poor range resolution compared to conventional radar for space debris observation, and a special signal processing method must be developed. In the previous research using MU radar, the Single- Range Doppler Interferometry (SRDI) method had been proposed to estimate the shape of space debris. In the SRDI method, the shape of space debris can be estimated from a 2D imaging that uses the information of actuating Doppler spectrogram caused by its spin motion. Also, shape estimation method using Radar Cross Section (RCS) had been proposed. In the RCS method, the shape of space debris can be estimated using the information of actuating echo of the target, which is also generated from the spin motion of the target. In this thesis, the basic idea and some results of shape estimation using both SRDI and RCS method are presented. Furthermore, a three dimensional shape estimation method which combines SRDI method and RCS method is described. In order to validate the accuracy of our method, we made actual observation using MU radar and we successfully estimated three dimensional shape of some targets.