ABSTRACTS (MASTER THESIS)

Study on Space Debris Removal Using Geomagnetic Lorentz Force

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The purpose of this study is to propose new methods for space debris removal using geomagnetic Lorentz force. The Lorentz force is produced when a charged object moves through a magnetic field. In this study, we assume space debris can be charged using small electron emitter, and generate the Lorentz force with the interaction between the charged space debris and the Earth's magnetic field. Then, we actively control charge to mass ratio (CTMR) of the space debris using the emitter, and control its orbit by the Lorentz force, aiming to make the space debris reach the Earth's atmosphere. First, we applied constant CTMR of 0.03 C/kg to the space debris. In this case, we found it difficult to make space debris reach the earth's atmosphere, because the oscillation of the altitude of the space debris is no more than 3 meters. Thus, we investigated two method to enable the removal by ON/OFF control of the emitter.

The first method is the excitation method. In this method, we focus on the oscillation of the altitude and turn on the emitter when the Lorentz force excites the oscillation of the altitude. Using this method, the eccentricity of the orbit become larger and larger, and finally the perigee reaches the Earth's atmosphere. For example, if the space debris has the inclination of 98.6 degree and the altitude of 800 km initially, the space debris reaches the Earth in 25 days. However, this method is effective only when the initial inclination is 90 degree to 180 degree. Besides, if the space debris has initial altitude of 1,500 km or more, the oscillation of the altitude will converge.

The second method is the energy attenuation method. We turn on the emitter when the Lorentz force attenuates the energy (in other words, when the Lorentz force acts in the opposite direction of space debris' velocity). Using this method, the energy of space debris gradually decreases and the altitude of the space debris decreases monotonically, because the radius of the orbit depends on the energy. For example, if the space debris has the inclination of 98.6 degree and the altitude of 500 km initially, the space debris reaches the Earth in 75 days. However, this method is effective only when the initial inclination is 5 degree to 160 degree. Furthermore, because the inclination keeps increasing while charging, the reduction of the altitude will converge when the inclination reaches 160 degree.