Space Structure Systems

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Education

Bachelor of Engineering, Nihon University, Chiba, Japan, 2016-current
Nihon University Narashino High School, Chiba, March 2016

Qualification

Amateur Third-Class Radio Operator, 2019

Research Theme (provisional)

"Effect on the spin deployment by changing the shape of bridge"

Research Overview

The solar sail IKAROS was launched in May 2010 by JAXA, and the 14m-sized sail membrane was successfully deployed in June 2011. JAXA is considering the next solar power sail which has 40m-sized membrane, OKEANOS (Oversize Kite-craft for Exploration and AstroNautics in the Outer Solar system) in the late 2020s.

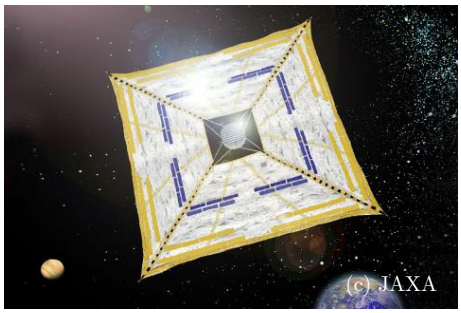


Fig.1 IKAROS

These structures that use extremely flexible thin or thin materials that easily buckle when compressed such as membranes and cables are called gossamer structures. Gossamer structures are expected as structural styles for future large space structures because of its excellent storability and light weight. However, because of its flexibility and light weight, motion (especially, deployment motion) on the ground is affected by the atmosphere and gravity, behaves completely different from the motion in the space. Therefore, it is not possible to adopt the usual development method of launching after confirmation of behaviour by ground experiment. Motion prediction by numerical calculation occupies an important position in design and development. However, the condition of whether the deployment will be success or failure have not been explained completely.

Research

My research is "Effect on the spin deployment by changing the shape of bridge". The petals of solar sail are connected by a rectangular membranes called bridges. The bridges have a role to absorb the manufacturing variation of each part of solar sail. I'm studying how affect to the deployment by changing the shape of bridges. The shape of bridges will be changed while keeping the total square measure so that the conditions of the solar sail will not be changed. And through this, I would like to find out the conditions of success or failure of solar sail deployment.

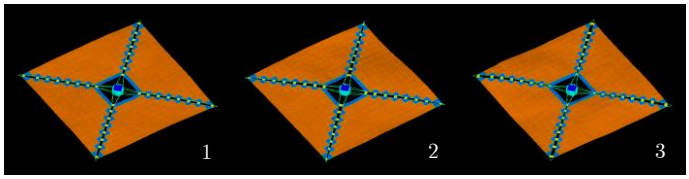
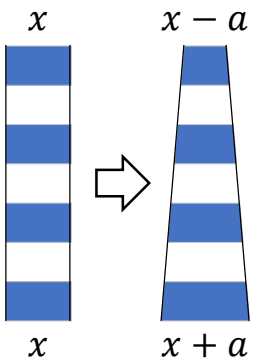


Fig.2 Solar sail analysis models

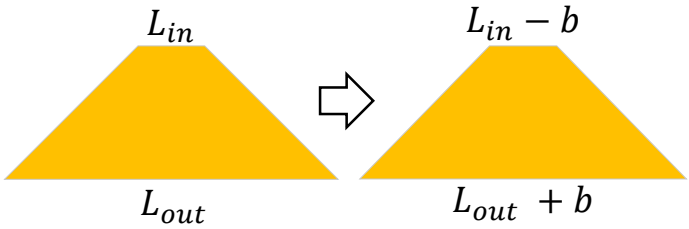
In the Fig.2, light blue cylinder is satellite main body, orange and blue membranes are petals, yellow membranes are bridges.



a is variation of bridge length

Fig.3 Trapezoidal bridge

As shown in the above figure, the shape is changed while keeping the total square measure. I'm studying not only the effect by changing shape of bridge, but also the effect on spin development by changing the shape of petal. As with the method of changing bridge, the shape of petals will be changed while keeping the total square measure so that the conditions of the solar sail will not be changed. Figure 4 shows the shapes which is changed before and after.



b is variation of bridge length

Fig.4 before and after petal

The deployment of solar sail can be divided into tip mass separation, 1st and 2nd deployment. In the 1st deployment, solar sail is deployed quasi-statically as rotation guide is moved. But the deployment finishes like a shuriken shape because membranes have be restrained. After the 1st , 2nd deployment begins. He solar sail deploys dynamically by unlocking the membrane restraint by releasing the rotation guide.

The calculation results of 2nd deployment are as follows.

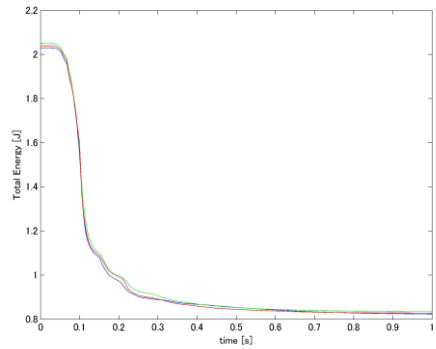


Fig.5 Total Energy

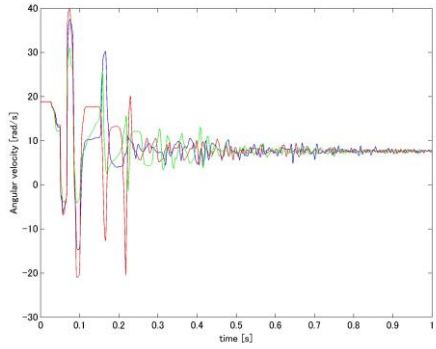


Fig.6 Angular velocity

The red, blue and green lines show the result of model 1, model 2, and model 3. The bridge shape of model 1 is rectangular, one of model 2 is trapezoid with long top side, one of model 3 is trapezoid with short top side.

From the results, There are little difference in total energy. However, in the angular velocity, there is the effect such as invention. Also, figure 2 is visualized images after 1 sec after the start of 2nd deployment. So, all models are considered to have been successfully deployment.

Research Destination

It is to find out the conditions of success or failure of solar sail deployment. Therefore, in order to see the max range that can be deploy and calculate even if changed, I continue the calculation with changing the degree of deformation. And I would like to provide feedback on future solar sail designs.