Seita Kataoka

Phone (room 323) : +81-47-469-5430
E-mail : csse15024@g.nihon-u.ac.jp

Miyazaki & Yamazaki Lab.
Space Structure Systems Laboratory

Education

Mar. 2015 Nihon University Fujisawa High School (Kanagawa/Japan)

Mar. 2019 Bachelor of Engineering in Aerospace Engineering,
College of Science and Technology, Nihon University (Chiba/Japan)

Mar. 2021 (expected) Master of Engineering in Aerospace Engineering,
Graduate School of Science and Technology, Nihon University (Chiba/Japan)

Qualifications

Aug. 2015 CATIA V5 Part Design Specialist
Aug. 2015 CATIA V5 Assembly Design Specialist
Oct. 2016 CATIA V5 Associate - Part Design
Oct. 2016 CATIA V5 Associate - Assembly Design
Oct. 2016 CATIA V5 Mechanical Designer Specialist

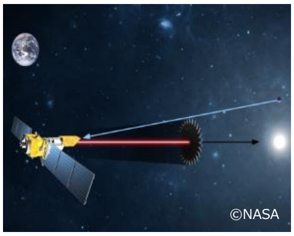
Research

"Deployment Characteristics of Self-Deployable Membrane Truss"

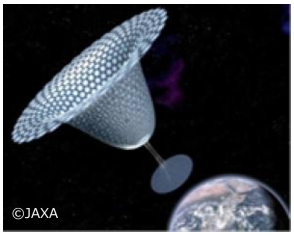
Background

In recent years, as missions have become more sophisticated and complex, space missions using large structures have been proposed and developed. However, at present, the only means of transport to space is rockets. Because of volume and weight, large space structures of 10 meter class to several kilometers class can not be transported as they are manufactured on the ground. Therefore, in order to store a large structure inside the fairing of a rocket, it is essential to apply extendible members, deployable structures, and modular structures. And many structural styles are being studied.

In our laboratory, we are aiming to realize Starshade for direct imaging of exoplanets, and SSPS (*Space Solar Power System*) for collecting solar energy in space and transmitting it to the ground. From the function requirements, the structure used for these is required to have a structure that satisfies the requirements for ① high rigidity, ② high accuracy of form, ③ large structure, and ④ Applicability to modular construction.



[Starshade]

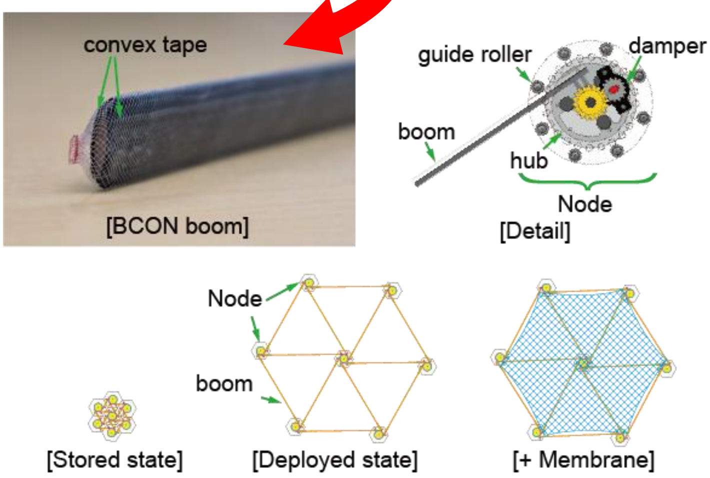


[SSPS]

[Main Extendible members & Deployable structures]

Structures		Extension/ Deployment mechanism	Packing rate	Stiffness	Weight	Accuracy of form	Long-term storability	Applicability to modular construction	Cost / Manufactura bility
Extensible bench		×	△	◎	○	◎	○	△	△
Deployable truss		×	×	◎	×	◎	○	○	×
Array paddle		△	×	◎	×	◎	○	△	△
Wrap-rib		○	×	○	○	○	△	△	○
Spin Deployment Membrane		○	◎	×	◎	×	△	×	×
Inflatable member + self-extendible member		△	△	○	○	○	×	×	△
Inflatable structure		×	◎	△	○	△	×	○	△
Self-Extendible member / Self-deployable structure	Twist type	○	◎	○	○	○	△	×	△
	Fold type	○	○	○	○	○	△	○	△
	Wind type	○	○	○	○	○	△	○	○

Self-Deployable Membrane Truss



[Self-Deployable Membrane Truss]

As shown in the figure to the upper left, it is a member called BCON (*Braid Coated Bi-cONvex tape*) boom, in which convex tapes are superimposed face to face at edge, wrapped in a braid, and has self-extension force by releasing strain energy generated when cylindrically wound. SDMT (*Self-Deployable Membrane Truss*), which deploys and extends a membrane by truss structure using a winding storage type self-extendible boom represented by BCON boom, has high specific rigidity and high packing rate. Furthermore, high accuracy of form and applicability to modular structures can be expected, so it can be applied to Starshade and SSPS. In addition, the main feature of SDMT is a simple deployment mode deployed by the self-extension force of the member, so no actuator is required for deployment. So the deployment structure that is the mission section becomes simple, probability considering cost is higher.

This structure deploys by the self-extension force of a boom, but if the extension force is large, impact on the member at deployment. If it is small, the structure will not overcome the frictional force and will not extend and even if it deploys it can lack the rigidity after deployment. Therefore, it is necessary to accurately model the actual phenomenon in the design of the self-deployable truss and to analyze deployment of the whole structure. Then, from analysis, we must design after organizing the failure mode and its occurrence condition.

Approach

As an analysis procedure in particular, perform development simulation by applying finite element method to each of a boom, a cylindrical hub for winding a boom, a guide roller for determining a extension direction of the boom, a Node for holding these, and a membrane which constitute SDMT. With regard to a boom, in order to accurately model the behaviour during extension, apply the ALE FEM (*Arbitrary Lagrangian-Eulerian Finite Element Method*) to it. In addition to this, by incorporating actual functions such as a damper to suppress boom extension speed and a latching mechanism that locks hub and Node to increase rigidity after deployment into the model, we aim for accurate analysis of deployment behaviour. After the analysis code is prepared, the development behaviour in space is simulated by microgravity experiment using an aircraft, and the validity of the code is evaluated.

Paper (co-author)

Momoko Fukunaga, Yasuyuki Miyazaki, Daiki Kousaka and **Seita Kataoka**, Condition for undetachment in Self-extending motion of tape-spring wrapped around cylinder, 62nd Space Sciences and Technology Conference, 2018