Momoko Fukunaga

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Education

Master of Engineering in Aerospace engineering Nihon University, Chiba, Japan	expected in March, 2019
Bachelor of Engineering in Aerospace engineering Nihon University, Chiba, Japan	March, 2017
Edogawa Girls' Senior High School, Tokyo, Japan	March, 2013

License

Amateur Third-Class Radio Operator October, 2014

Research and Development Experience

I participated in nano satellite "SPROUT Project" as the inflatable membrane structure group in 2013. The launch succeeded in May 2014, I carried out satellite operation, deployment experiment on orbit and experiment data processing. In 2015, as a posteriori experiment of SPROUT, deployment experiment of inflatable membrane structure was carried out by microgravity experiment using aircraft. From these activities, I am interested in the deployable structure, and in 2016 I began to research on deployable structure using self-extensible boom. In the same year, I conducted one conference presentation and succeed the deployment experiment of a self-deployable truss for satellite. The graduation thesis presented a theme entitled "Undetachment Condition of a Tape-Spring Wrapped Around a Hub" and acquired a bachelor's degree in engineering. After entering the graduate school, based on previous studies, I showed design method of self-deployable structure and have targeted improvement of deployment reliability. In Master's 1st year, I conducted three conference presentations. In addition, we succeeded in deploy a 30m class self-deployable truss designed based on my research, and have demonstrated the feasibility of a self-deployable structure. Currently, I am aiming to demonstrate the feasibility of the large gossamer space structure using a self-deployable structure and to apply it to a space structure that has not yet been realized.

Presentations

[1] Momoko Fukunaga, Yasuyuki Miyazaki, Structural Characteristics of Self-Extensible Boom, 2018 AIAA Spacecraft Structures Conference, AIAA Scitech Forum, AIAA 2018-0451, pp.1-10, 8-12 January 2018, Kissimmee, Florida, USA, DOI: https://doi.org/10.2514/6.2018-1201. (Oral)

[2] Yasuyuki Miyazaki, Momoko Fukunaga, Daiki Kousaka, Membrane Structure Supported by Self-Deployable Truss for Space Applications, 2018 AIAA Spacecraft Structure Conference, AIAA Scitech Forum, AIAA 2018-1201, pp.1-13, 8-12 January 2018, Kissimmee, Florida, USA, DOI: https://doi.org/10.2514/6.2018-1201. (Oral)

[3] Momoko Fukunaga, Yasuyuki Miyazaki, Improvement of Deployment Behavior of Self-Deployable Truss, The 61st Proceedings of the Space Sciences and Technology Conference, JSASS-2017-4701, pp.1-6, 25-27 October 2017, Toki Messe, Niigata, Japan. (Poster)

[4] Momoko Fukunaga, Yasuyuki Miyazaki, Structural Characteristics of BCON Truss, 2017-c23, 3-9 June 2017, pp.1-8, Himegin Hall, Matsuyama, Ehime, Japan, online: http://archive.ists.or.jp/upload_pdf/2017-c-23.pdf. (Oral)

[5] Momoko Fukunaga, Yasuyuki Miyazaki, Detachment Condition of a Tape-Spring Wrapped Around a Hub, The 25th Space Engineering Conference, 1B5, pp.1-7, 21-22 December 2016, Yamaguchi, Japan. (Oral)

Awards

[1] Daiki Kousaka, Daishi Kawarabayashi, Momoko Fukunaga, 2nd Debris Mitigation Competition, First Place, University of Rome, Rome, Italy, December 4, 2017.

[2] Momoko Fukunaga, Yasuyuki Miyazaki, The 61st 61st Proceedings of the Space Sciences and Technology Conference, The Japan Society for Aeronautical and Space Sciences Excellence Presentation Award, Toki Messe, Niigata, Japan, 26 October 2017.

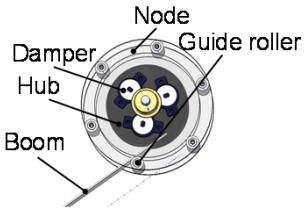
[3] Momoko Fukunaga, The Japan Society for Aeronautical and Space Sciences Student Award, 25 March 2017.

[4] Momoko Fukunaga, College of Science and Technology Nihon University Academic Dean's Award, 14 March 2016.

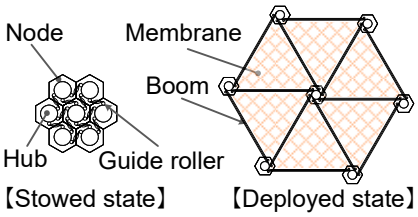
Research Content

My research theme is "Design method of Large Gossamer Space Structure Using Self-Deployable Structure". Demand for space structure has diversified with the advancement of mission in recent years. Therefore, the structure itself has become characteristic. In particular, it is required to have four features: (1) Large & ultra lightweight structure, (2) Large & lightweight deployment structure, (3) Ultra large structure, and (4) Large & ultra high accuracy structure. In this laboratory, we have been conducting research on a simple structure using a self-extensible boom that does not require an actuator. This is exactly suitable for (2). The self-deployable structure using this boom is expected to be applied to an actual space structure from the viewpoint of high lightweight / specific rigidity and high deployability / storage efficiency. I think that it is a very useful structure because it is possible to realize a (3)Ultra large structure by combining these structures into a module structure.

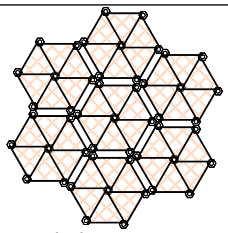
Research subjects	Characteristics	Application example
(1) Large & ultra lightweight structure	Ultra lightweight / large area deployable structure. Supported by struts etc.	Solar sail etc.
(2) Large & lightweight deployment structure	Maintain autonomous shape against orbital disturbance.	Starshade etc.
(3) Ultra large structure	With a ultra large structure, it can autonomously maintain shape.	SSPS etc.
(4) Large & ultra high accuracy structure	High shape accuracy and relative position accuracy requirement are satisfied.	Astronomical antenna etc.



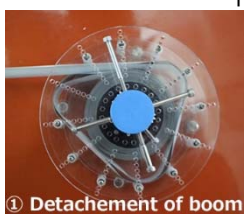
【Inside the node】

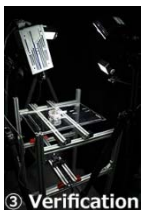


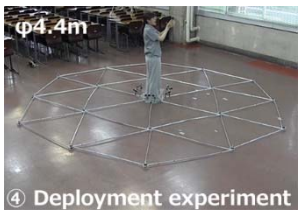
【Self-deployable structure】


【Modular structure】

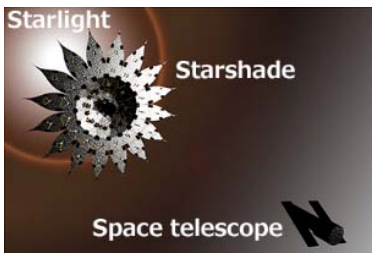
The self-deployable structure is advantageous in that the deployment method is very simple. However, the design method has not been established so far, and design and development with try & error has been carried out. I thought that there are many disadvantages because the deploy reliability is low and development cost is high with respect to the current design method. Therefore, in my previous studies, I have been understanding the structural characteristics of self-extensible members, presenting a structure form that is superior in deployability and storage efficiency, and clarifying the problems that arise during deployment. Then, by clarifying the design method of the self-deployable truss structure, its usefulness was shown.







In future, I would like to show the feasibility of the large gossamer space structure using the self-deployable trusses we have proposed so far. Structures such as a few tens of meters of star shades and large scale thin film solar cell arrays of several tens of meters, which are large in size and requiring shape maintaining accuracy, have not yet been realized, but I believe it is possible to realize by using a self-deployable truss. However, it is not clear whether the self-deployable structure can be deployed in outer space or can be designed according to the space mission. Therefore, we design a model in which the structural elements of the self-deployable structure that operate under space environment: (1) a rotationally free hub, (2) a node, (3) a self-extensible boom, (4) a membrane, and (5) a holding and releasing mechanism. And, the validity of the design is evaluated by experiment and analysis. At that time, the experimental model simulates a starshade and also evaluates whether it can design according to the space mission. From the above, I aim to realize large space structures that have not been realized worldwide by a simple and low-resource self-deployable structure.



【Starshade】