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Experiments on Stability of A Spin-axis Extension Mast and Technology of Improving Micro Gravity Environment

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8. Summary of Research
Large space deployable structures with lightweight, high storage rate, high reliability and low cost can expand various possibilities of space utilization. Space Inflatable structure is an expected deployment method to enhance such deployable structural performances and being studied by space development agencies worldwide for the purpose of its practical use. One of critical issues to be addressed to realize the practical space inflatable structure is how to control the movement during its deployment or extension and how to harden the structure and maintain the accuracy of shape for a long term after extended. To resolve this issue, two types of inflatable structure have been developed by making use of structural rigidizing method. One is to keep stiffness of the structure consistently during and after the extension by the shape recovery of open section tubular member that is called SPINAR (Space Inflatable Actuated Rod to keep here in after). The other is to store the tube made of aluminum/PET laminate material into pentalpha folding to ensure straight-ahead movement during the extension and to be
rigidized by work-hardening of structural material after the extension. With those two individual methods, experimental model were developed and evaluated through extension test under the low-gravity environment using the plane, Gulfstream-II in this study. SPINAR is a prominent candidate as an extension structure which is extendible along the spin axis as a sensor installed in the radio and plasma investigation satellite for a scientific mission under consideration in ISAS/JAXA. To simulate the condition of installation on the satellite through this low-gravity experiment on the plane, SPINAR was mounted on a spin table and then extended by around 2.3m when it spins. On the real satellite, however, SPINAR can be extended by 5m along the spin axis to upward and downward of the satellite which spins with 20rpm. Due to the experimental area restrictions on the plane (Gulfstream-II), SPINAR experimental model was extended by 2.3m and the spin rate was set to 125rpm as maximum to provide an equivalent dynamic condition. It made the loading condition due to the centrifugal force harder. Despite that, it was confirmed that SPINAR was extended successfully and stably, the inflatable structure using this SPINAR solution is practical and also the feasibility of adopting this solution for the radio and plasma sensor is high.

In the meantime, extendible mast stowed in the pentalpha folding has proved that it is superior to the hexagonal folding in terms of straight-ahead movement. It also showed that pentalpha folding with appropriately selected parameters provides the enhancer performance of straight-ahead deployment. In addition, it’s been confirmed that work-hardening is effective to maintain stiffness after depressurization.

Meanwhile, in the experiment of this SPINAR experimental model, a semi-active controlled damper system using electro rheological fluid (ERF) damper was applied. This ERF damper system can reduce the low-gravity level on the plane, which is more than 1000 times of microgravity level on the real satellite, for improving the experimental environment of SPINAR. As this vibration damping experiment is one of objectives of this study and has been conducted, the results has shown that ERF damper can perform sufficient reduction of G-jitter during the parabolic flight and this technology is effective to develop a practical, highly performing and safe damper to improve the microgravity experimental environment.

9. Publication List

10. URL
http://www.wel.co.jp