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花柄ディンプルと曲線折りで金属製多面体を展開する月面ベースキャンプ

Lunar Base Camp Composed of Metal Polyhedron Derived from Sakura Dimples and Curved Crease

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1. Minimal setup of a lunar base camp

The lunar pole is a suitable site for the photovoltaic system due to its sunny spot, while the lava tube in the pit is considered a favorable site due to its protected environment. The minimal setup of the base camp was presented by J. Sato et al.[1,2]. As shown in Figure 1 and Figure 2, the habitation module and related infrastructure equipped with simultaneous and semi-passive deployment mechanisms for its primary structures are composed as a minimum.

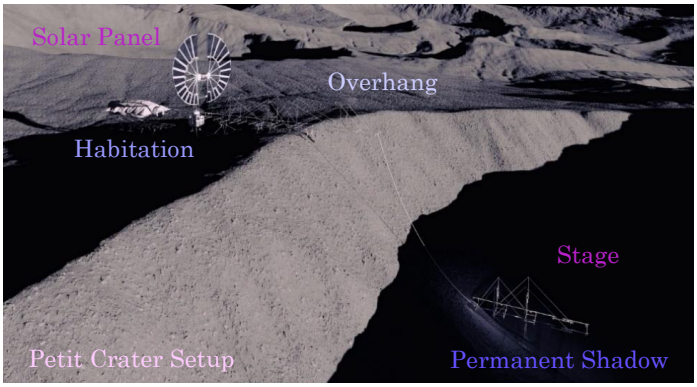

Figure 1. Base camp setup on the lunar pole.

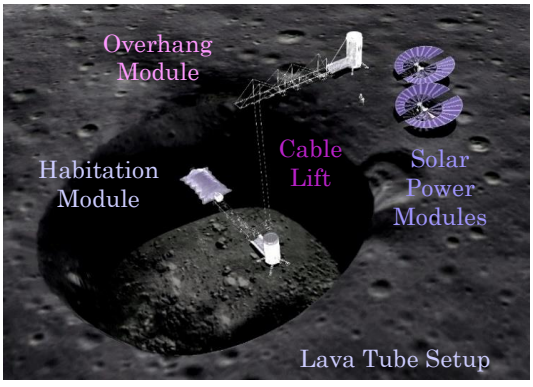

Figure 2. Base camp setup in the lava tube[1,2].

Once the metal polyhedral envelope of the habitation module (Figure 3) inflates owing to the internal air pressure, the embedded floor expands inside the envelope simultaneously, while adjustable legs are ejected and touchdown on bumpy terrain. The multi-faceted pillow shape is made of aluminum plate for which Sakura dimples and curved crease allow for easy snap-through. The solar power module has fanning panels that deploy in reference to the hind wing of an earwig[3]. An overhang suspends a cable lift from its cantilever.

To suppose a single transportation for the site on the lunar pole, these modules are composed into all-in-one setup (Figure 4). In the beginning phase of the crewed exploration, two crews are supposed to stay one to four weeks in this habitation module.

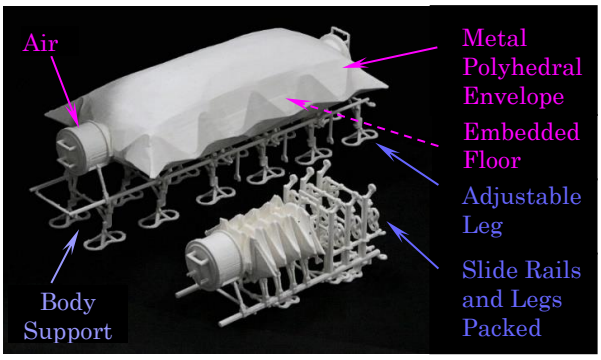

Figure 3. Composition of the habitation module.

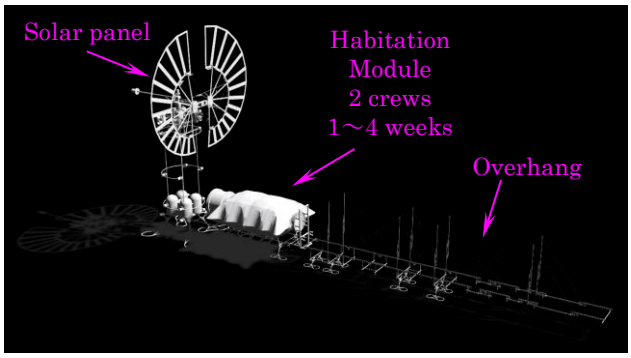

Figure 4. All-in-one setup.

2. Inflatable metal polyhedron

The pillow-shaped envelope is made of high tensile aluminum alloy A7178-T6, with a thickness of 1mm, a width of 7m, and a length of 9m. Using aluminum alloy, the fastener between the envelope and other elements such as air lock becomes easier than using membrane materials.

The deployment test (Figure 5) using a mock-up with a scale of 1:10 shows performances of the Sakura dimples (Figure 6) and the curved crease (Figure 7), both of which enable the envelope to snap through readily.

Figure 5. Deployment test, Scale=1:10.

Figure 6. Sakura dimples.

Figure 7. Full scale mock-up of the partial polyhedron.

References

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3) K. Saito, R. P. Fuente, K. Arimoto, Y. Seong, H. Aonuma, R. Niiyama, Z. You: Earwig fan designing: Biomimetic and evolutionary biology applications. The National Academy of Science (2020), 117(30), pp.17622-17626.