Mechanics/Machinery

Lexan Linear Shaped Charge Holder With Magnets and Backing Plate

Lyndon B. Johnson Space Center, Houston, Texas

A method was developed for cutting a fabric structural member in an inflatable module, without damaging the internal structure of the module, using linear shaped charge. Lexan and magnets are used in a charge holder to precisely position the linear shaped charge over the desired cut area. Two types of charge holders have been designed, each with its own backing plate. One holder cuts fabric straps in the vertical configuration, and the other charge holder cuts fabric straps in the horizontal configuration.

This work was done by Matthew W. Maples, Maureen L. Dutton, Scott C. Hacker, and Richard J. Dean of Johnson Space Center; Nicholas Kidd and Chris Long of Jacobs Technology; and Robert C. Hicks of Barrios Technology. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24529-1

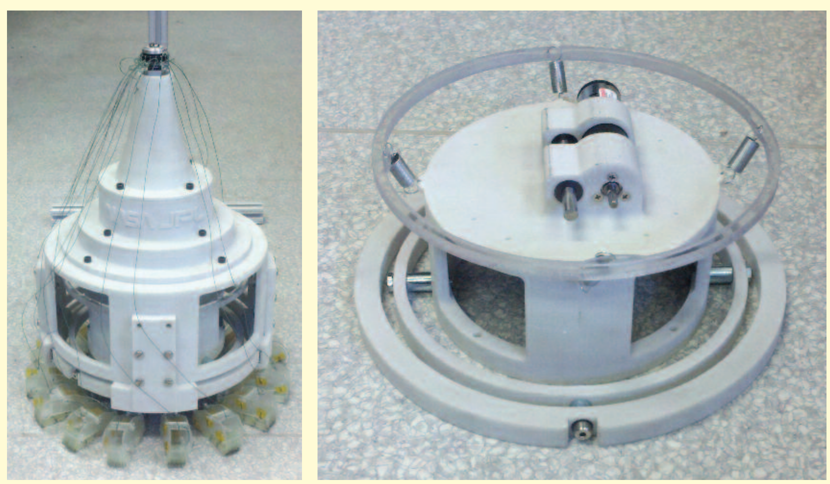
Robotic Ankle for Omnidirectional Rock Anchors

This mechanism could provide mobility for military robots on vertical cliff faces or on ceilings.

NASA's Jet Propulsion Laboratory, Pasadena, California

Future robotic exploration of near-Earth asteroids and the vertical and inverted rock walls of lava caves and cliff faces on Mars and other planetary bodies would require a method of gripping their rocky surfaces to allow mobility without gravitational assistance. In order to successfully navigate this terrain and drill for samples, the grippers must be able to produce anchoring forces in excess of 100 N. Additionally, the grippers must be able to support the inertial forces of a moving robot, as well gravitational forces for demonstrations on Earth. One possible solution would be to use microspine arrays to anchor to rock surfaces and provide the necessary load-bearing abilities for robotic exploration of asteroids.

Microspine arrays comprise dozens of small steel hooks supported on individual suspensions. When these arrays are dragged along a rock surface, the steel hooks engage with asperities and holes on the surface. The suspensions allow for individual hooks to engage with asperities while the remaining hooks continue to drag along the surface. This ensures that the maximum possible number of hooks engage with the surface, thereby increasing the load-bearing abilities of the gripper. Using the microspine array grippers described above as the end-effectors of a robot would allow it to traverse terrain previously unreachable by traditional wheeled robots. Furthermore, microspine-gripping robots that can perch on cliffs or rocky walls could enable a new class of persistent surveillance devices for military applications.



The **Ankle Mechanism** (left), and the interior of the ankle (right), showing the gimbal systems, springs, and actuation device for the engagement wires.

In order to interface these microspine grippers with a legged robot, an ankle is needed that can robotically actuate the gripper, as well as allow it to conform to the large-scale irregularities in the rock. The anchor serves three main purposes: deploy and release the anchor, conform to roughness or misalignment with the surface, and cancel out any moments about the anchor that could cause unintentional detachment.

The ankle design contains a rotary DC motor that can drag the microspine arrays across the surface to engage them with asperities, as well as a linear actuator to disengage the hooks from the surface. Additionally, the ankle allows the gripper to rotate freely about all three axes so that when the robot takes a step, the gripper may optimally orient itself with respect to the wall or ground. Finally, the ankle contains some minimal elasticity, so that between steps, the gripper returns to a default position that is roughly parallel to the wall.

In order to give the ankle freedom to rotate about all three degrees of freedom, the gripper is mounted on a series of gimbals similar to those found on a gyroscope. The rotation of the gimbals about radial directions is limited by springs, which bring the gripper back to a default position in between steps of the robot. These springs have a relatively low spring-constant so as not to induce large torques that may upset the gripper's hold on the rock. Additionally, microspine engagement is achieved through a motor that turns a spool and pulls on cables connected to the spine arrays. A linear actuator that pulls the microspines up and away from the rock face provides disengagement. Previous microspine robots have been limited by their feet, which only sustain forces in one direction and only work on globally smooth surfaces like brick walls and concrete. The omnidirectional anchors extend the potential of legged robots using microspines to natural rock, and would allow gripping at any orientation including inverted or in zero gravity.

This work was done by Aaron Parness, Matthew A. Frost, and Nitish Thatte of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-48315 volume and number of this NASA Tech Briefs *issue, and the page number.*

Wind, Wave, and Tidal Energy Without Power Conditioning

NASA's Jet Propulsion Laboratory, Pasadena, California

Most present wind, wave, and tidal energy systems require expensive power conditioning systems that reduce overall efficiency. This new design eliminates power conditioning all, or nearly all, of the time.

Wind, wave, and tidal energy systems can transmit their energy to pumps that send high-pressure fluid to a central power production area. The central power production area can consist of a series of hydraulic generators. The hydraulic generators can be variable displacement generators such that the RPM, and thus the voltage, remains constant, eliminating the need for further power conditioning.

A series of wind blades is attached to a series of radial piston pumps, which pump fluid to a series of axial piston motors attached to generators. As the wind is reduced, the amount of energy is reduced, and the number of active hydraulic generators can be reduced to maintain a nearly constant RPM. If the axial piston motors have variable displacement, an exact RPM can be maintained for all, or nearly all, wind speeds. Analyses have been performed that show over 20% performance improvements with this technique over conventional wind turbines.

This work was done by Jack A. Jones of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48620

An Active Heater Control Concept to Meet IXO Type Mirror Module Thermal-Structural Distortion Requirement

This innovation offers a number of advantages in terms of reduced mass, problem of routing, and the risk of x-ray attenuation.

Goddard Space Flight Center, Greenbelt, Maryland

Flight mirror assemblies (FMAs) of large telescopes, such as the International X-ray Observatory (IXO), have very stringent thermal-structural distortion requirements. The spatial temperature gradient requirement within a FMA could be as small as 0.05 °C. Conventionally, heaters and thermistors are attached to the stray light baffle (SLB), and centralized heater controllers (i.e., heater controller boards located in a large electronics box) are used. Due to the large number of heater harnesses, accommodating and routing them is extremely difficult. The total harness length/mass is very large. This innovation uses a thermally conductive pre-collimator to accommodate heaters and a distributed heater controller approach. It minimizes the harness length and mass, and reduces the problem of routing and accommodating them.

Heaters and thermistors are attached to a short (4.67 cm) aluminum portion of the pre-collimator, which is thermally coupled to the SLB. Heaters, which have a very small heater power density, and thermistors are attached to the exterior of all the mirror module walls. The major portion (23.4 cm) of the pre-collimator for the middle and outer modules is made of thin, non-conductive material. It minimizes the view factors from the FMA and heated portion of the pre-collimator to space. It also minimizes heat conduction from one end of the FMA to the other. Small and multi-channel heater controllers, which have adjustable set points and internal redundancy, are used. They are mounted to the mechanical support structure members adjacent to each module.

The IXO FMA, which is 3.3 m in diameter, is an example of a large telescope. If the heater controller boards are centralized, routing and accommodating heater harnesses is extremely dif-