Robotic Ankle for Omnidirectional Rock Anchors

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

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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.

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 ankle 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...
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.

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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 thermists 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 thermists 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 thermists are attached to the exterior of all the mirror module walls. The major portion (25.4 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-