

# Spherically Actuated Motor

## Project Manager(s)/Lead(s)

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## Sponsoring Program(s)

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Space Technology Mission Directorate  
Center Innovation Fund

## Project Description

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A three degree of freedom (DOF) spherical actuator is proposed that will replace functions requiring three single DOF actuators in robotic manipulators providing space and weight savings while reducing the overall failure rate.

Exploration satellites, Space Station payload manipulators, and rovers requiring pan, tilt, and rotate movements need an actuator for each function. Not only does each actuator introduce additional failure modes and require bulky mechanical gimbals, each contains many moving parts, decreasing mean time to failure. A conventional robotic manipulator is shown in figure 1. Spherical motors perform all three actuation functions, i.e., three DOF, with only one moving part. Given a standard three actuator system whose actuators have a given failure rate compared to a spherical motor with an equal failure rate, the three actuator system is three times as likely to fail over the latter. The Jet Propulsion Laboratory reliability studies of NASA robotic spacecraft have shown that mechanical hardware/mechanism failures are more frequent and more likely to significantly affect mission success than are electronic failures. Unfortunately, previously designed spherical motors have been unable to provide the performance needed by space missions. This inadequacy is also why they are unavailable commercially. An improved patentable spherically actuated motor (SAM) is proposed to provide the performance and versatility required by NASA missions.

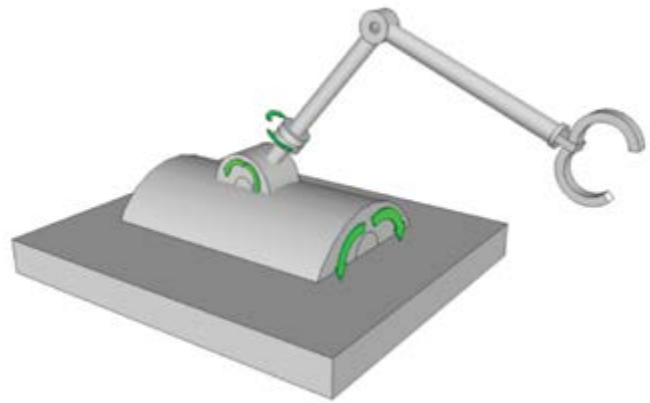


Figure 1: Conventional robotic manipulator.

### *Anticipated Benefits*

Using SAM instead of conventional actuators in robotic manipulators would have the following benefits: Reduced failure rates and maintenance costs, longer service life, lower mass, and reduced volume.

### *Potential Applications*

The proposed spherical motor has properties making it useful for a rolling/walking rover. In normal mode (fig. 2), the rover would turn its wheels to accomplish exploration missions as always. If difficult terrain or sandy soil is encountered and wheels rendered useless, the walking property of SAM (fig. 3) can be used to traverse the area. This innovation will add new versatility to NASA robotic missions.

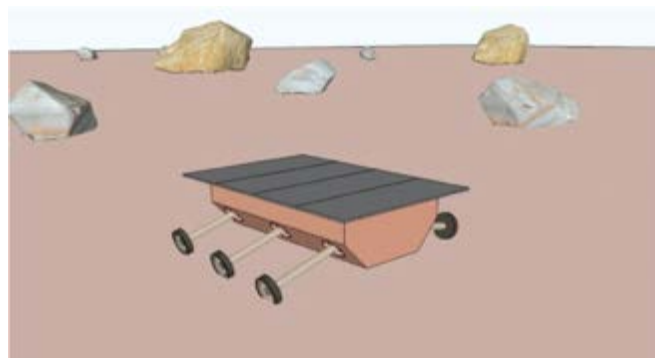
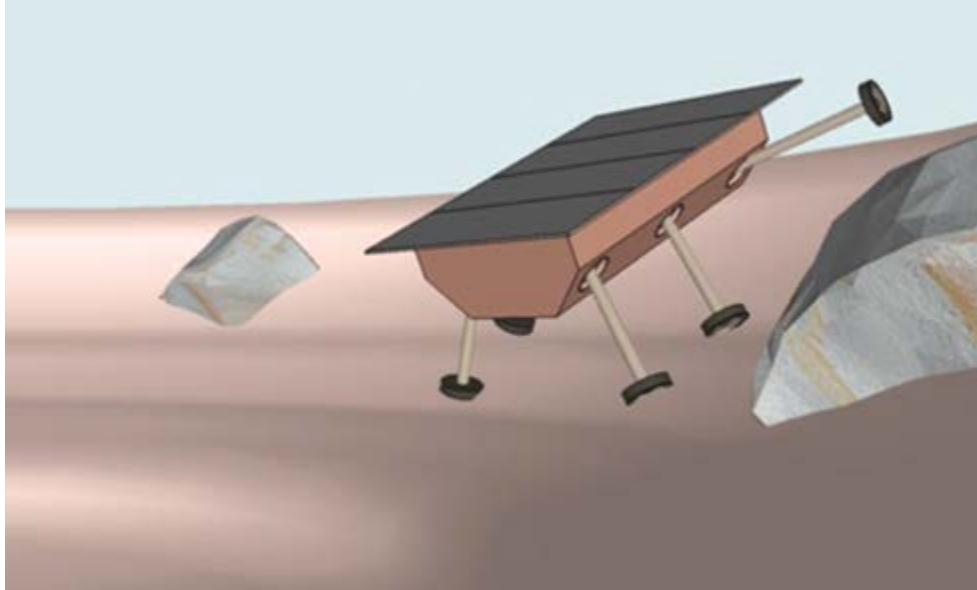


Figure 2: Exploration rover in normal mode.



**Figure 3: Exploration rover in walking mode.**

There are many other uses in spaceflight. Spherical motors can be the basis for robotic manipulators in landers and sample return missions. Satellites and probes could use them to point instruments or high gain antennas. The International Space Station could use it in robotic manipulator arms to move payloads, make repairs, or even to point sensors or cameras in payload experiments. Having only one moving part gives the spherical motor an extended service life, making it ideal for long-duration missions. Since the cost for space access is measured by the pound, weight savings offered by this design over traditional multi-actuator design merit significant project savings.

In the commercial sector, applications in human prosthetics and exoskeletal suits could give wounded soldiers, the elderly, and the disabled new mobility, enhancing their quality of life.

Factory assembly line robots could also benefit from the use of simpler robotic actuators, thus lowering production costs.

## **Notable Accomplishments**

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The 3D model of SAM has been completed and printed. One prototype SAM has been built, validating the proposed unique manufacturing technique.