

MATERIALS AND STRUCTURES SYMPOSIUM (C2)  
Space Vehicles – Mechanical/Thermal/Fluidic Systems (7)

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THE BUILDING BLOCK OF SMALL SPACE MECHANISMS AND ROBOTS - A MICRO ACTUATOR  
WITH HIGH TORQUE/WEIGHT RATIO

**Abstract**

A space actuator is a spacecraft component responsible for rotating payloads at specified speed and precision. It normally consists of motor, gear, bearing, angular sensor, and structural parts, etc. It is a core component of many space mechanisms, including solar array drive assembly, antenna pointing mechanism, laser communication mechanism, and electrical thruster pointing mechanism. It is also an important building block of the rotary joints of robotic arms onboard space stations and extraterrestrial rovers. The main specifications of space actuators include driving & holding torquer, rotational precision, power consumption, weight, size, and lifespan. Many specifications restrict each other. For instance, large torque is usually accompanied by high weight and high power consumption. In recent years, micro-satellites have gone through a rapid development. Mars mission has become a hot spot. These missions pose more challenging requirements for the next-generation actuators compared with their predecessors, such as larger driving torque, lower weight, smaller size, longer lifespan, and higher robustness under space environment. In response to these requirements, Beijing Institute of Control Engineering developed a micro-actuator which features: 1) A high power/weight ratio ultrasonic motor cooperating with a micro-harmonic drive to provide large driving torque and unpowered holding capability (the driving torque/weight ratio is over 30Nm/kg, and the holding torque/weight ratio is over 50Nm/kg); 2) Dual angular sensors to provide desired measurement precision and backup; 3) Rotary seal against mars dust; 4) Optimized lubrication to reduce the wear of rotary parts such as gears and bearings, and to increase the lifespan under space environment. The design, simulation, and the development process are summarized in this paper.