



Robotics, Automation and Control

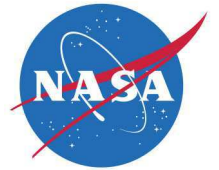
Regolith Advanced Surface Systems Operations Robot (RASSOR) Excavator

Unique Robot Excavates In Space And On Earth

The National Aeronautics and Space Administration (NASA) seeks partners interested in the commercial application of the Regolith Advanced Surface Systems Operations Robot (RASSOR) Excavator. NASA's Kennedy Space Center is soliciting licensees for this innovative technology.

RASSOR is a teleoperated mobile robotic platform with a unique space regolith excavation capability. Its design incorporates net-zero reaction force, thus allowing it to load, haul, and dump space regolith under extremely low gravity conditions with high reliability. With space transportation costs hovering at approximately \$4,000 per pound and tight launch vehicle shroud constraints, this compact, lightweight unit enables the launch of an efficient, rugged, versatile robotic excavator on precursor landing missions with minimum cost. RASSOR could also be scaled up and used for terrestrial mining operations in difficult-to-reach or dangerous locations.

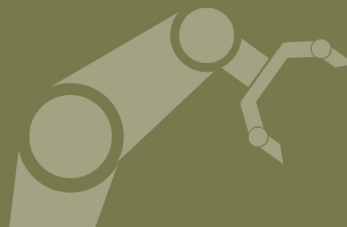
National Aeronautics and
Space Administration



BENEFITS

- ➔ **Weight/Space Efficient** - Lightweight materials and foldable design reduce launch weight and payload dimensions
- ➔ **Low-Gravity-Capable** - Design provides near-zero horizontal and minimal vertical net reaction force, enabling operation in extremely low gravity conditions.
- ➔ **Versatile** - Platform can traverse steep slopes and rough terrain, and reversible design allows continued operation even if unit is overturned. Wireless control, telemetry, and onboard cameras provide teleoperation and situational awareness.
- ➔ **Dependable** - Minimalist design approach reduces complexity and parts count for higher platform reliability and maintainability. Design also incorporates a high strength-of-materials safety factor.
- ➔ **Scalable** - Platform design can be scaled up or down to meet project requirements. Smaller sizes are suitable for space missions; larger designs could be used for terrestrial mining in hazardous or hard-to-reach locations.

technology solution



THE TECHNOLOGY

Regolith excavation is desired in future space missions for the purpose of In Situ Resource Utilization (ISRU) to make local commodities, such as propellants and breathing air, and to pursue construction operations. The excavation of regolith on another planetary body surface, such as the Moon, Mars, an asteroid, or a comet is extremely difficult because of the high bulk density of regolith at lower depths. Additionally, because of the low gravity in these space surface environments, the mass of the excavator vehicle does not provide enough reaction force to enable the excavation blade to penetrate the regolith if traditional terrestrial methods are used.

RASSOR uses counterrotating bucket drums on opposing arms to provide near-zero horizontal and minimal vertical net reaction force so that excavation is not reliant on the traction or weight of the mobility system to provide a reaction force to counteract the excavation force in low-gravity environments. The excavator can traverse steep slopes and rough terrain, and its symmetrical design enables it to operate in reverse so that it can recover from overturning by continuing to dig in the new orientation. The system is capable of standing up in a vertical position to dump into a receiving hopper without using a ramp. This eliminates the need for an onboard dump bin, thus reducing complexity and weight.

During loading, the bucket drums excavate soil/regolith by scoops mounted on the drums exteriors that sequentially take multiple cuts of soil/regolith while rotating at approximately 20 revolutions per minute. During hauling, the bucket drums are raised by rotating the arms to provide clearance above the surface being excavated. The mobility platform can then travel while the soil/regolith remains in the raised bucket drums. When the excavator reaches the dump location, the bucket drums are commanded to reverse their direction of rotation, which causes soil/regolith to be expelled out of each successive scoop. RASSOR has wireless control, telemetry, and onboard transmitting cameras, allowing for teleoperation with situational awareness. The unit can be programmed to operate autonomously for selected tasks.



RASSOR 2.0 In Swamp Works Regolith Bin

APPLICATIONS

The technology has several potential applications:

- Extraterrestrial In Situ Resource Utilization (ISRU)
- Extraterrestrial Construction Operations
- Space Mining of Regolith and Water Ice
- Robotic Terrestrial Mining Operations
- Autonomous and Teleoperated Sand Mining

PUBLICATIONS

Patent No: 9,027,265

IEEE Big Sky 2013, Regolith Advanced Surface Systems Operations Robot (RASSOR), 03/02/2013

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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