**RASSOR, the reduced gravity excavator.** J. M. Schuler[1], J. D. Smith[2], R. P. Mueller[3], and A. J. Nick[4], [1,2,3] NASA, Kennedy Space Center (Mail Stop: UB-R1, Kennedy Space Center, FL 32899, [1]jason.m.schuler@nasa.gov, [2]jonathan.d.smith@nasa.gov, [3]rob.mueller@nasa.gov), [4] Bionetics, Kennedy Space Center (Mail Stop: LASSO-001, Kennedy Space Center, FL 32899, andrew.j.nick@nasa.gov)

**Introduction:** Lunar regolith is full of resources that can enable a sustained human presence on the moon. Oxygen can be found in abundance and can be used for breathing air and rocket propellant. The regolith can be used as an in-situ building material for constructing infrastructure. Metals can be extracted and used to produce spare parts.

But before we can use this valuable regolith we need to excavate it. An excavator will need to be low mass to meet launch and landing payload requirements and it will operate in a 1/6G environment. The challenge is this: how can we generate enough reaction force to excavate regolith with such a lightweight vehicle? One solution is the Regolith Advanced Surface Systems Operations Robot (RASSOR); a robotic mining vehicle designed to operate in low-gravity environments.

**Capabilities:** RASSOR utilizes digging tools called bucket drums that have small staggered scoops around a central hollow cylinder. The scoops direct the regolith into the bucket drum and through a series of baffles. The baffles ensure that the regolith is trapped inside the drum as long as the direction of rotation is maintained. The regolith can then be transported to the appropriate site and then dumped by simply reversing the direction of rotation of the drums.

The bucket drums reduce excavation forces because of their small scoops however this isn't enough. To ensure that the vehicle's weight is not the main source of reaction force, RASSOR uses two sets of bucket drums that dig in opposing directions. The primary excavation forces from these drums cancel out enabling this small excavator to collect significant amounts of regolith.

Additionally, the bucket drums on RASSOR are positioned at the ends of actuated arms to precisely control the digging depth while driving over uneven terrain. These arms happen to also provide RASSOR with unique mobility capabilities. RASSOR's configuration allows it to right itself if flipped onto its back or side, stand-up to reach into tall hoppers, climb obstacles up to 75cm (29.5in) tall, and use the bucket drums as a second set of wheels for contingency operations.

**Technical Information:** The following table provides key technical parameters for the latest generation of RASSOR (TRL 4) built at Kennedy Space Center:

**Table 1. Key Technical Parameters**

| | | |
|---|---|---|
| Power source | Li-ion battery | |
| Battery capacity | 1410 | Whr |
| Max driving slope | 20 | deg |
| Max obstacle height | 75 | cm |
| Regolith delivered/trip | 90 | kg |
| Max speed | 49 | cm/s |
| Trips/charge (100m) | 20 | Trips |
| Dry Mass | 67 | kg |
| Energy/Delivered Regolith | 0.761 | Whr/kg |

**Figure 1. RASSOR excavating a slot trench in BP-1**

**Figure 2. Traversing max obstacle**

**Next Steps:** Future work to increase the TRL of RASSOR will include: thermal management system development, flight-like material selection, thermal-vacuum testing, design lifetime considerations.