Quarry-Bot: A Mobile Cable-Suspended Robot for Lunar Excavation

Zahir Castrejon, Nathan Kassai, Francis Palustre, Thomas McNulty and Dr. Paul Oh

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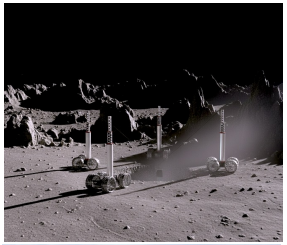
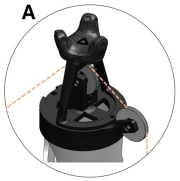
Motivation:

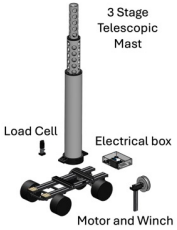
- Support NASA Artemis Space Program
- Heavy machinery infeasible on Moon
- ISRU
- Prepare lunar terrain using Drag-Line Approach
- System deploys by reconfigurable mobile bases
- Soil drag disrupts cable tensions

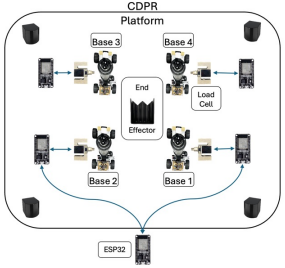


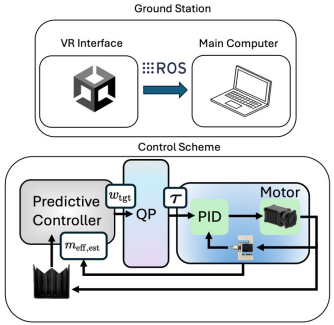
Design Intent

- 4 mobile bases with telescopic masts
- ESP-32 mesh via ESP-NOW protocol
- ROS 1 Noetic ground-station control
- Tension Monitoring via: Heemab S-type load cells
- Dynamixel spools + galvanized steel cables



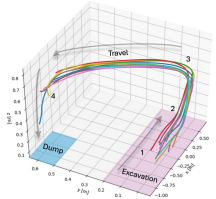


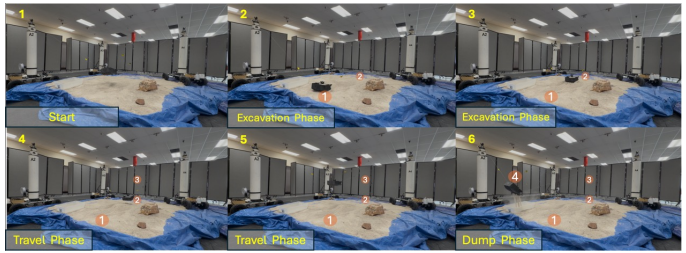




Methods/Analysis

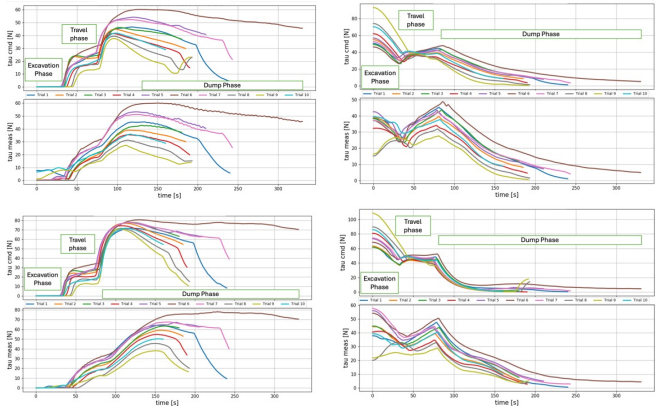
- MPC parameterized by real-time mass
- 200 N horizontal drag compensation force
- No prior payload knowledge required
- Torque equilibrium sets scoop dump angle





Results/ Future Work

- 10 indoor cycles, 2 m excavation distance
- 2.12 kg average collected per scoop
- 8–23% mass estimation error range
- Outdoor trial field deployment
- 31.8 kg/hr material handling throughput
- Future Work: Expansion of workspace with Mobile Bases



Acknowledgments

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