NASA Lunabotics Challenge 22-23

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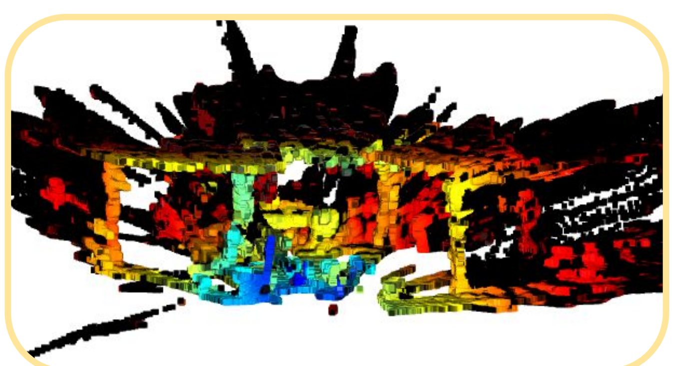
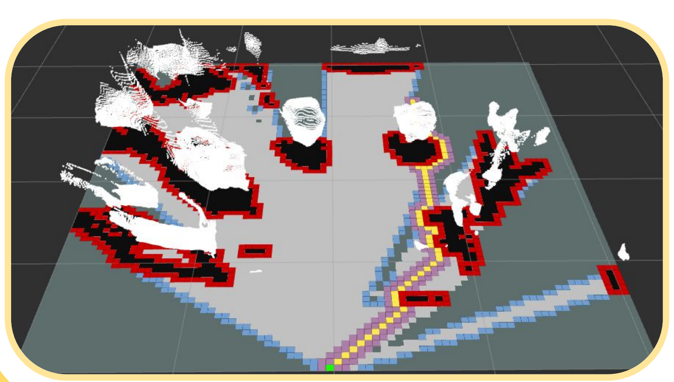
Abstract

The goal of the 22-23 Lunabotics team was to improve mechanical subsystems previously implemented, including the excavation and collection/deposit systems, and make the robot fully autonomous in navigation and task performance.

Autonomous Navigation

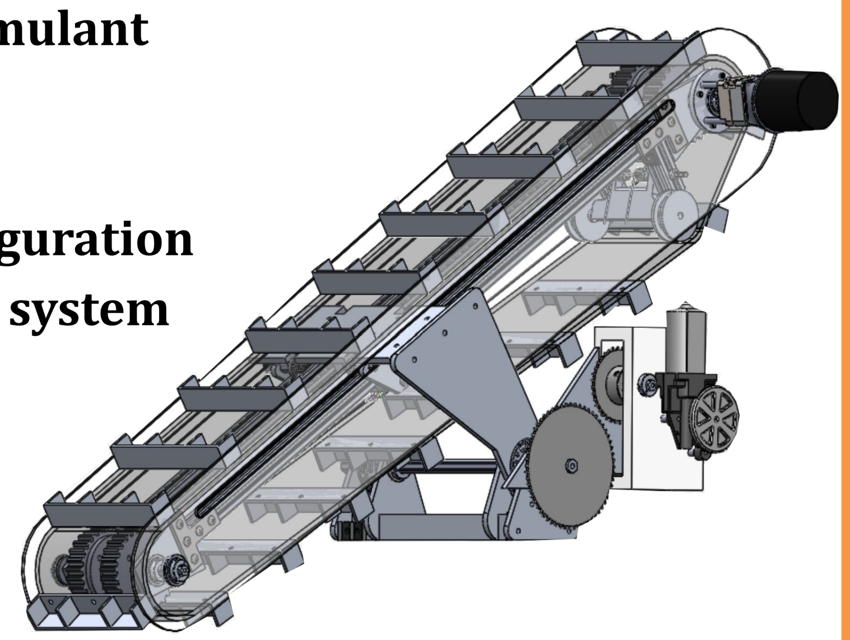


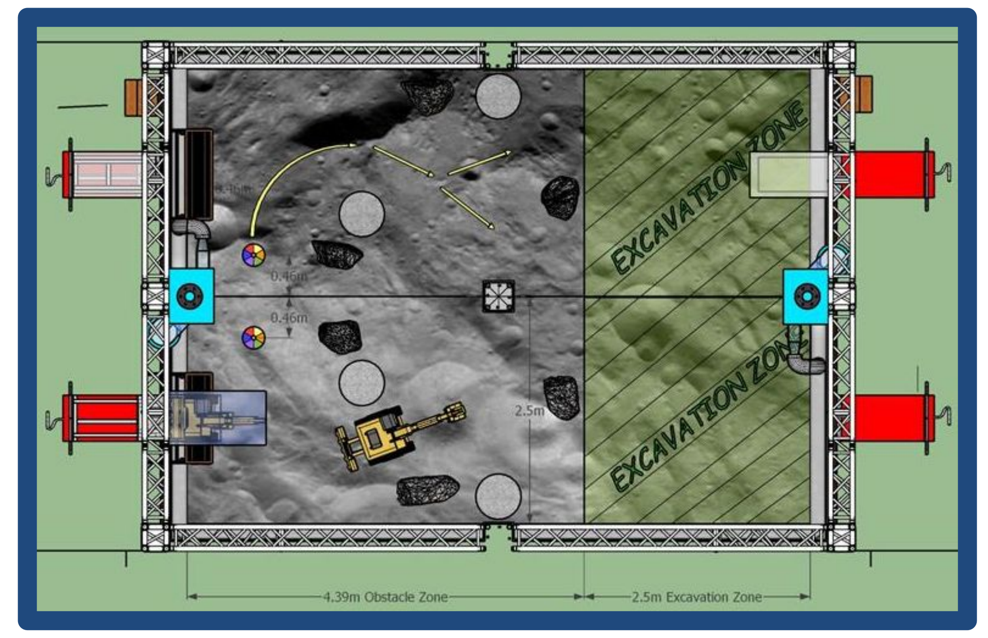


- Perform initial stereo depth imaging with Intel RealSense D455i camera
- Generate combined point cloud using the Iterative Closest Point algorithm
- Filter the point cloud using standard deviation of the distance to neighboring points
- Using the Canny edge detection algorithm identify frontiers for the robot to explore. Select Frontier based on a weight scoring system of distance and size
- Apply C-space constraints to map
- Create a navigation path based on a modified version of the A* algorithm

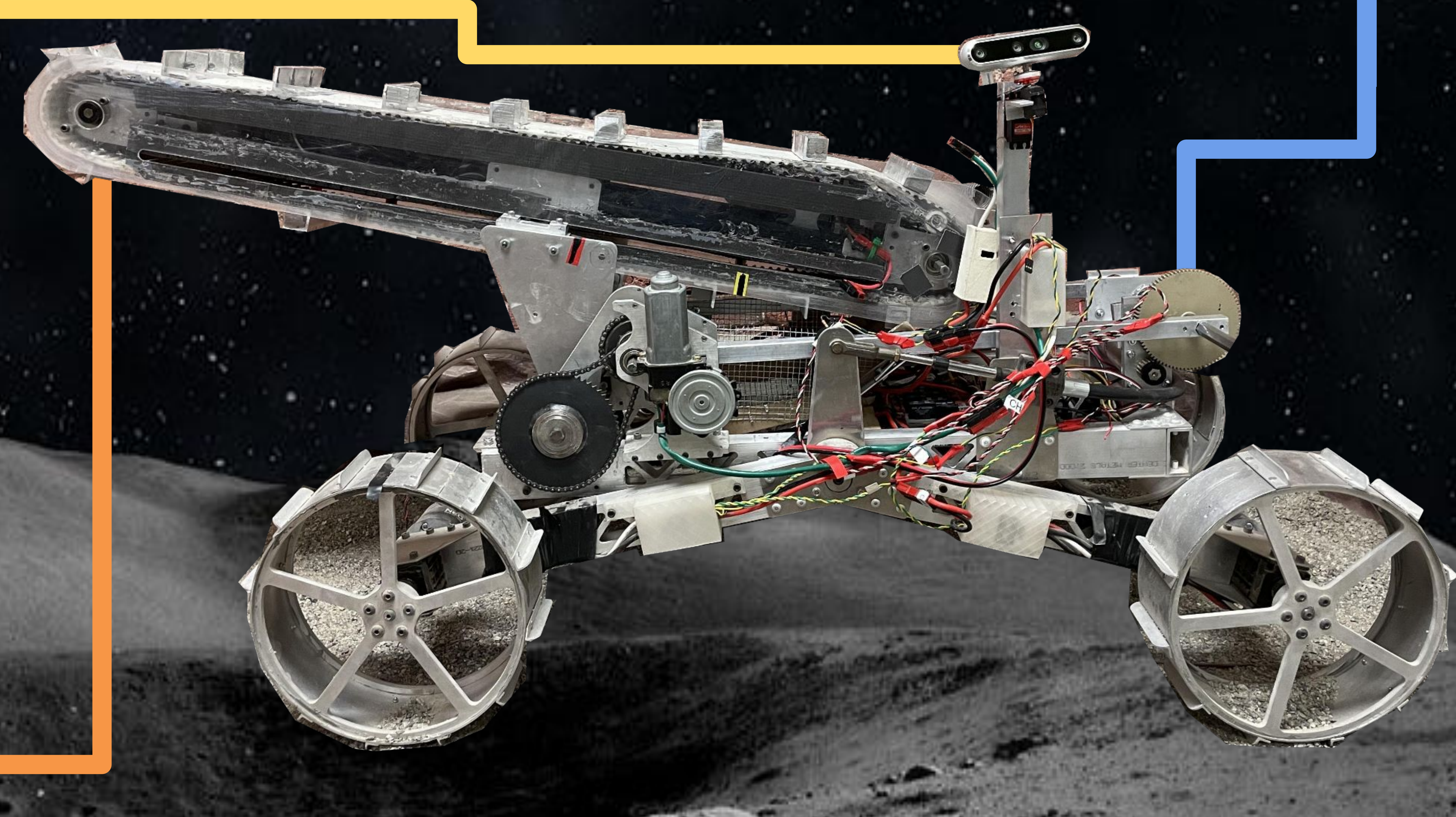
Excavation

- Excavate BP-1 and Regolith simulant (sand and gravel)
- Mine up to 40 cm in depth
- Improved top-to-bottom configuration speed by replacing lead screw system
- Redesign of belt tensioning system
- Improved dust protection
- Added encoder and hall effect sensors for autonomy accuracy





Shown is a model of the NASA RMC competition field. Robots must drive into an excavation zone, excavate into lunar regolith, extract and filter gravel pieces, and drive back to dump into a sieve located at starting base zone.



Results

- Mass of the robot: 35.7 kg
- Autonomous Operation
- Can deposit 4.5 kgs of gravel
- Linear slider speed of 56 seconds
- Localization accuracy of +/- 3 cm
- Obstacle detection at a range of 4 m

Acknowledgements

The team wants to thank our project advisors, FRC Team 190, Kate Lindsay, Daniel Ali Tribaldos, Neil Rosenberg, Washburn Lab staff, Worcester Sand and Stone, and the African Community Education for their contributions and support throughout this project.

Storage and Deposit

- Improved ground clearance by 7 inches
- Deposit time reduced to 4 seconds
- Lighter than the old conveyor by 5.5 kg
- Over 50% less moving parts
- Uses pressure sensors to detect when the bucket is full
- Actuated with a gear transmission system of VEX gears with a gear ratio of 4.65:1 and a PG188 motor

Concept of Operations