Abstract
In-situ resource utilization, or the use of the resources available in a foreign environment, is crucial to the success of manned missions to Mars; however, it is a severely underdeveloped technology. This project explores the development of a rover capable of operating in a simulated Martian environment. The rover is capable of mining large amounts of simulated ice chunks from below the surface, driving its payload to a collection station, and unloading all of the collected material. This project is partially inspired by NASA's Robotic Mining Competition which served to establish a set of guidelines around which the robot was constructed.

Material Collection and Release
- Dynamic chain system: keeps scoop chain tensioned & acted between two independent carriages
- Allows for excavation at depths up to 16" with consistent dump into bucket without dust creation
- Scoop guide rail system increases robustness of system
- Synchronized material deposit system: single motor gearbox design with co-axial output shaft controls winch & four-bar mechanism

Drive System
- Rock pilots provide support & protection
- Tank tread drive system
- Passive belt tensioning system
- Powered by CIM motors w/ 75:1 3 stage gearboxes

Software
- Queue-based augmented autonomy
- Low bandwidth message protocol
- Localization through vision tracking and image processing

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Manufacturing and Assembly
• Lightweight rigid aluminum chassis w/ sandblasted finish
• $8000 budget, ~300 machined parts, 30 waterjet parts

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Rover Design

Specifications
<table>
<thead>
<tr>
<th>Dimension (LxWxH)</th>
<th>40in x 28in x 29in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>176 lbs.</td>
</tr>
<tr>
<td>Rated Payload</td>
<td>220 lbs.</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>10 in/s</td>
</tr>
<tr>
<td>Operating Time</td>
<td>12 min</td>
</tr>
<tr>
<td>Material Collection Rate</td>
<td>14 oz/s</td>
</tr>
<tr>
<td>Collection Depth</td>
<td>16 in</td>
</tr>
</tbody>
</table>

Software
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Field Testing
• Tested in mock Martian mining environment w/ sand & gravel
• Capable of mining full 220lb load in 4 minutes
• Dumps total load in 15 seconds

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