Ibex: Robotic Mining Platform

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Abstract

The use of resources in foreign environments is essential to the success of manned missions to Mars. This project explores the different ways a rover can mine and deliver resources in a simulated Martian environment. This robot is capable of autonomously excavating the simulated ice chunks 30 cm (11 in) below the surface and driving to a collection station to unload the material it has collected. This project was inspired by the NASA Robotic Mining Competition which established a set of rules for how the robot was to be constructed.

Electronic Components

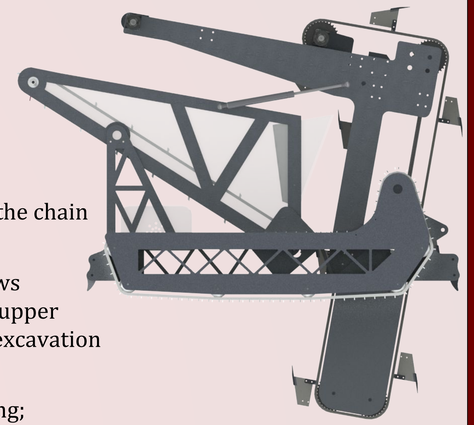
- Battery: 12V 18Ah
- Power Distribution Panel
- Fanless Embedded Microbox PC (Linux)
- Motors; (2 CIM's , 2 Globes, 1 VEX 775pro)
- 5 Talon SRX's
- Motor Controller: HERO Board
- Sensor Board: Arduino Uno

Fanless Microbox PC

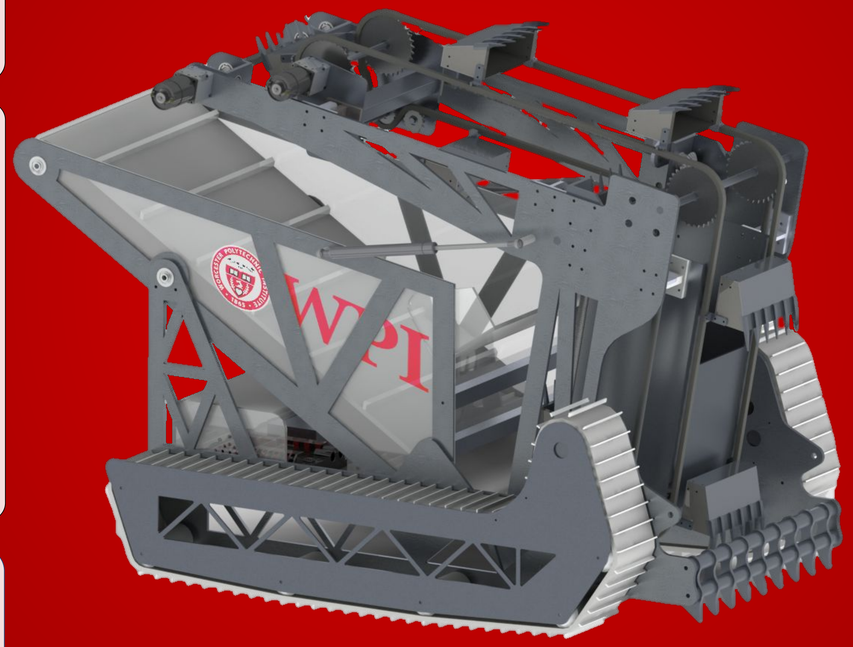
HERO

Arduino Uno

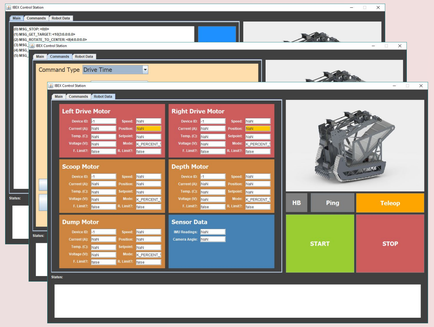
Excavation Method



- 3-step digging process
  - Start scoops
  - Extend downwards
  - Drive backwards
- Scoop connections protect the chain from jamming
- Dynamic chain system allows synchronous movement of upper and lower carriages of the excavation system up to 45 cm (17 in)
- Advantages of angled digging;
  - No material falls inside the hole from the front of the robot
  - Loosens material to facilitate digging
  - Decreases amount of force applied on the scoops



Autonomous Operation

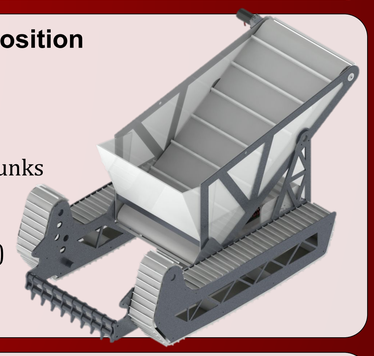


Control Station GUI

- Sends messages from the control station to the robot in a queue
- Recovery Stack runs functions to get out of hazardous situations
- Ability to switch between autonomous and teleoperated control

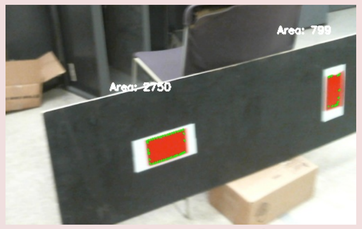
Material Deposition

- Conveyor belt bucket system
  - Belt angle: 32°
  - Volume: 0.25 m^3 (8 ft^3)
  - Capacity: 55 kg (120 lbs) of ice chunks
  - Belt grousers ensure efficient unloading
  - Lifts collected material 0.6 m (2 ft)

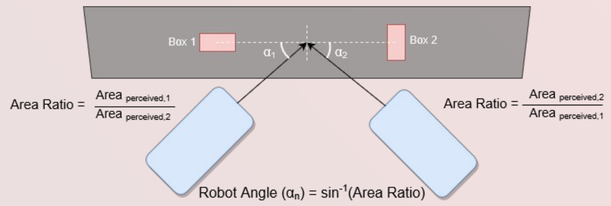


Computer Vision

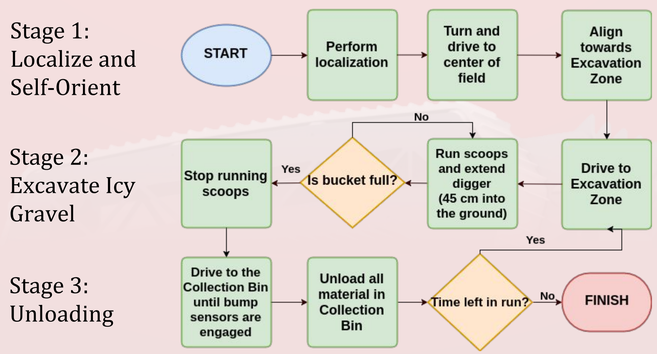
- Localization using OpenCV to determine starting orientation
- Compares perceived areas of the targets in relation to camera rotation
- Centers with target when returning to the collection bin by comparing the perceived areas



Target Image Processing



Flow Chart of Autonomous Operation



Manufacturing

- Water jet 3.2 mm (⅛ in) thick aluminum sheets for the chassis
- Manufactured 40+ parts (3D printing, laser cutting, milling and lathing)