Robotic Mining in a Martian Environment

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Autonomy and Navigation

Harvester navigates using a completely autonomous cycle based on the navigation code. This code will in real-time, give an accurate reading of distance and angle from a pre-positioned board through image recognition software from a rotating mounted webcam.

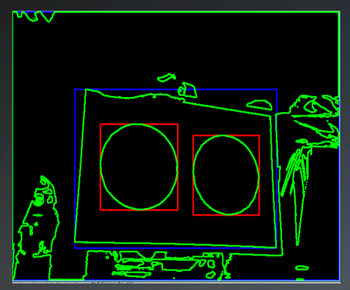
The Image Processor gains navigation information from a video feed and sends that information to the Autonomous Routine.

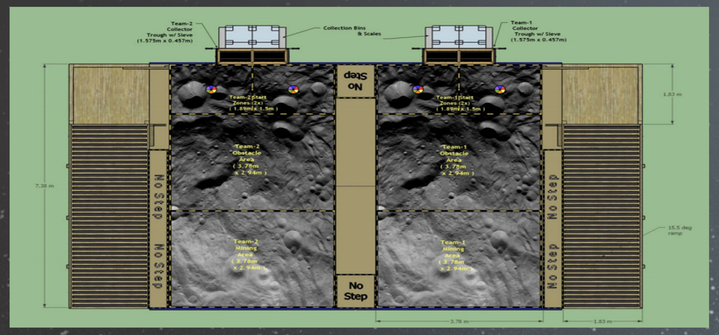
» Receives images from a video feed on the web camera mounted on the Harvester

» Locates the target in the image

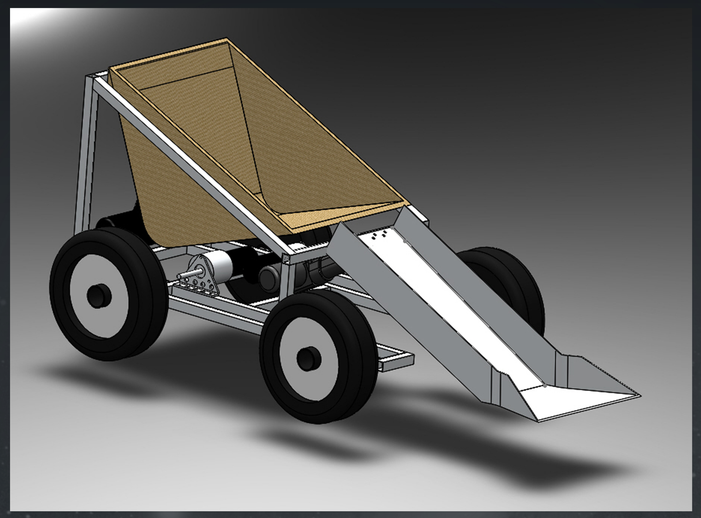
» Calculates the size and distortion of the target

» Uses size and distortion to generate a distance and angle from the target
Sends the distance and angle to the Autonomous Routine





The field that the robot will have to navigate is composed of a Martian simulant and is comprised of three different sections. The starting area, the obstacle area where the robot will have to traverse Martian craters and rocks, and finally the mining area where the robot will mine the simulant.



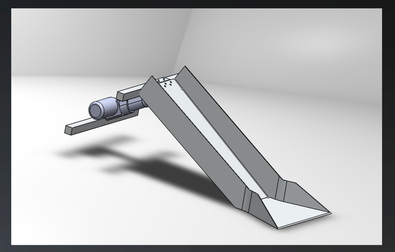
Objective

The NASA Robotic Mining Competition challenges university teams to design, build, and test a mining robot that could function on the surface of Mars. An autonomous mining robot was designed and built to mine 10kg of simulant in 10 minutes, navigate an obstacle field, and return to base. The robot utilizes image recognition technology to navigate through a simulated Martian environment.

Mining Apparatus

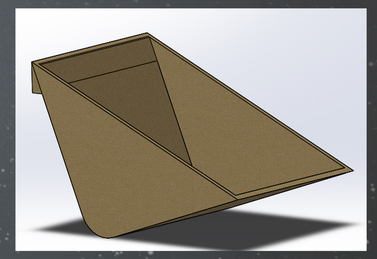
Harvester contains a two stage Mining Apparatus, consisting of the Mining Arm and the Hopper. The primary goal for the Mining Team is to create a simple, yet effective process to mine the Simulant. The two part design maximizes Simulant storage through the use of a hopper, while also providing a simple routine for autonomous mining.

Mining Arm



The first part of the Mining Apparatus is the Arm used to mine the Simulant. The arm is designed to be a surface skimmer. The advantage of using a surface skim is that it simplifies the process of mining, thus simplifying the process of automating the mining.

Hopper



The hopper is made out of fiberglass, which created a strong storage space for the simulant mined by the mining arm. It dumps the simulant into the
collection box.

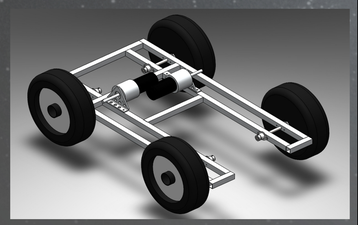
Drivetrain

» Utilizing ‘tank drive’ for tight turn radius and responsive controls.

» Solid rubber tires provide large clearance and traction for traversing Martian simulant.

» Simple and robust component selection for intuitive drive controls; ideal for automation.

» Design to fill minimum volume and reduce weight.



Controls

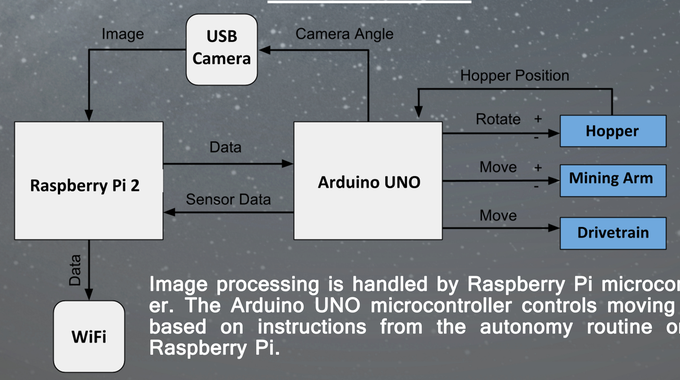
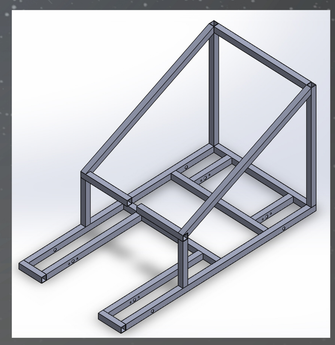


Image processing is handled by Raspberry Pi microcomputer. The Arduino UNO microcontroller controls moving parts based on instructions from the autonomy routine on the Raspberry Pi.

Chassis



» Constructed using 1” aluminum square tubes that were welded together.

» Both 1/8” and 1/16” walled tubes were used to optimize the weight of the robot. A finite element analysis was preformed in SolidWorks to determine which tube could be lighter.

» Triangular truss design was used to optimize the strength and weight.