# Team Hindsight: Image Analysis Tool for Dust in Abrasions for Mars 2020 Rover

Charles Beck, Alexanderia Nelson, Adam Paquette, Hunter Rainen
College of Engineering Forestry, and Natural Sciences
Mentor: Austin Sanders

Client: Iona Brockie
Mechatronics Engineer at JPL/caltech NASA

Contact info: hrainen@hotmail.com, cjb456@nau.edu, acp263@nau.edu, ann72@nau.edu

JPL

NASA

NORTHERN ARIZONA UNIVERSITY | College of Engineering, Forestry, and Natural Sciences

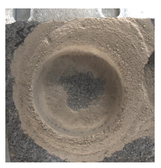
## The Mission:

JPL is a federally funded NASA research and development center whose primary role is to construct and operate planetary robotic spacecraft.The primary goal of JPL's latest Mars rover, M2020 will be to look for evidence of past life on Mars by drilling holes and collecting samples.

## The Problem:

When the rover drills it creates dust that obscures the hole. This is an issue since the rover uses instruments such as PIXL to analyze the chemical makeup of the abrasion. JPL's solution is to use compressed gas to blow dust out of the hole.

Before Air Blast

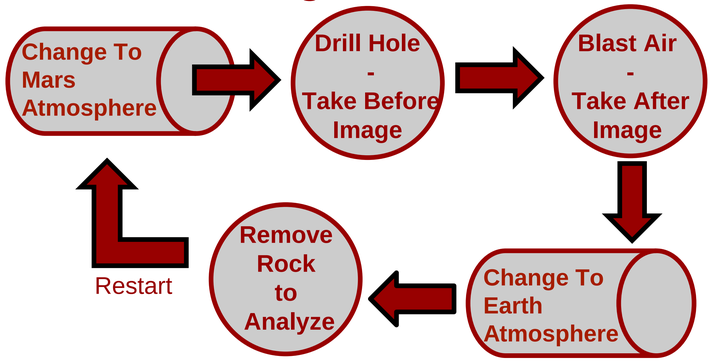


After Air Blast

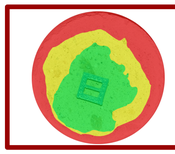
Images Courtesy NASA JPL/Caltech

Now JPL needs to calibrate their dust removal tool. The process can be seen below.

## JPL's Original Process:



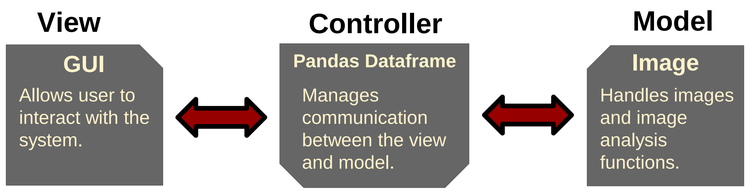

**Total Time: ~ 120 minutes**



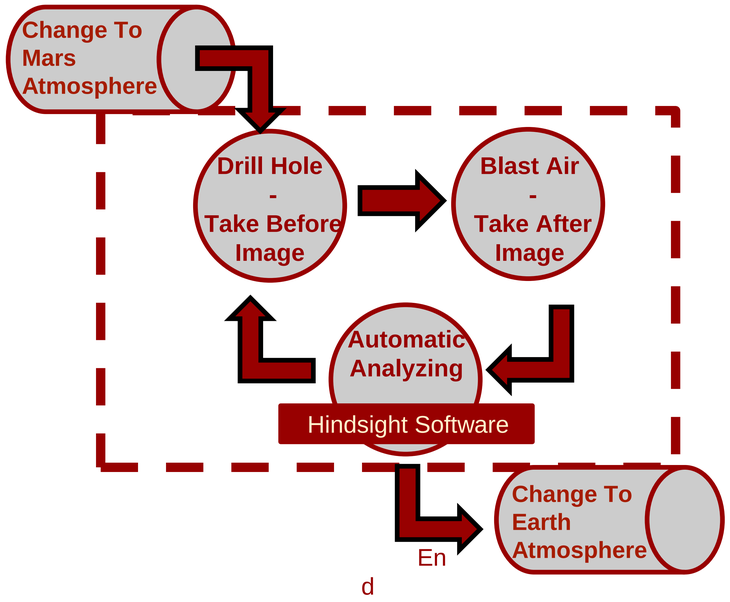
Hand Analyzed Image

Main Issues:
- Time consuming
- Inconsistent
- Prone to Human error

## The Solution and Architecture:




## Hindsight's New Process:




Our automated process allows JPL to conduct and analyze multiple tests in the same vacuum chamber session. This process also maintains consistency since a computer is doing the analyzing as well as speed up the process of testing and calibration of their dust removal tool..

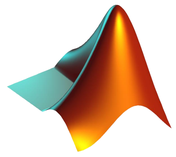
## Key Features:

Functional:
- Takes in batches of image sets
- Analyzes dust and output percentage of abrasion covered in dust
- Marks areas within 10% of JPL's hand analyzed results.

Non-Functional:
- Displays new analyzed version and original image data.
- Takes no-longer than 1 minute per image pair

## Technologies:

Python 3.6

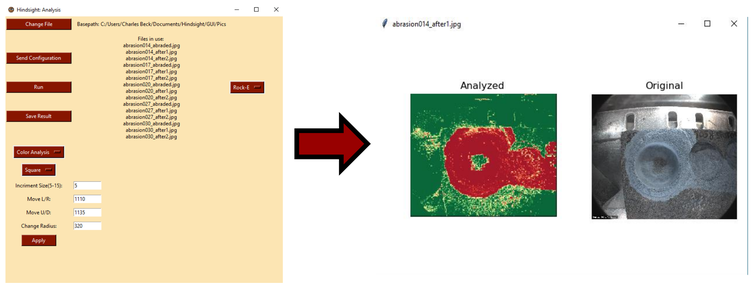


MATLAB

OpenCV

## Outcomes:

- Automatically detects dust
- Returns percentage of abrasion covered in dust
- Creates and displays a heat map of regions covered in dust
- Takes less than a minute per image pair




## Challenges:

**Shadows**
Shadows in the hole cause our application to incorrectly report there is no dust in that region. To fix this we have specified to JPL that lighting is important.

**Dust Color is Similar to Rock Color**
For some rocks, the dust color is the same or similar color as the rock itself, so color analysis is different for each rock.

**Detecting Perimeter of Abrasion**
Due to how the abrasion is cut in the rock, a majority of the edge detection algorithms out there, i.e., Canny Edge detection, were unable to correctly identify the edge of the abrasion in the image. This was resolved by converting the radius from millimeters to pixels using the camera parameters and using the center coordinates to draw the circle on the image and cut the abrasion from the image.

## Testing:

- Unit testing dust detection
  - Returning correct pixel values
- Integration testing modules of architecture
  - Correct passing of data between modules
- User testing the graphical user interface
  - JPL uses software and recommends changes

## Future:

Our software sets the ground for JPL to improve their current dust removal tool or test the capability of new dust removal tools. The software also would let JPL implement other computer vision algorithms to do other image analysis tests.