Design Review II

Team Hindsight

Intro Statement

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JPL's Mission to Understand Mars

JPL is a federally funded NASA research and development center whose primary role is to construct and operate planetary robotic spacecraft. With the help of JPL, the scientific community have been looking to answer whether or not we are alone in the universe. Mars is a good place to start looking for answers for a few reasons. JPL has sent many missions to Mars with the goal of looking for evidence that Mars once had the conditions necessary to support life.

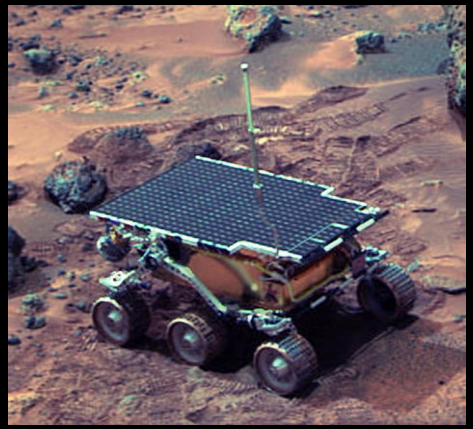

Figure 1.0. Pathfinder

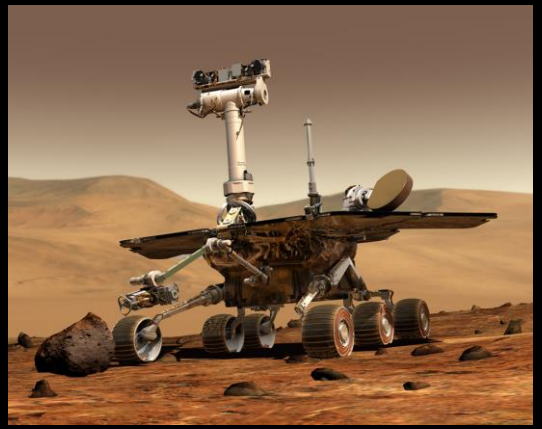

Figure 1.1. Spirit and Opportunity

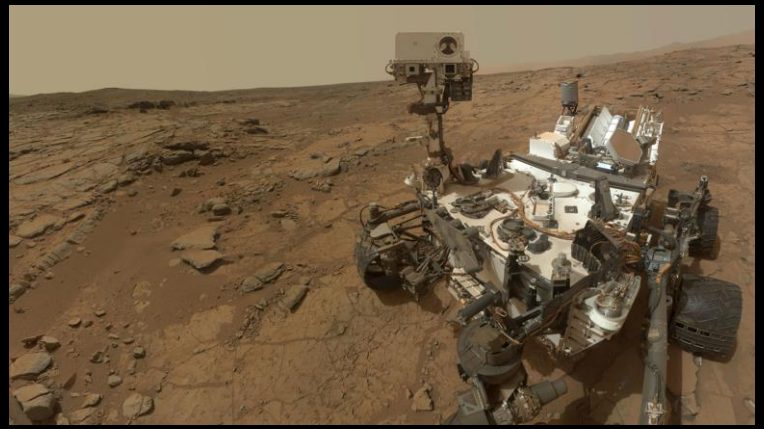

Figure 1.2. Curiosity

Mars 2020 (M2020)

JPL’s latest rover, M2020 will aim to further deepen our understanding of whether or not the red planet was once habitable. Specifically, the primary goal of M2020 will be to look for evidence of past life on Mars by analyzing and collecting samples of the Martian surface which will then be picked up, and returned to Earth by a future mission.

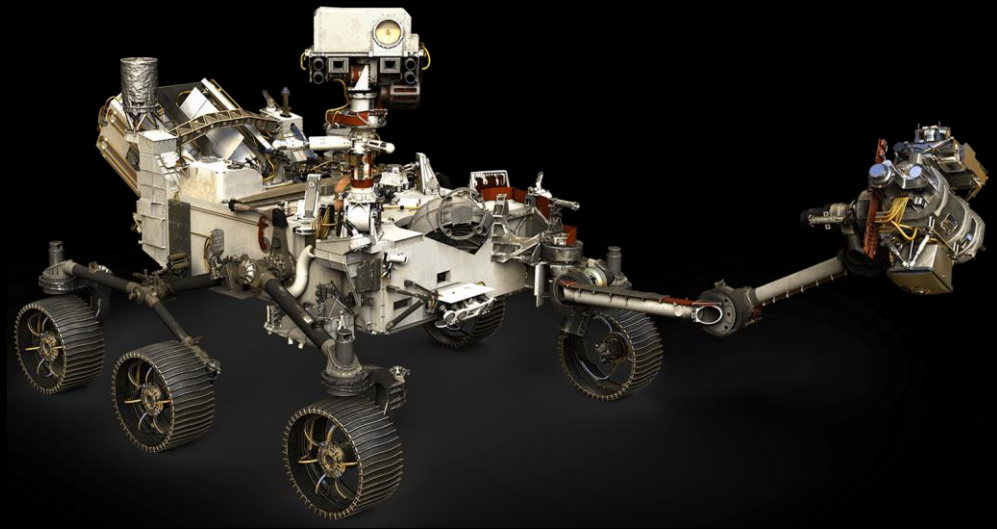

Figure 2.0. Mars 2020

Challenge facing JPL

When the rover drills it creates dust that obscures the hole. JPL's solution is to use compressed gas to blow dust out of the hole.

Figure 3.0. Before dust removal

Figure 3.1. After dust removal

Why JPL's testing method is a problem:

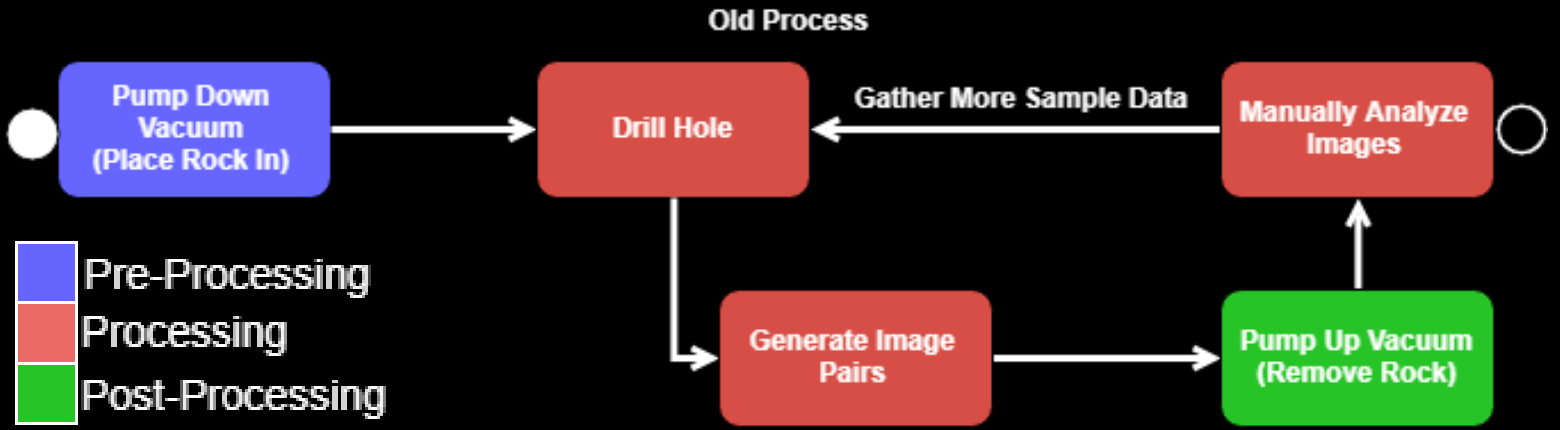

Figure 4.0. JPL Testing process

- Slow
- Inconsistent
- Could be better

Solution Overview

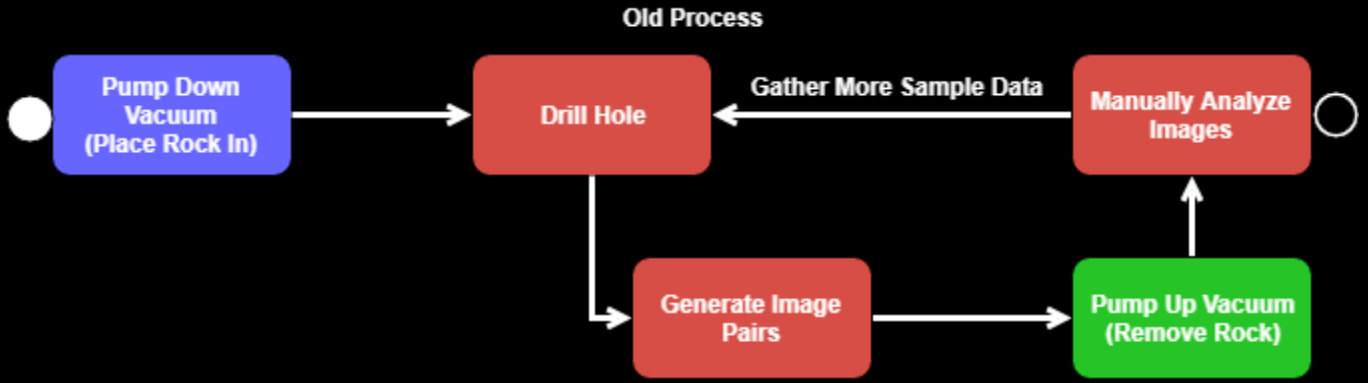

Figure 5.0. Old process from JPL

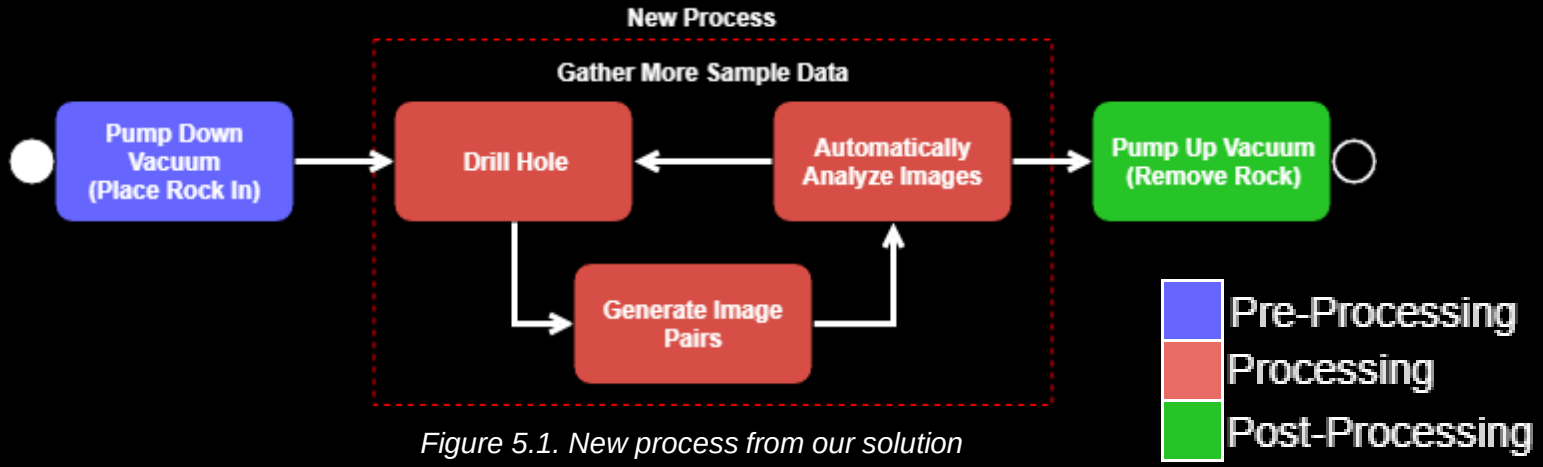

Figure 5.1. New process from our solution

Our Solution

Our software includes the following to the process:

- Faster :
  - No longer need to depressurize vacuum chamber
  - Image analysis speeds up to less than 5 minutes (from one hour)
- More consistent:
  - For all images per rock type
  - less prone to human error
- Further improvements and flexibility
  - Can be parallelized
  - Algorithms added or changed

Requirements

- Functional
  - Handle batch of images
  - Analyze image(s) for dust
  - Allow user to adjust parameters
  - Mark areas of dust coverage
- Non-Functional
  - Display percentage of areas cleared
  - Display before air blast, after air blast, and analyzed images in a GUI
  - Should take no longer than a minute per image pair

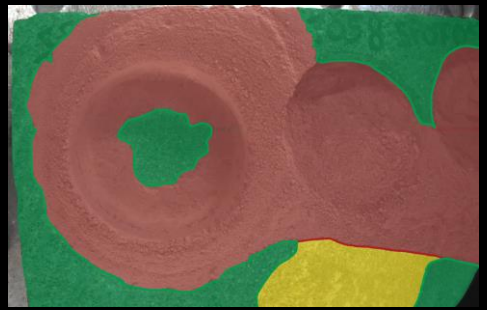

Figure 6.0. Example abrasion analysis

Figure 6.1. Examples of a before, after, and JPL analyzed image

Architecture Overview

- Model View Controller (MVC)
  - Graphical User Interface integration
  - Logic Separation
  - Parallel Development

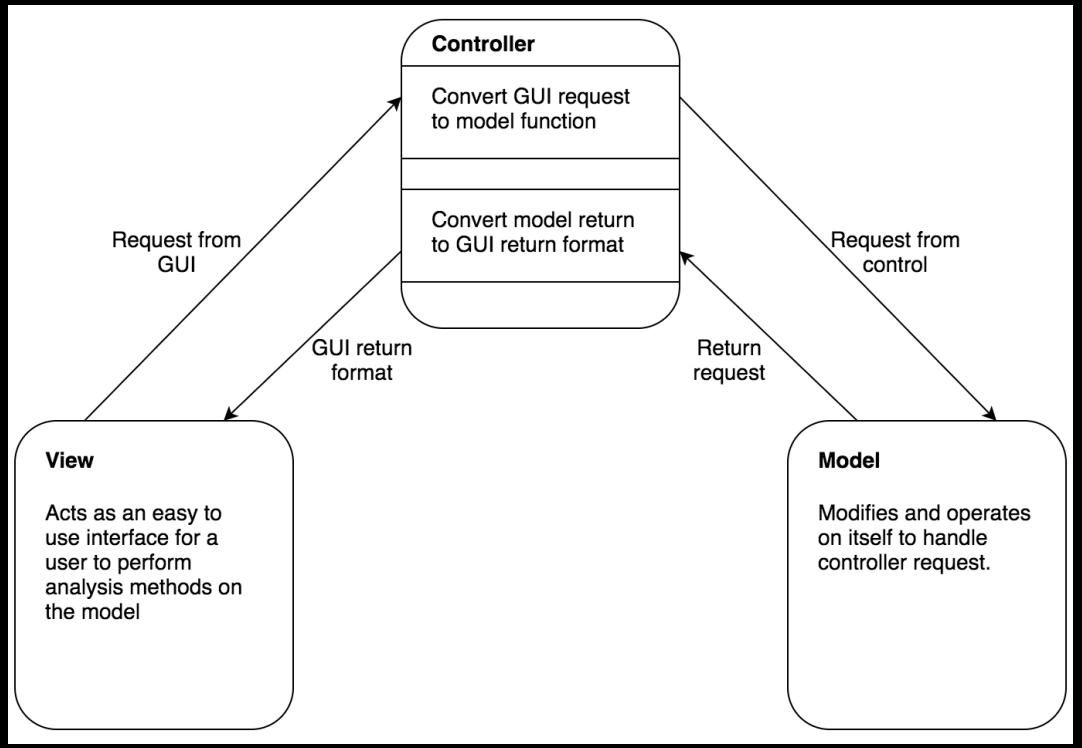

Figure 7.0. High level architecture of the processing pipeline

Implementation Overview

Model:

- Image
- Communicates with Controller through return values
- Uses third party libraries
  - Numpy
  - OpenCV

Figure 8.0. Before image data

Figure 8.1. After image data

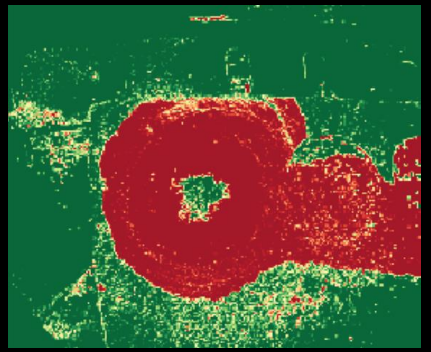

Figure 8.2. Analyzed image data

Implementation Overview

View:

- Window Class
- Analysis Window Class
- Communicates with Controller using Config Class
- Uses tkinter

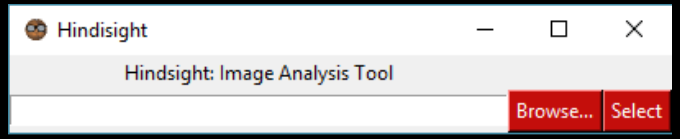

Figure 9.0. Window

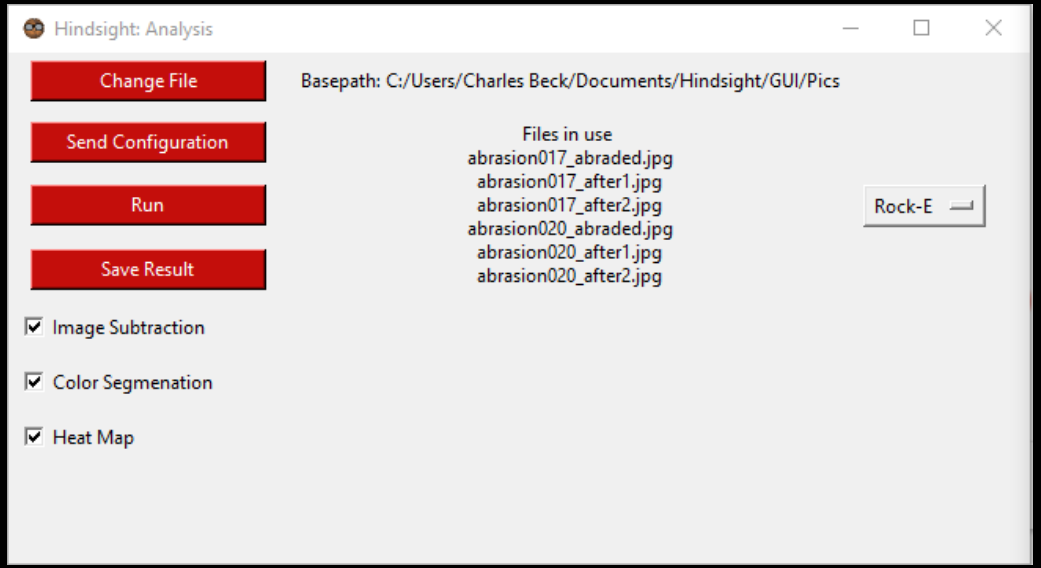

Figure 9.1. Analysis Window

Implementation Overview

Controller:

- Control Class
- control_funcs
- Sends returns from Model to View
- Applys Config functions to Model
- Uses Pandas Dataframe

	after_image	before_image	image_group	output_image
0	<image.image.Image object at 0x10601a6d8>	<image.image.Image object at 0x10601a128>	abrasion020_abraded.JPG	None

Figure 10.0. Controller Pandas Dataframe

See our Software Design Document for more details on our implementation .

Challenges and Resolutions

- Edge detection
  - After applying multiple algorithms and methods for detecting the edge, we found they led to a dead end
  - Resolution: Client suggested we do it ad-hoc (based on camera parameters)
    - Another team at JPL is working on same problem (so they may solve it before we do)
      - Better to focus our efforts on dust detection/ analysis
- Color segmentation for other rock types
  - What we currently have for Rock Type E doesn’t work/may not work for other rock types
  - Resolution: Each rock type will have a customized algorithm

Schedule

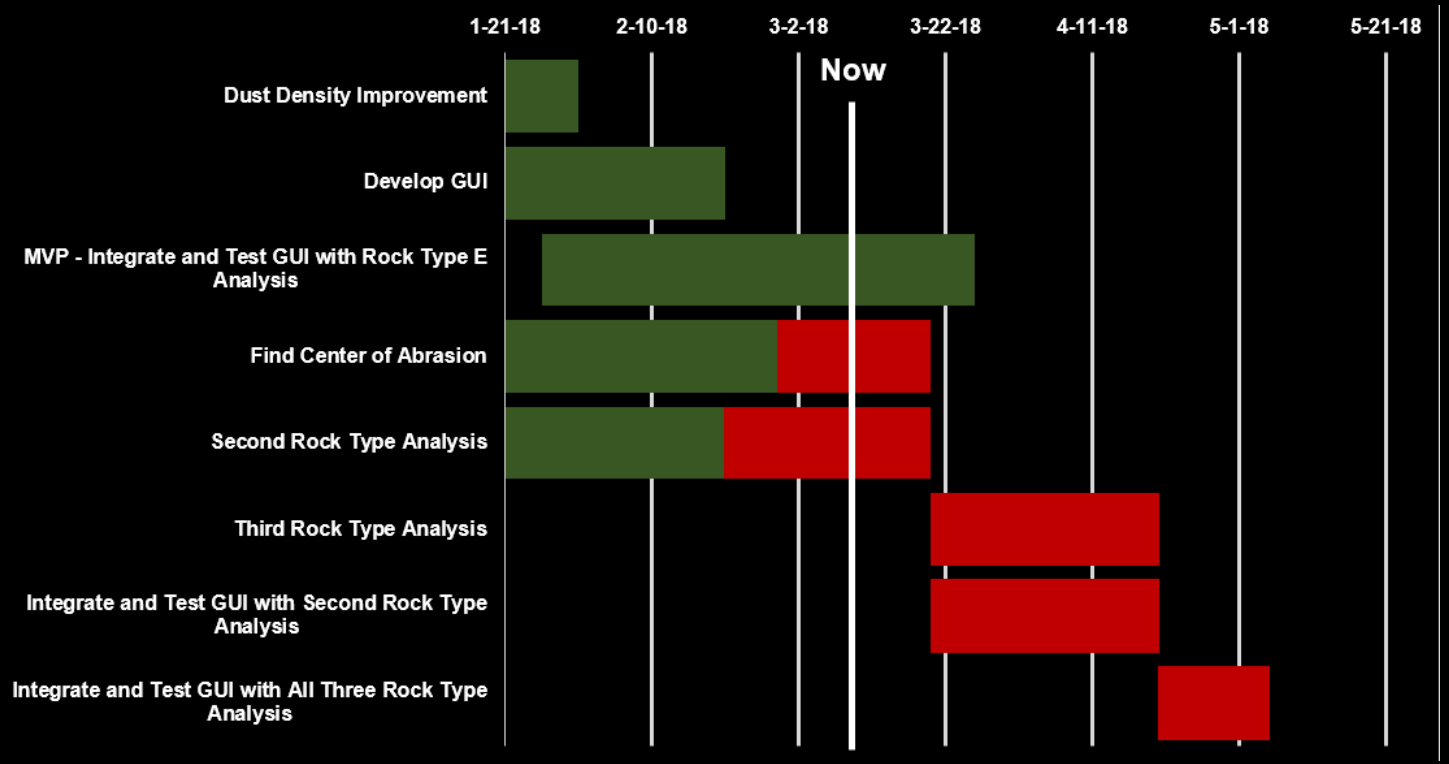

Figure 11.0. Current Implementation Schedule

Hand analyzed:

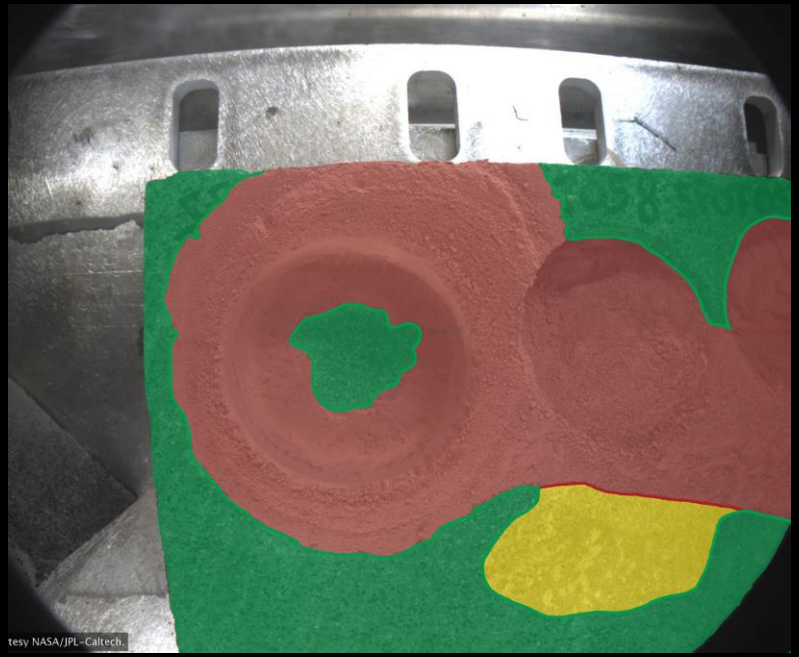

Figure 12.0. Example abrasion analysis

Automatically analyzed:

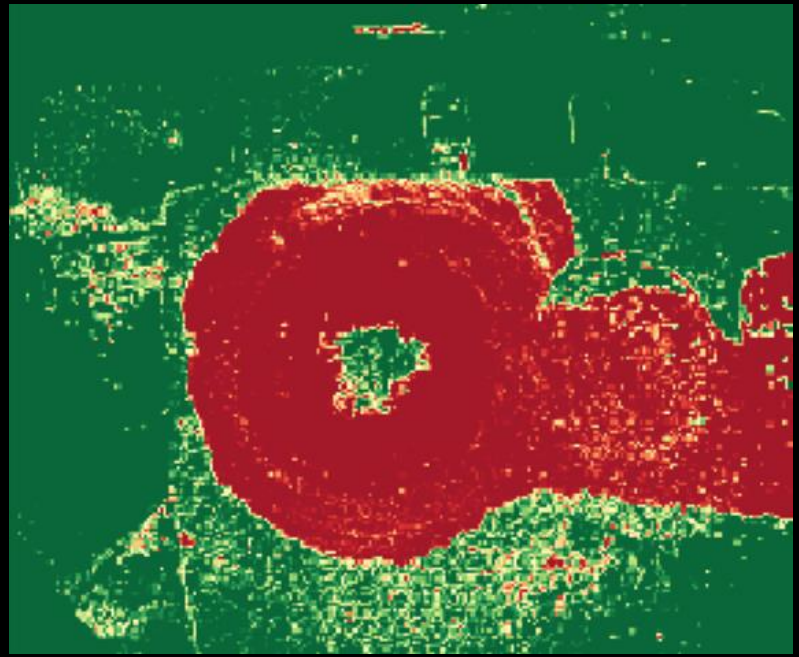

Figure 12.1. Current abrasion analysis

Conclusion

- Client and Problem
- Solution Vision
  - Take in batch of images
  - Automatically apply computer vision algorithms to detect dust
  - JPL can then run multiple tests in a single vacuum chamber pump down session
    - And get feedback on how effective their gas Dust Removal Tool is
- Overview of:
  - Requirements
  - Architecture
  - Implementation
- Challenges and Resolutions
- What’s Coming Up for Team Hindsight

Sources

https://mars.nasa.gov/programmissions/missions/present/2003/

https://en.wikipedia.org/wiki/Mars_Pathfinder

https://www.jpl.nasa.gov

https://mars.nasa.gov/mars2020/mission/rover/