National Aeronautics and Space Administration

Improved terrain classifier for Mars rovers, using a virtual IR sensor

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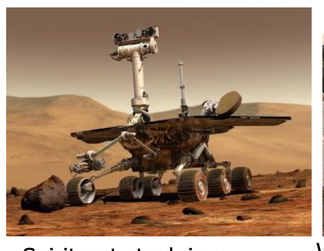
Program: Spontaneous Concept

Project Objective

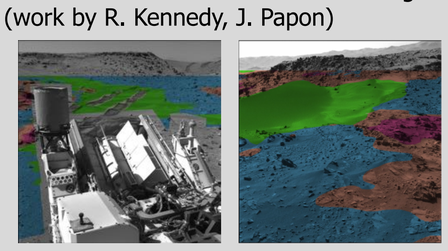
Terrain classification is an essential component of a broader understanding of the terrain to be traversed by rovers



Spirit got stuck in a sand trap, 2010

Wheels of Curiosity rover got damaged

Terrain classification from **visible** images (work by R. Kennedy, J. Papon)



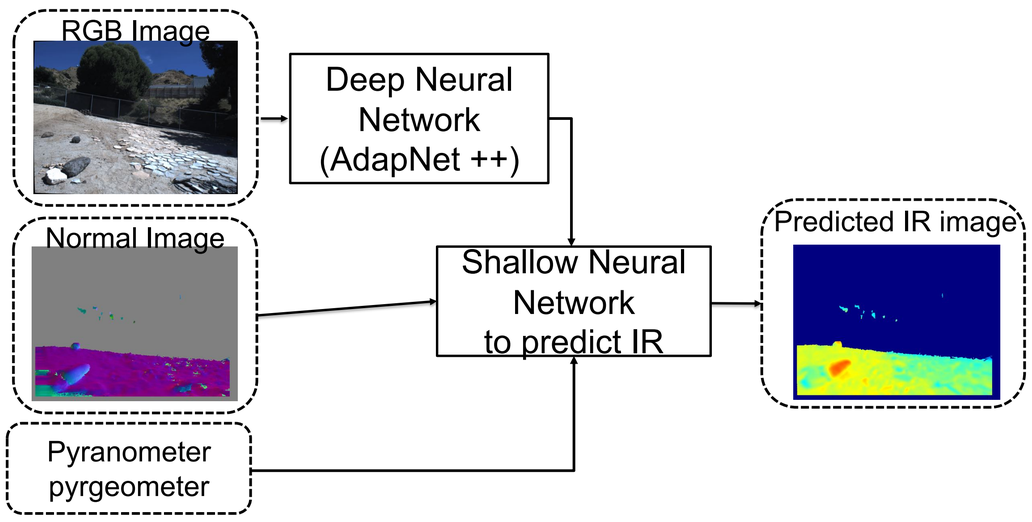
In FY18, we developed a terrain classification system that uses both RGB and thermal IR images, improving terrain classification accuracy. However, Curiosity and M2020 do not have IR cameras.

<u>Objective: Demonstrate that machine learning can estimate thermal IR images, thus acting as a virtual IR sensor, and determine improved classification of terrain based on imagery from a single sensor input (RGB camera).</u>

Methodologies and results

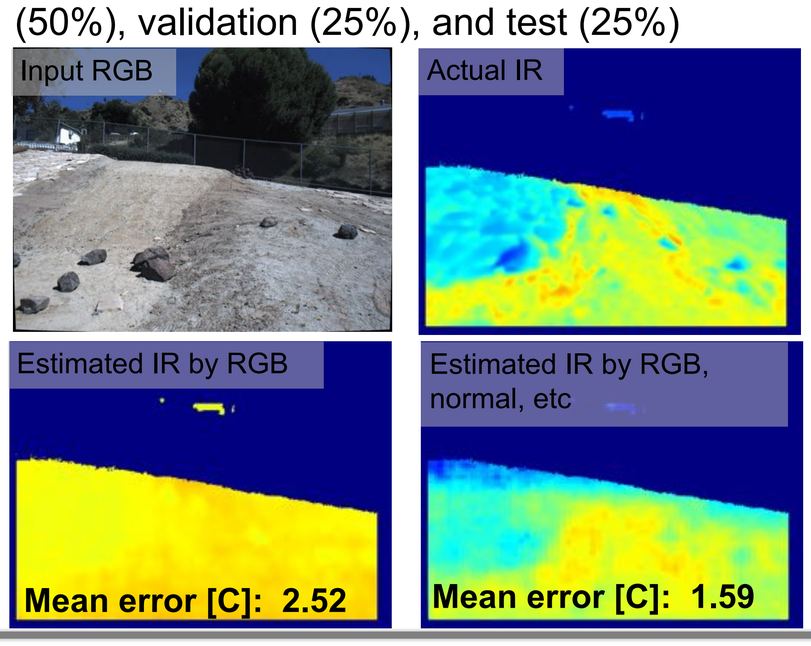
<u>Virtual IR sensor</u>

Estimate of IR images from other sensors, such as RGB images, depth images, pyranometer, and pyrgeometer



<u>Results of virtual sensor</u>

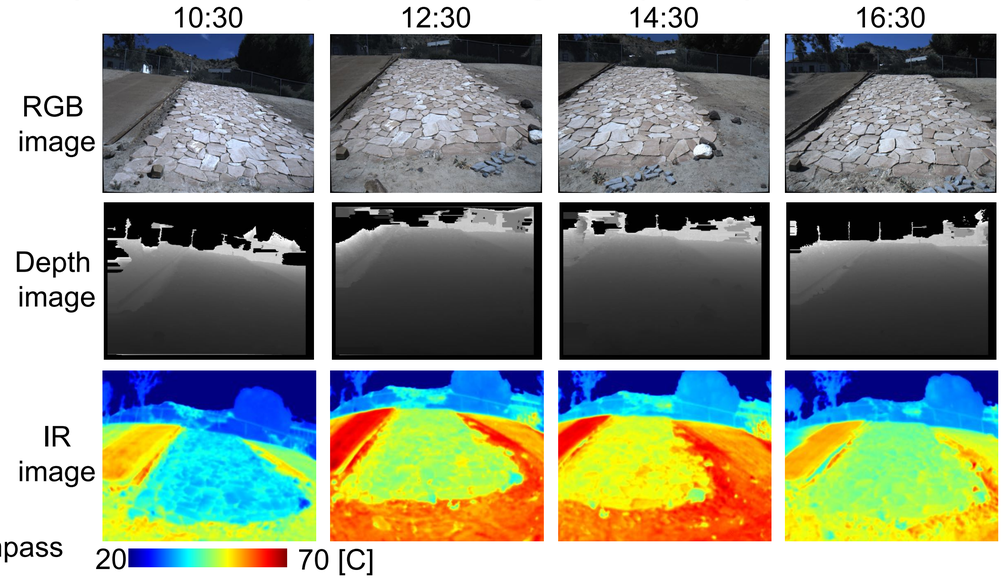
At each hour, randomly separate data into training (50%), validation (25%), and test (25%)



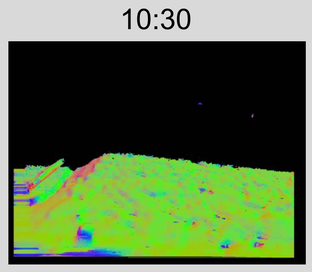
<u>Data collection</u> Jul 24th and Aug 2nd 2019

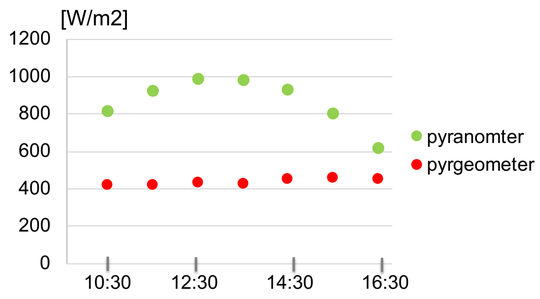
(10:30 am ~ 4:30 pm. About 25 images every 1 hour)

A: Stereo camera
B: Far Infrared camera
C: Pyranometer
D: Pyrgeometer
Behind the cameras: compass



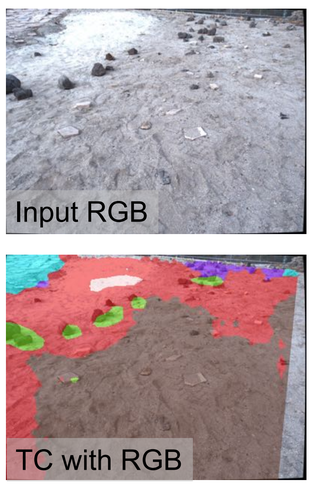
Depth image, compass, and time data are used to obtain normal image with respect to the Sun

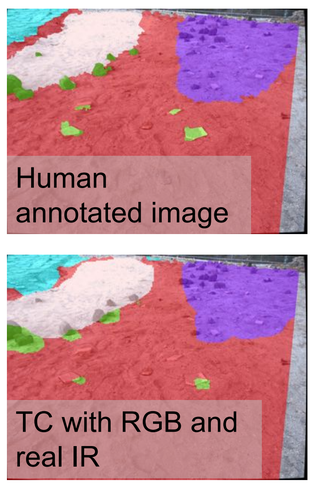


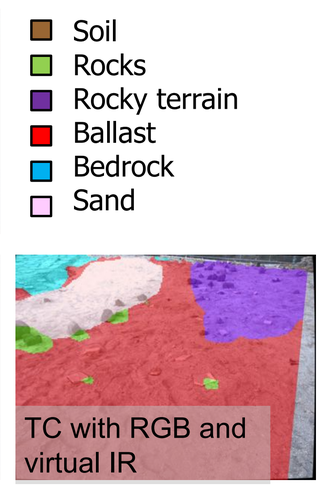


<u>Results of terrain classification (TC)</u>

	Pixel accuracy
RGB	0.872
RGB and real IR	0.911
RGB and virtual IR	**0.911**







Benefits to NASA and JPL

Calibrated virtual sensors would be useful for future Mars rovers
The developed technique can be used for other domains, such as classification with hyper spectral images

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