Gazebo renders the moon

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RP Driving ConOps Simulator

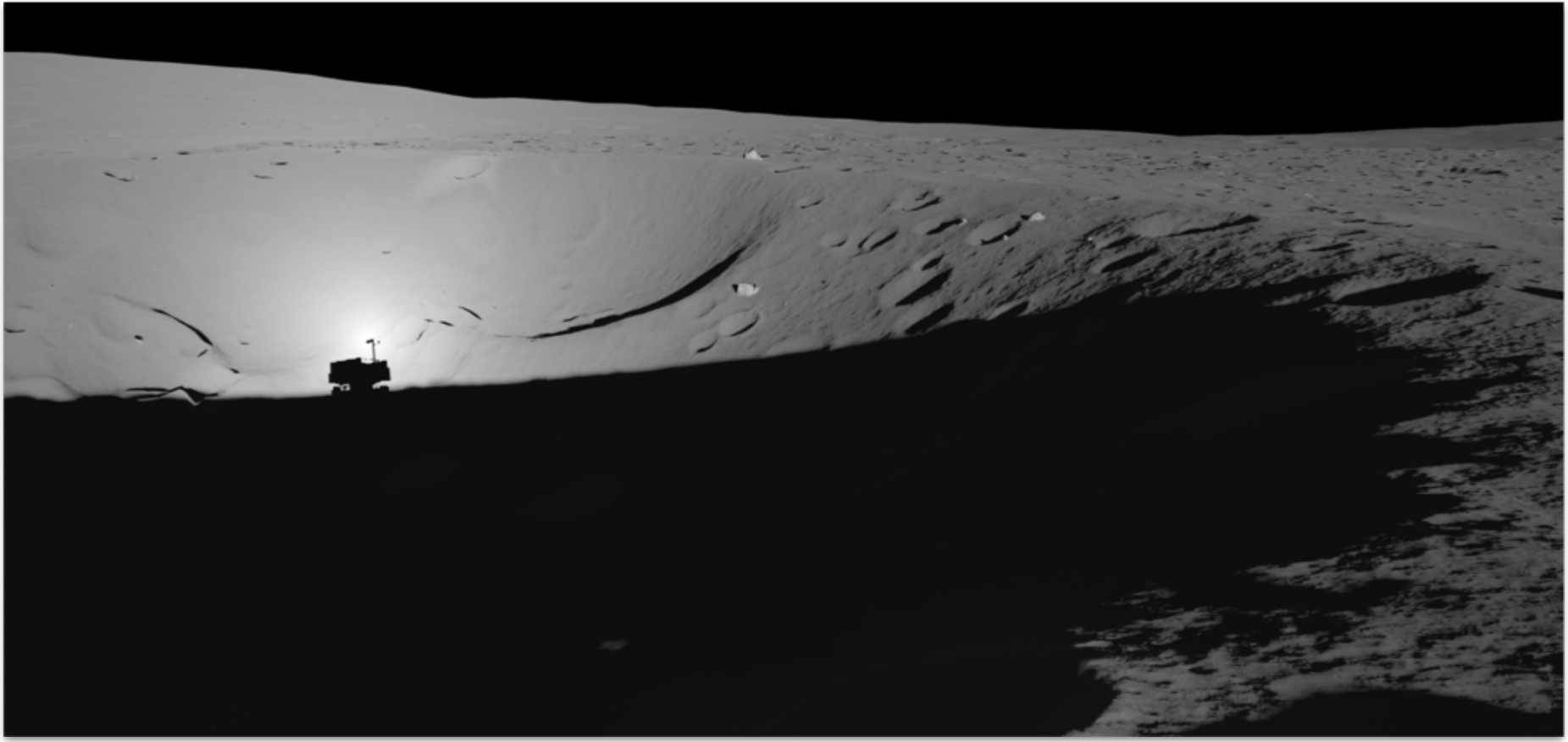
Resource Prospector

Goal: send a rover to the moon to mine volatiles such as hydrogen, oxygen and water

Simulation

End-to-end lunar rover driving simulation to assist in the development of the RP Driving Concept of Operations

- ROS used to emulate flight software and ground software functionality
- Simulated rover is 4 wheel steer platform scaled to RP rover dimensions with RP chassis and mast



Large Scale, High Fidelity Terrain Simulation

Synthetic Terrain Generation

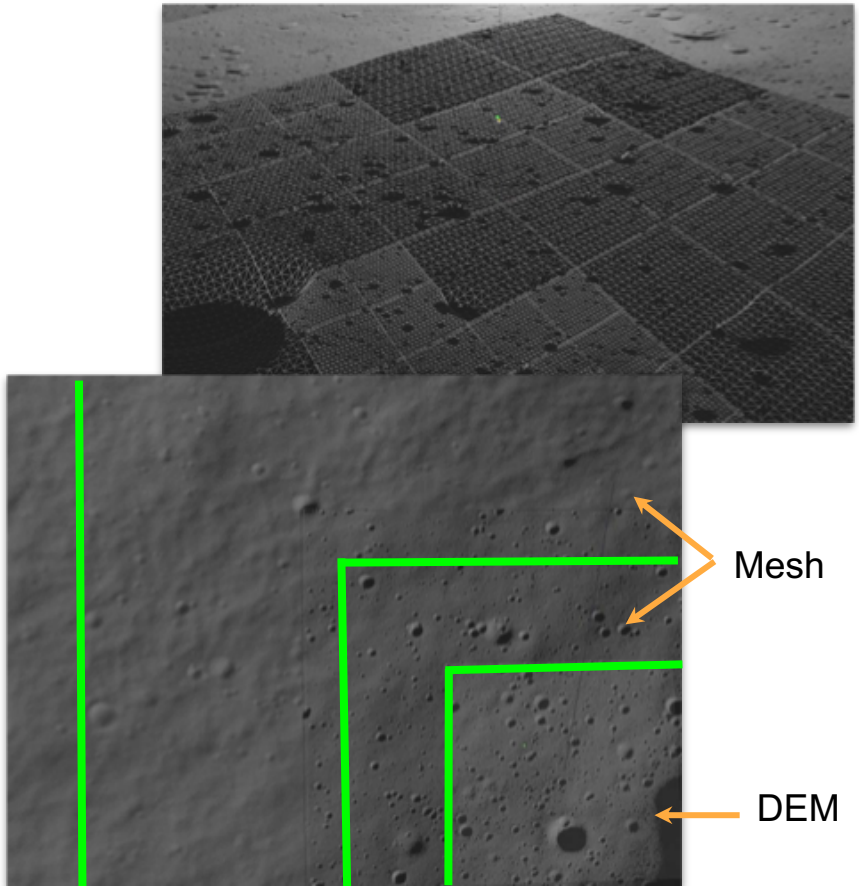
- High resolution (~4cm) to simulate obstacles: positive (rocks), negative (craters)

Large DEMs rendered too slow in Gazebo

- 8K resolution, 213MB
- load time ~5min

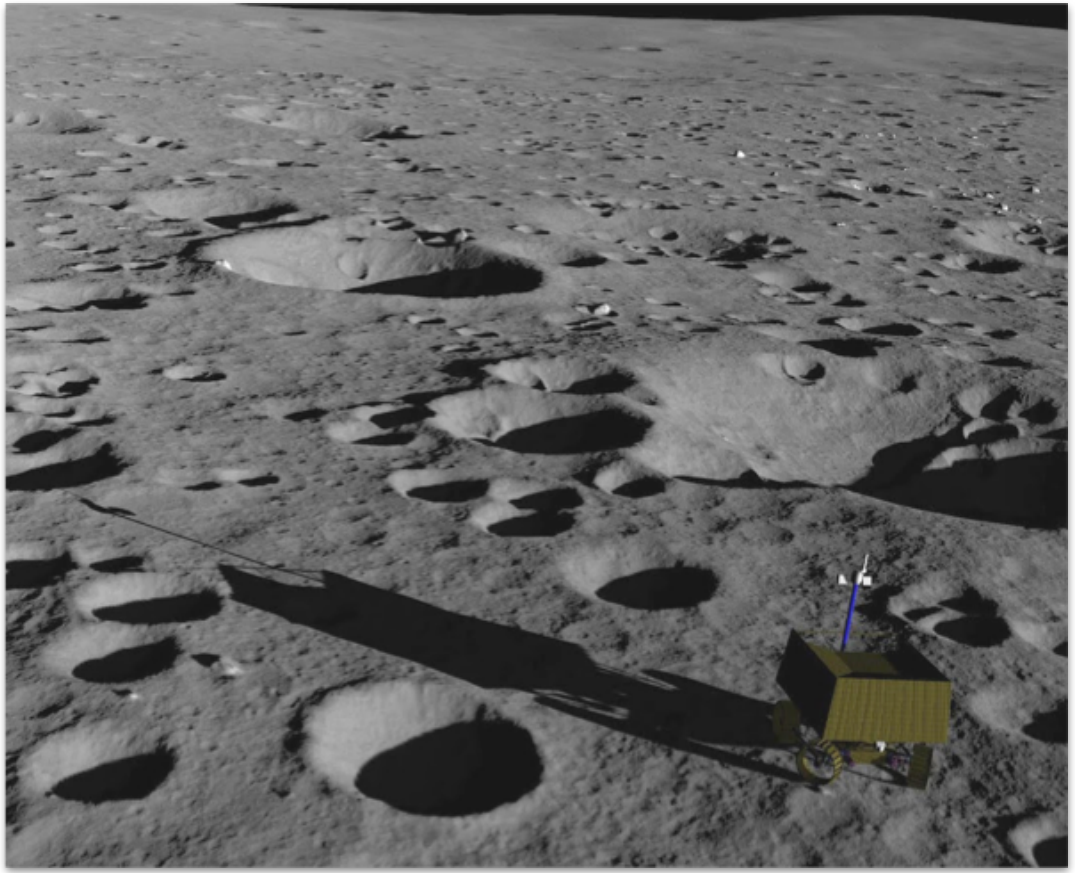
Improvements

- Enabled caching of terrain data
- Added Level-Of-Detail
- Background tiles - coarse meshes
  - 6 levels

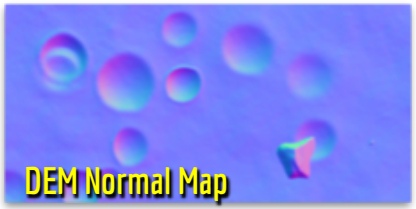


Lunar Appearance

Default shading model - inadequate to model the unique reflective properties of lunar surface



Terrain Material Shader Components



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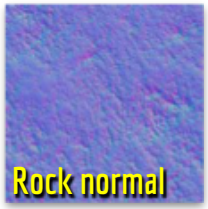
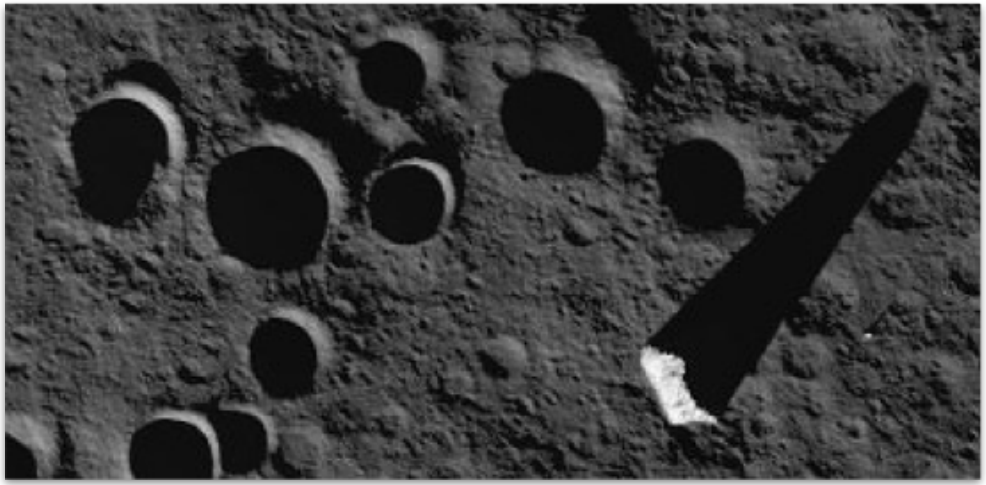
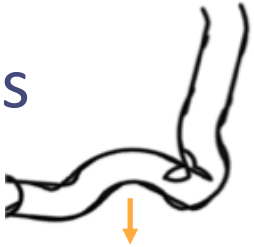


+ Real time shadows set up by Gazebo

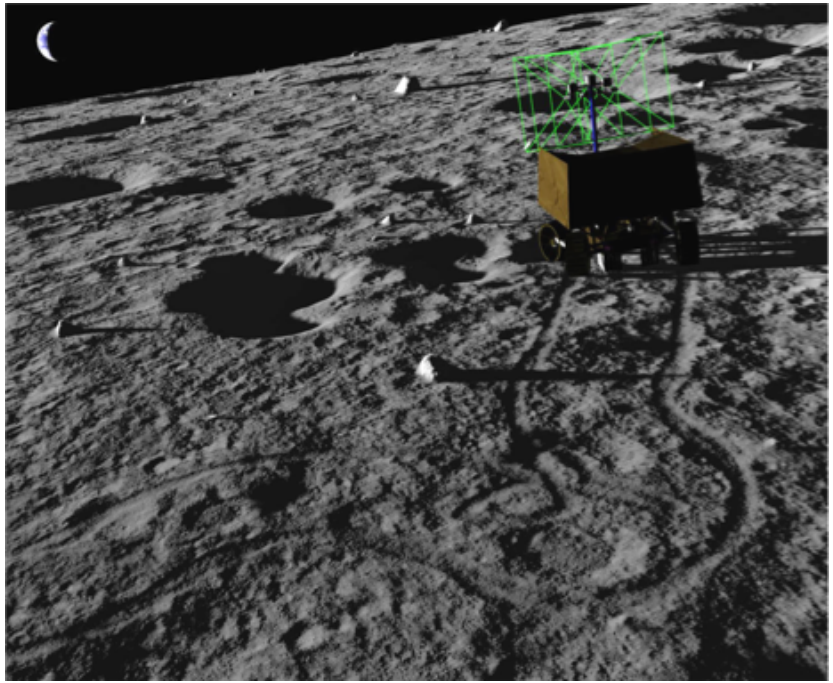
+ Hapke Lunar regolith reflectance model



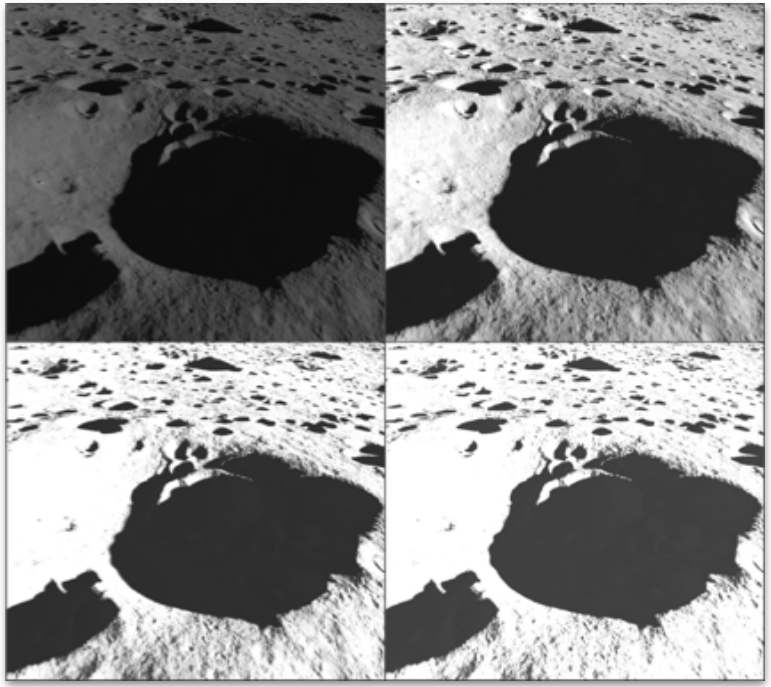
Shader Parameters



Wheel Tracks Plugin



Camera Exposure



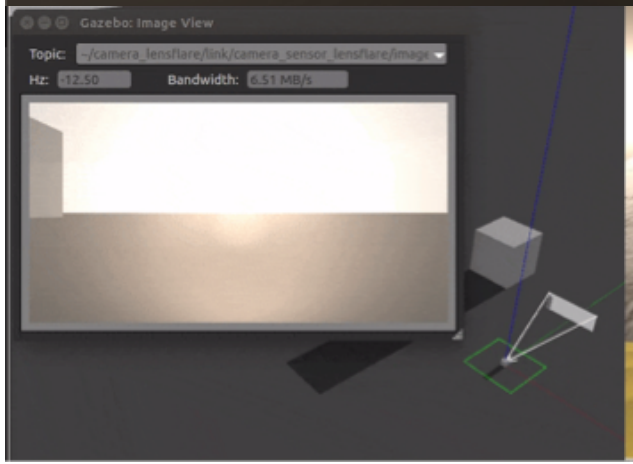
Lens Flares

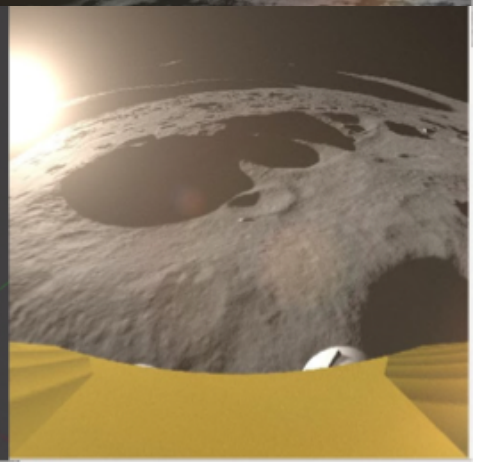
Sun is few degrees above horizon at lunar pole

Camera often points at sun or sees long dark shadows

Implementation

- Post processing effect
- Works with wide angle cameras
- Sparse ray based occlusion checking



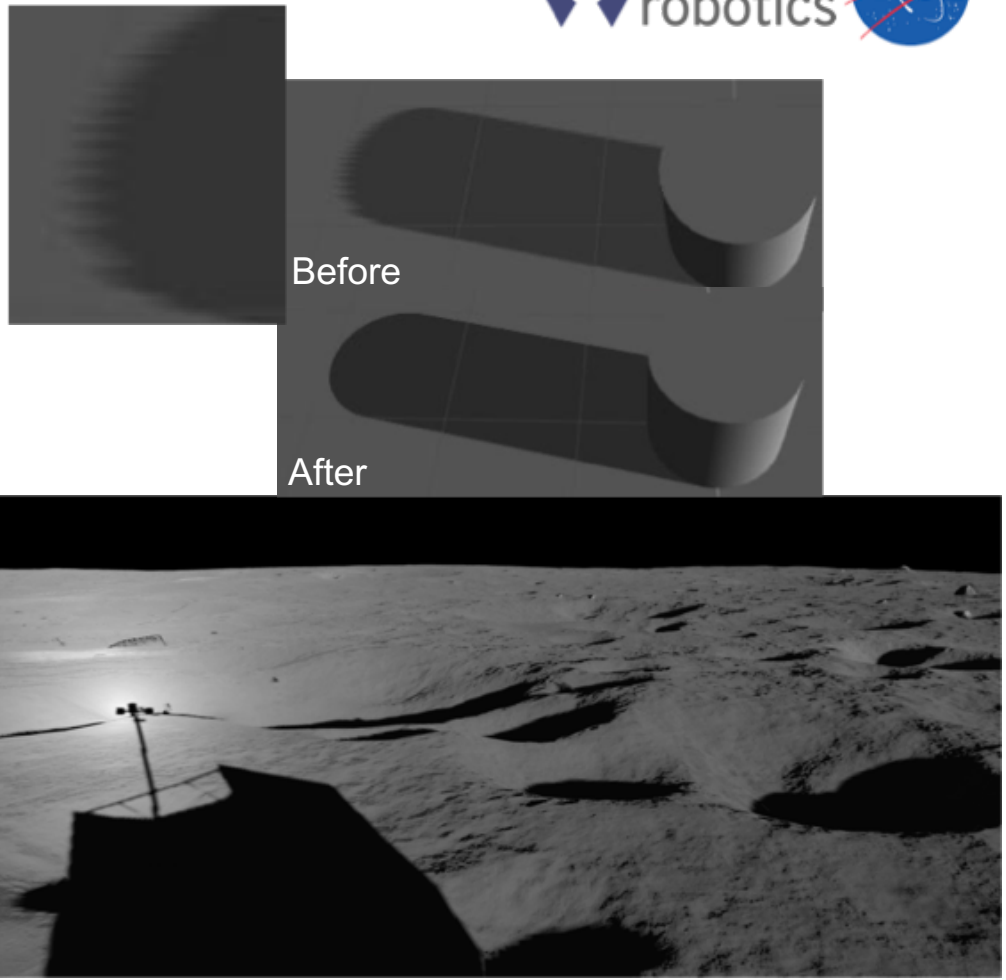


Real Time Shadows

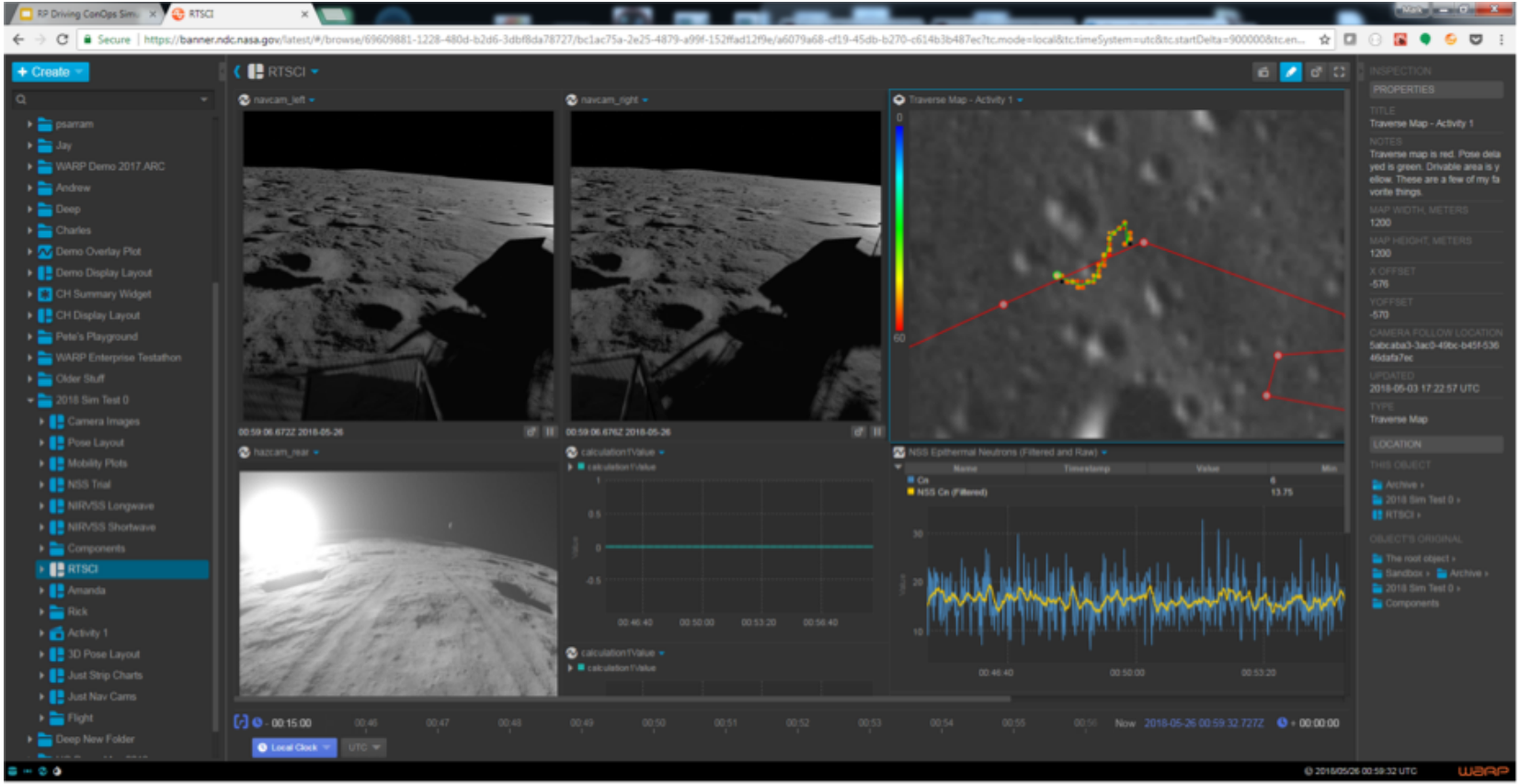
Problem: Poor quality overall esp. when camera view angle is coincident with light direction

Improvements

- Override shadow map generation step
- Increased shadow texture resolution
- Hardware PCF + Poisson disk blur filter
- Lowered “built-in ambient” light



WARP


RP Driving ConOps Sim
RTSCI
Secure
https://banner.ndc.nasa.gov/latest/#/browse/69609881-1228-480d-b2d6-3dbf8da78727/bc1ac75a-2e25-4879-a99f-152ffad12f9e/a6079a68-cf19-45db-b270-c614b3b487ec?tc.mode=local&tc.timeSystem=utc&tc.startDelta=900000&tc.en...
+ Create
RTSCI
psarram
Jay
WARP Demo 2017 ARC
Andrew
Deep
Charles
Demo Overlay Plot
Demo Display Layout
CH Summary Widget
CH Display Layout
Pete's Playground
WARP Enterprise Testathon
Older Stuff
2018 Sim Test 0
Camera Images
Pose Layout
Mobility Plots
NSS Trial
NIRVSS Longwave
NIRVSS Shortwave
Components
RTSCI
Amanda
Rick
Activity 1
3D Pose Layout
Just Strip Charts
Just Nav Cams
Flight
Deep New Folder
navcam_left
navcam_right
Traverse Map - Activity 1
hazcam_rear
calculationTValue
NSS Epithermal Neutrons (Filtered and Raw)
INSPECTION
PROPERTIES
TITLE
Traverse Map - Activity 1
NOTES
MAP WIDTH, METERS
1200
MAP HEIGHT, METERS
1200
X OFFSET
-570
YOFFSET
-570
UPDATED
2018-05-03 17:22:57 UTC
TYPE
Traverse Map
LOCATION
THIS OBJECT
OBJECT'S ORIGINAL
Local Clock
UTC
WARP

Summary of Gazebo Improvements

All features and improvements are available in Gazebo7+

Heightmap improvements

- LOD using `HeightLODPlugin`, heightmap data caching is built-in

Lights and Shadows

- `LensFlareSensorPlugin`, all real time shadows changes merged

Custom Material Shaders

- `ShaderParamVisualPlugin` (to demo rendering API)

Light as child of link

- Added in SDF 1.6

gazebo_ros_pkgs

- 16 bit camera image format
- `gazebo_triggered_[multi]camera` plugin

Wheel Slip Model

- `WheelSlipPlugin`

Team

Open Robotics

NASA Ames Intelligent Robotics Group
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Brian Gerkey
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Terry Welsh
Michael Furlong
Scott McMichael
Arno Rogg

Questions?

End of Presentation

NOTES

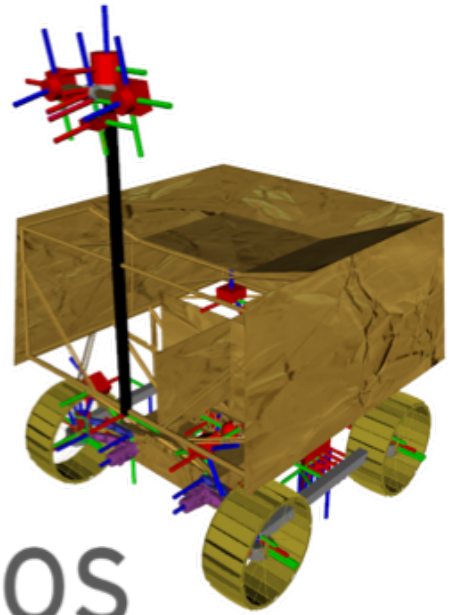
Rover Software and Physical Simulation

Rover Software

- ROS used to emulate flight software and ground software functionality
- Simulated rover is 4 wheel steer platform scaled to RP rover dimensions with RP chassis and mast

Physical Simulation

- Gazebo 7 with ODE
- Coulomb friction model with custom wheel slip model
  - first order approximation of wheel slip on unconsolidated soil



ROS

GAZEBO

Synthetic terrain generation

Obstacles in terrain geometry:

- positive (rocks)
- negative (craters)

Existing lunar DEMs

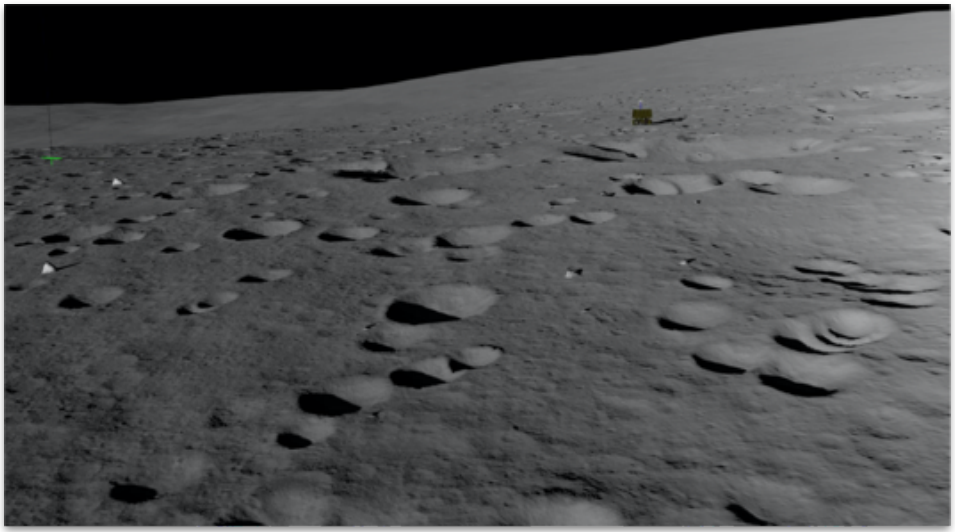
- Coarse (5-20m) and noisy

Terrain Generation

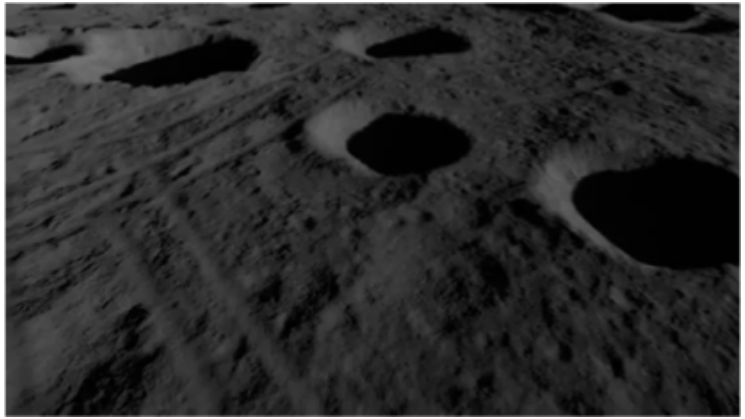
- Fractal expansion of existing lunar DEMs
- Insertion of rocks and craters based on size-frequency distribution models from lunar scientists

Lunar Highlands

LRO Reference Image



Custom material shaders



Wheel Tracks
Pass rover pose to heightmap shaders using Visual Plugin

When should you use it?
Finer control through GLSL shaders
But..

- Need knowledge of shaders / OGRE
- Consumes time and effort,
  - e.g. apply your own lighting and shadows!

In RP, custom shaders are only used for the main heightmap model

Shader Parameters

Camera exposure can be emulated by modifying shader parameters in real time

Implementation

- Gazebo plugin finds all shaders with parameter of interest
- ROS listener allows parameters to be set interactively