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Big Data Analysis with NASA's Solar System Treks

E. Law (1), Solar System Treks Development Team (1), B. Day (2), V. Bickel (3,4), S. Dell'Agnello (5)
(1) NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA. (Emily.S.Law@jpl.nasa.gov, trek@jpl.nasa.gov)
(2) NASA Solar System Exploration Research Virtual Institute. NASA Ames Research Center, Moffett Field, CA, USA. (Brian.H .Day@nasa.gov)
(3) Max Planck Institute for Solar System Research, Göttingen, Germany. (bickel@mps.mpg.de)
(4) ETH Zurich, Zurich, Switzerland (valentin.bickel@erdw.ethz.ch)
(5) National Institute for Nuclear Physics-Frascati National Labs (INFN-LNF), Frascati, Italy. (simone.dellagnello@lnf.infn.it)

Abstract

NASA's Solar System Treks (https://trek.nasa.gov) online portals provide web-based suites of interactive visualization and analysis tools enabling mission planners, planetary scientists, students, and the general public to explore planetary surfaces as seen through the eyes of many different instruments aboard a wide range of spacecraft. The portals present a big data collection of mapped data products from past and current missions for a growing number of planetary bodies. The interactive and immersive capabilities of these toola are being used for site selection and analysis by NASA and a number of its international and commercial partners, supporting upcoming missions. They are also being used by formal and informal educators, students from elementary through university levels of study, and members of the public who are engaged in the excitement of solar system exploration. This presentation will provide an overview of the Solar System Treks and highlight big data analysis tools readily available and being developed.

1. Solar System Treks Overview

NASA's Solar System Treks program of lunar and planetary mapping and modeling produces a suite of interactive visualization and analysis tools. These tools enable mission planners, planetary scientists, and engineers to access mapped data products derived from big data returned from a wide range of instruments aboard a variety of past and current missions, for a growing number of planetary bodies.

The portals provide easy-to-use tools for browsing, data layering and feature search, including detailed information on the source of each assembled data product. Interactive maps, include the ability to overlay a growing range of data sets. They allow users to easily find and access the geospatial products that are available. Data products can be viewed in 2D and 3D, and can be stacked and blended together rendering optimal visualization. Data sets can be plotted and compared against each other. Standard gaming and 3D mouse controllers allow users to maneuver first-person visualizations of flying across planetary surfaces.

The portals provide a set of advanced analysis tools that facilitate measurement and study of terrain including distance, height, and depth of surface features. The tools allow users to perform analyses such as lighting and local hazard assessments including slope, surface roughness and crater/boulder distribution, and surface electrostatic potential.

Six portals are available to the public to explore the Moon, Mars, Vesta, Ceres, Titan and IcyMoons, with more portals in development and planning stages.

2. Analysis Tools Highlights

NASA's Solar System Treks portals provides a set of analysis tools that enhance the usability of enormous amount of data returned from solar system missions. These tools faciliate a wide range of activities including the planning, design, development, test and operations associated with lunar sortie missions; robotic (and potentially crewed) operations on the surface; plan-ning tasks in the areas of landing site evaluation and selection; design and placement of landers and other stationary assets; design of rovers and other mobile assets; developing terrain-relative navigation (TRN) capabilities; deorbit/impact site visualization; and assessment and planning of science traverses. Available tools include:

Distance Measurement – An user can draw a line, a polyline, or a freehand polyline on the map and the distance will be calculated and shown.

Elevation Profile Generation – An user can draw a line, a polyline, or a freehand polyline on the map and the elevation will be shown as a plot and the numeric values can be downloaded as a spreadsheet.

Sun Angle Calculation – An user can select a point on the map, specify start and end time and interval. The results will be shown as a plot.

Subsetting – An user can specify an area by drawing a bounding box, select a map available area and desired output format. The result will be downloaded.

Slope Analysis - An user can specify an area by drawing a bounding box, select an available Digital Elevation Map (DEM) in the area and enter an email address. Upon completion of the analysis, the user will be notified through email with result as a slope map and a contour map for download.

Crater Detection - An user can specify an area by drawing a bounding box, select an available map in the area, specify downsample rate, and enter an email address. Upon completion of the analysis, the user will be notified through email with result rendered including distribution map and location, width and depth of each crater found for download.

Rock Detection - An user can specifiy an area by drawing a bounding box, select an available map in the area, specify downsample rate, and enter an email address. Upon completion of the analysis, the user will be notified through email with result rendered including distribution map and location of each rock found for download.

Surface Lighting Analysis - An user can specify an area by drawing a bounding box, enter start and end date/time, select time increment and height above surface, select an available map in the area, specify downsample rate, choose type of map to be rendered, and enter an email address. Upon completion of the analysis, the user will be notified through email with result rendered including lighting simulation, distribution plot of watts/square meter for download.

Surface ElectroStatic Potential - An user can specify an area by drawing a bounding box, and enter an email address. Upon completion of the analysis, the user will be notified through email with result rendered including a map and analysis plots for download.

Tools under development that will be integrated into the Moon portal (https://trek.nasa.gov/moon) include:

Rockfall detection – In collaboration with a researcher at the Max Planck Institute for Solar System Research and the ETH Zurich, a Convolutional Neural Network (CNN) has been implemented and trained to automatically detect rockfalls in LRO NAC imagery. This tool can be used to map rockfall distribution on a global scale, using more than 1.6 million high-resolution images.

Lunar Laser Retroreflector (LLR) Geometry Calculator - In collaboration with investigators from INFN-LNF, this calculator will support planning for future LLR deployment and LLR research on lunar cartography, lunar interior and precision tests of general relativity. It will be used to predict relative geometries between Earth laser stations, LLRs, LRO (and similar future orbiters) and to identify NAC images showing reflections of the Sun or lasers off of LLRs.

3. Summary and Conclusions

NASA's online, web-based Solar System Treks planetary visualization portals provide exciting, interactive, immersive tools that allow scientists, mission planners, and the public to understand planetary surfaces in ways they never have before. The EPSC community is invited to provide suggestions and requests as the development team continues to expand the portals' tool suite to maximize usage of data big in support of solar system research and exploration.

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