Visualizing the Universe Using OpenSpace

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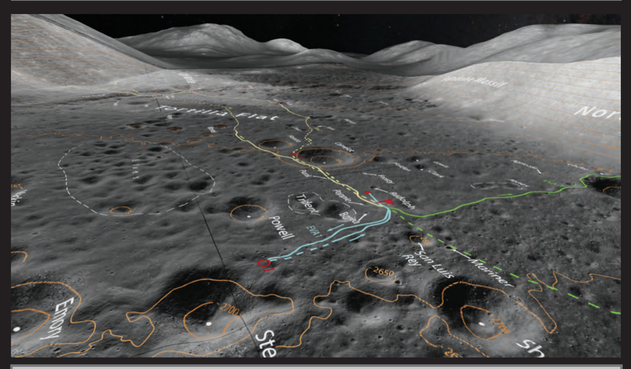
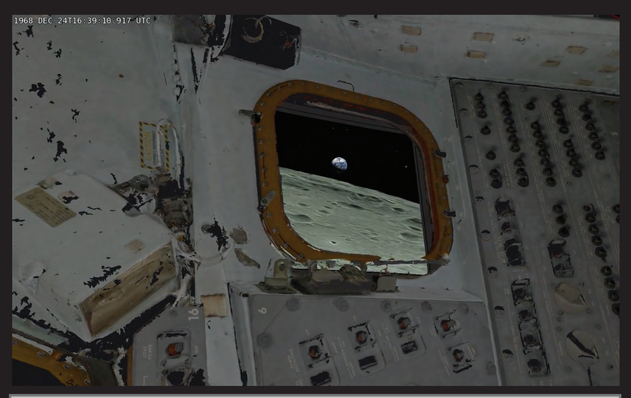
New Features:

- Visualization of Mercury's hollows at high resolution using the Ames Stereo Pipeline
- Implementation of SPICE kernel reconstructions of the Apollo 8 mission to visualize the Earthrise moment from the interior of the crew module
- Photogrammetry of boulders from Apollo 17 Haselblad photography
- USGS/DLR visualizations of Apollo 17 rover traverses
- Visualizations of NASA's InSight mission landing and NASA's Mars 2020 landing site using CRISM, CTX, HiRise data
- **Technical Improvements:**
  - updated UI using WebGUI in html5
  - ability to record and playback an interactive session, together with audio recording, and stream live to YouTube



Tarus-Littrow valley with USGS/DLR plotted rover traverses, labels, and elevation contours. Kaguya global imagery over LOLA elevation background.



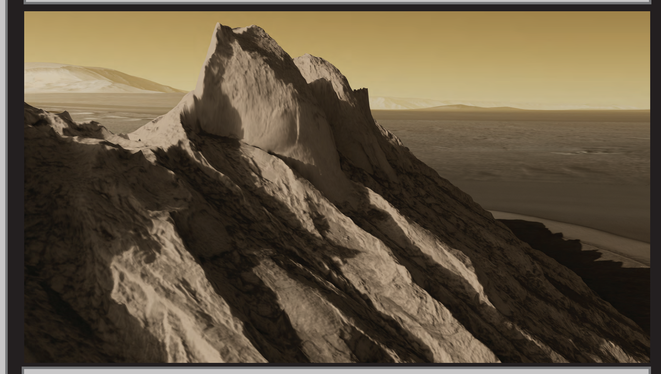
Earthrise from the interior of the Apollo 8 crew module, December 24, 1968. Using SPICE kernel reconstructions based on DSN telemetry (by Ernie Wright, GFSC, SVS). Interior 3D reconstruction by Smithsonian.

★ Capable of displaying ANY global dataset, including chemical, not shown here. ★

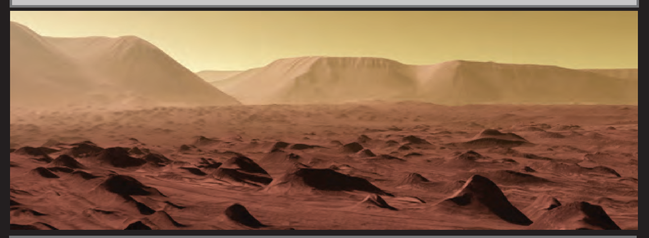
For a full list of datasets, contributors, downloads, and more. ←

Planet-Perspective

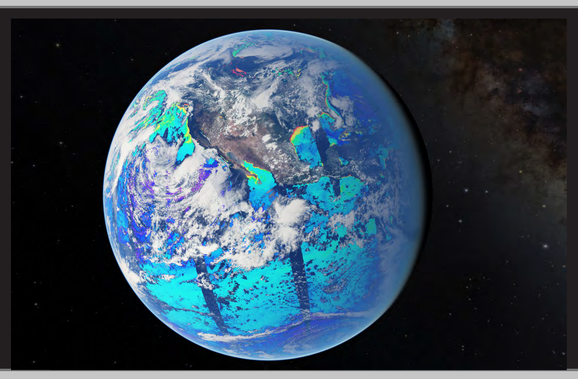
- Center on any planet in the Solar System
- View datasets draped on topography from landers, rovers and orbiters
- Easily change perspective and orientation



Light-toned sulfate mounds in Ganges Chasma, Mars. Crest of the mountain is similar in form and scale to Yosemite's Half Dome. HiRise over CTX. [2]



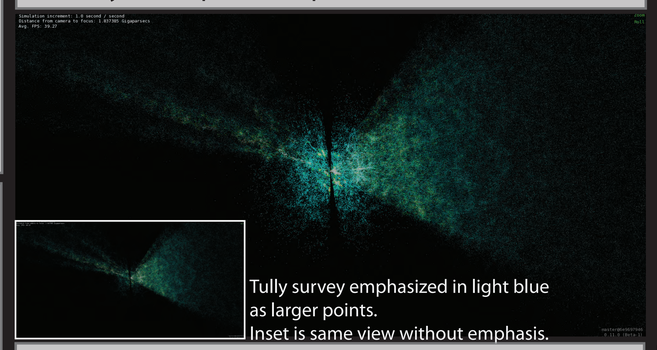
Western Candor Chasm, Mars made with high resolution Mars Reconnaissance Orbiter data.



Earth: ESRI VIIRS imagery combined with MODIS Terra Chlorophyll A temporal data.

Universe-Perspective

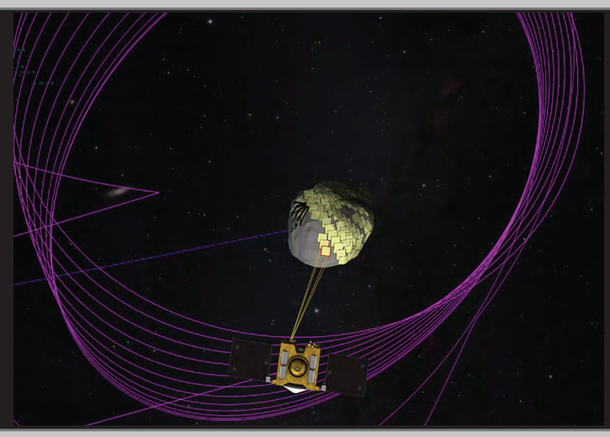
- Zoom from planet perspective to Solar System to galaxy to cosmic microwave background
- Ability to emphasize specific datasets



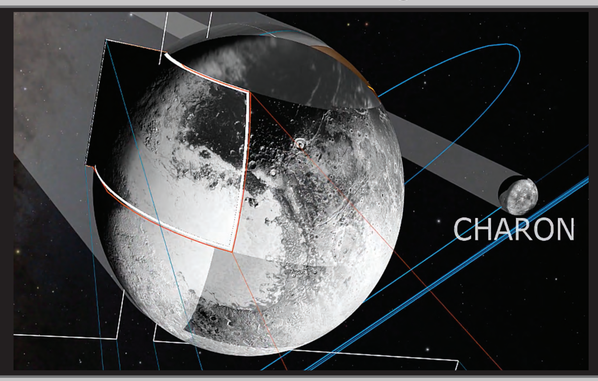
Tully and Sloan galaxy surveys. Each point is a galaxy. Viewpoint is 1.84 Gpc from Earth.

Mission-Perspective

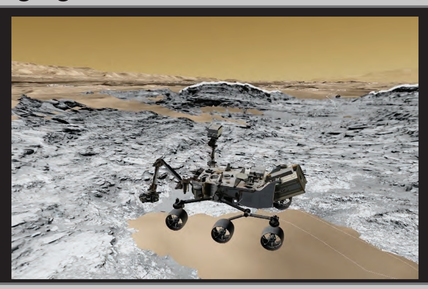
- Follow and visualize the paths of missions both in space and time
- View renderings of spacecraft
- Visualize high-resolution data *in situ*



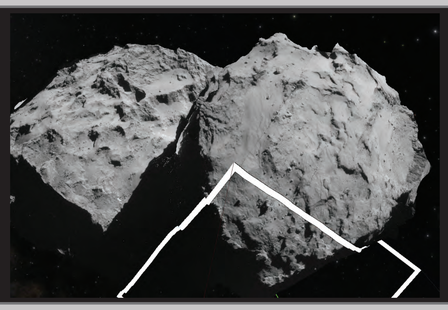
OSIRIS-REx encounter with asteroid Bennu. Spacecraft orbits shown in purple. Pointing and projection of imaging frustrum onto Bennu from SPICE kernels, with accurate background stars.



New Horizons' encounter with Pluto. Projection of LORRI camera images onto Pluto with pointing and imaging frustum from SPICE kernels [4].



Curiosity at Gale Crater. Navcam terrain models arrayed along rover transect over HiRise terrain mosaic with rover articulation from telemetry.



Projection of Rosetta's NAVCAM images onto the comet 67P/Churyumov-Gerasimenko [3].

Open Space

- OpenSpace [1] is an open source, interactive software designed to visualize the known universe and portray our ongoing efforts to investigate the entire cosmos.
- Bringing the latest techniques from data visualization research to the general public, OpenSpace supports interactive presentation of dynamic data from observations, simulations, atmospheres, and space mission planning and operations on a variety of platforms and across continents.

Datasets

- *Digital Universe (DU)*: The AMNH 3D atlas of the cosmos.
- *Missions*: Dynamically visualized within the DU.
- *Simulations and Atmospheres*: Accurately represented.
- Additional datasets continuously being added.

Platforms

- Scalable to nearly ANY platform, from computer screens to classroom projectors to planetarium domes.
- Broad compatibility with multiple software platforms and graphics hardware

Team

- OpenSpace builds on a collaboration between Sweden's Linköping University and the AMNH by including computer science experts at University of Utah's Scientific Computing and Imaging Institute and NYU's Tandon School of Engineering.
- Multiple informal science institutions (ISI's) are actively engaged in the emerging OpenSpace ISI Network.
- The AMNH team has worked with scientists from OSIRIS-REx, New Horizons, MESSENGER, the NASA Goddard Community Coordinated Modeling Center, and others to incorporate their mission activities and data into the platform for public education and engagement.

Features and Capabilities

- A scale graph approach to handle coordinate systems of magnitudes from outcrops to the Universe.
- Volume visualization techniques to inspect, verify, and make simulation output available to the public.
- Interface to NAIF's SPICE navigation and spacecraft pointing kernels.
- Capability to display fields-of-view of instruments and missions.
- Seamlessly switch between single-user/machine operation to planetarium dome display.
- Synchronization for networked remote education.
- Globe browsing techniques across spatial and temporal scales to immersively explore scientific campaigns.
- Record and image exploration sessions for education and research.
- Ability to interface with PDS archives.

What would you use visualization software for? The possibilities with OpenSpace are infinite!

References

[1] http://openspaceproject.com/ OpenSpace Website Home
[2] https://www.openspaceproject.com/projects
Images from OpenSpace website demonstrating previous projects.
[3] https://www.youtube.com/watch?v=gqWBgL4wSjo
Rosetta comet 67P imaging campaign visualization
[4] Carter Emmart Vimeo

Acknowledgements

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