Data and Methods for Recreating Earthrise

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1. Introduction

The famous Apollo 8 photograph known as Earthrise, as well as two others taken at about the same time, document the moment when the Earth was seen for the first time by human eyes from behind the Moon. But historians, and the astronauts themselves, disagree about exactly how these photographs came about.

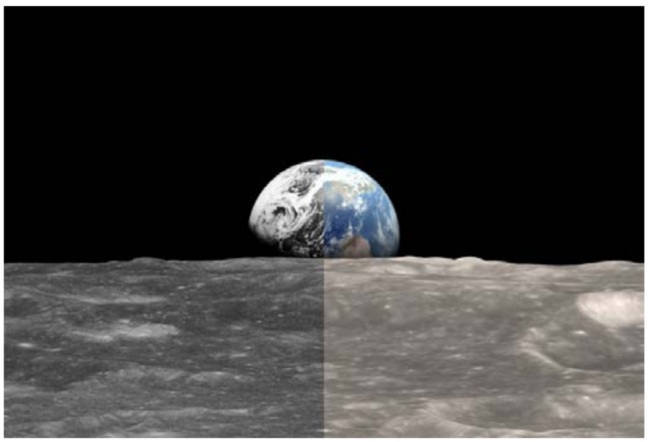

Figure 1. *AS08-13-2329, taken by Bill Anders at 16:38:42 UT on December 24, 1968 (left), visualization by the author (right).*

A new visualization recreates this moment in the flight and answers a number of open questions, including the orientation of the spacecraft, the precise timing of the photographs, the windows they were taken through, and the identity of the photographer. I will discuss important elements of the visualization, all derived from data products and software that are readily available to the public but which may not be widely known among CG artists.

2. The Moon Model

In order to recreate the mountains, craters, and surface markings seen in the photographs, an accurate model of the lunar terrain is crucial. The visualization uses maps generated by the Lunar Reconnaissance Orbiter (LRO) mission. Launched in 2009, LRO is the first mission to produce elevation and albedo maps with the necessary registration accuracy and spatial resolution, about 100 meters per pixel for the displacement and color textures used in the visualization. All of the data gathered by LRO, currently more than a quarter of a petabyte, is archived online.

SIGGRAPH 2014, August 10 – 14, 2014, Vancouver, British Columbia, Canada.

ACM 978-1-4503-2977-4/14/08

3. The Earth Model

Unlike the Moon, the appearance of the Earth is affected by daily and seasonal processes. Ideally, an Earth texture for a specific date will incorporate seasonally appropriate vegetation, snow cover, and sea ice, as well as the actual clouds for that date. The clouds can be especially important for research—they are the only clearly visible features in some Apollo photographs, for example.

The visualization's Earth model is built on the December Next Generation Blue Marble mosaic assembled from Terra MODIS data by the Earth Observatory group at NASA Goddard. NG Blue Marble images correct for the haze and color shifts caused by the atmosphere, but for realistic views from space, these corrections must be reversed. In particular, greens need to be suppressed and a light blue haze added. The cloud map in the visualization is derived from a global mosaic for December 24, 1968 produced by ESSA-7, an early weather satellite.

4. The Scene

The visualization was animated in Maya. The Moon is modeled as a stationary unit sphere at the origin, making Maya's world coordinates into Moon body-fixed coordinates. The Earth is positioned at true scale and distance, about 218 units (Moon radii) away. The sun is represented as a directional light. Several cameras, each providing the view through a different window in the spacecraft, are parented to a locator corresponding to the spacecraft's position in its orbit. The locator position is updated by an expression that references an ephemeris of the Apollo 8 orbit calculated specifically for this visualization.

The calculations used to construct this scene—the orbit ephemeris, the position and rotation of the Earth, the direction of the sun, the conversion to Moon body-fixed coordinates—all relied on the NAIF SPICE Toolkit widely used by NASA mission operations. The toolkit and data files, called SPICE kernels, are online.

5. Results

A 7-minute video incorporating the visualization was released on December 20, 2013 to commemorate the 45th anniversary of the Apollo 8 mission.

References

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LRO Planetary Data System Archive
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Earthrise: The 45th Anniversary on YouTube