

plotted to identify spikes in activity for persistently active eruptions. The entire process from start to end is autonomous.

Future spacecraft, especially those in deep space, can react to detection of transient processes without the need to

communicate with Earth, thus increasing science return. Terrestrially, this removes the need for human intervention.

This work was done by Ashley G. Davies, Joshua R. Doubleday, and Steve A. Chien of Caltech for NASA's Jet Propulsion Lab-

oratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-48123.

Raster-Based Approach to Solar Pressure Modeling

Combinations of simple geometry yield answers to complex light pressure problems.

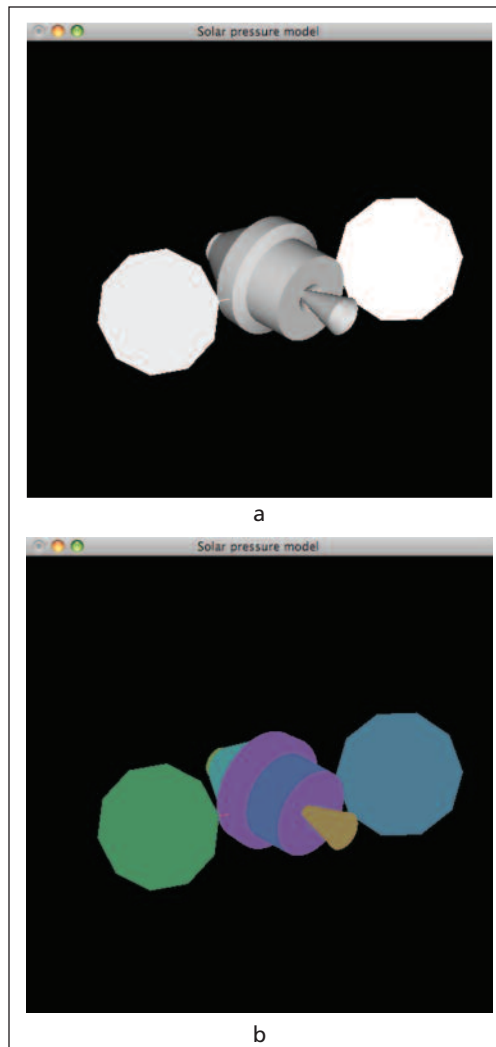
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An algorithm has been developed to take advantage of the graphics processing hardware in modern computers to efficiently compute high-fidelity solar pressure forces and torques on spacecraft, taking into account the possibility of self-shading due to the articulation of spacecraft components such as solar arrays. The process is easily extended to compute other results that depend on three-dimensional attitude analysis, such as solar array power generation or free molecular flow drag.

The impact of photons upon a spacecraft introduces small forces and moments. The magnitude and direction of the forces depend on the material properties of the spacecraft components being illuminated. The parts of the components being lit depends on the orientation of the craft with respect to the Sun, as well as the gimbal angles for any significant moving external parts (solar arrays, typically). Some components may shield others from the Sun.

The purpose of this innovation is to enable high-fidelity computation of solar pressure and power generation effects of illuminated portions of spacecraft, taking self-shading from spacecraft attitude and movable components into account. The key idea in this innovation is to compute results dependent upon complicated geometry by using an image to break the problem into thousands or millions of sub-problems with simple geometry, and then the results from the simpler problems are combined to give high-fidelity results for the full geometry.

This process is performed by constructing a 3D model of a spacecraft using an appropriate computer language (OpenGL), and running that model on a modern computer's 3D accelerated video processor. This quickly and accurately



A typical view (a) of the Crew Exploration Vehicle (CEV) with the solar array gimbals optimized to point the arrays in the Sun direction, and (b) a view of the CEV with surfaces color-coded to help identify spacecraft material properties.

generates a view of the model (as shown on a computer screen) that takes rotation and articulation of spacecraft components into account. When this view is interpreted as the spacecraft as seen by the Sun, then only the portions of the craft visible in the view are illuminated.

The view as shown on the computer screen is composed of up to millions of pixels. Each of those pixels is associated with a small illuminated area of the spacecraft. For each pixel, it is possible to compute its position, angle (surface normal) from the view direction, and the spacecraft material (and therefore, optical coefficients) associated with that area. With this information, the area associated with each pixel can be modeled as a simple flat plate for calculating solar pressure. The vector sum of these individual flat plate models is a high-fidelity approximation of the solar pressure forces and torques on the whole vehicle.

In addition to using optical coefficients associated with each spacecraft material to calculate solar pressure, a power generation coefficient is added for computing solar array power generation from the sum of the illuminated areas. Similarly, other area-based calculations, such as free molecular flow drag, are also enabled.

Because the model rendering is separated from other calculations, it is relatively easy to add a new model to explore a new vehicle or mission configuration. Adding a new model is performed by adding OpenGL code, but a future version might read a mesh file exported from a computer-aided design (CAD) system to enable very rapid turnaround for new designs

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Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-19019-1.