Books & Reports

Graph-Based Path-Planning for Titan Balloons

A document describes a graph-based path-planning algorithm for balloons with vertical control authority and little or no horizontal control authority. The balloons are designed to explore celestial bodies with atmospheres, such as Titan, a moon of Saturn. The algorithm discussed enables the balloon to achieve horizontal motion using the local horizontal winds. The approach is novel because it enables the balloons to use arbitrary wind field models. This is in contrast to prior approaches that used highly simplified wind field models, such as linear, or binary, winds.

This new approach works by discretizing the space in which the balloon operates, and representing the possible states of the balloon as a graph whose arcs represent the time taken to move from one node to another. The approach works with arbitrary wind fields, by looking up the wind strength and direction at every node in the graph from an arbitrary wind model. Having generated the graph, search techniques such as Dijkstra's algorithm are then used to find the set of vertical actuation commands that takes the balloon from the start to the goal in minimum time. In addition, the set of reachable locations on the moon or planet can be determined.

This work was done by Lars James Blackmore, Nanaz Fathpour, and Alberto Elfes of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-46607

Nanolaminate Membranes as Cylindrical Telescope Reflectors

A document discusses a proposal to use axially stretched metal nanolaminate membranes as lightweight parabolic cylindrical reflectors in the Dual Anamorphic Reflector Telescope (DART) — a planned spaceborne telescope in which the cylindrical reflectors would be arranged to obtain a point focus. The discussion brings together a combination of concepts reported separately in several prior *NASA Tech Briefs* articles, the most relevant being "Nanolaminate Mirrors With Integral Figure-Control Actuators" NPO-30221, Vol. 26, No. 5 (May 2002), page 90; and "Reflectors Made From Membranes Stretched Between Beams" NPO-30571, Vol. 33, No. 10 (October 2009), page 11a. The engineering issues receiving the greatest emphasis in the instant document are (1) the change in curvature associated with the Poisson contraction of a stretched nanolaminate reflector membrane and (2) the feasibility of using patches of poly(vinylidene fluoride) on the rear membrane surface as piezoelectric actuators to correct the surface figure for the effect of Poisson contraction and other shape errors.

This work was done by Jennifer Dooley, Mark Dragovan, Gregory Hickey, and Shyh-Shiu Lih of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).
NPO-40797

Air-Sea Spray Airborne Radar Profiler Characterizes Energy Fluxes in Hurricanes

A report discusses ASAP (Air-sea Spray Airborne Profiler), a dual-wavelength radar profiler that provides measurement information about the droplet size distribution (DSD) of sea-spray, which can be used to estimate heat and moisture fluxes for hurricane research. Researchers have recently determined that sea spray can have a large effect on the magnitude and distribution of the air-sea energy flux at hurricane-force wind speeds.

To obtain information about the DSD, two parameters of the DSD are required; for example, overall DSD amplitude and DSD mean diameter. This requires two measurements. Two frequencies are used, with a large enough separation that the differential frequency provides size information. One frequency is 94 GHz; the other is 220 GHz. These correspond to the Rayleigh and Mie regions. Above a surface wind speed of 10 m/s, production of sea spray grows exponentially. Both the number of large droplets and the altitude they reach are a function of the surface wind speed.

This work was done by Stephen L. Durden and D. Esteban-Fernandez of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-46537

Large Telescope Segmented Primary Mirror Alignment

A document discusses a broadband (white light) point source, located at the telescope Cassegrain focus, which generates a cone of light limited by the hole in the secondary mirror (SM). It propagates to the aspheric null-mirror, which is optimized to make all the reflected rays to be normal to the primary mirror (PM) upon reflection. PM retro-reflects the rays back through the system for wavefront analysis. The point source and the wavefront analysis subsystems are all located behind the PM. The PM phasing is absolute (white light) and does not involve the SM.

A relatively small, aspheric null-mirror located near the PM center of curvature has been designed to deliver the high level of optical wavefront correction. The phasing of the segments is absolute due to the use of a broadband source. The segmented PM is optically aligned independently and separately from the SM alignment. The separation of the PM segments alignment from the PM to the SM, and other telescope optics alignments, may be a significant advantage, eliminating the errors coupling. The "point source" of this concept is fully cooperative, unlike a star or laser-generated guide-star, providing the necessary brightness for the optimal S/N ratio, the spectral content, and the stable on-axis position. This concept can be implemented in the lab for the PM initial alignment, or made to be a permanent feature of the space-based or ground-based telescope.

This work was done by Mayer Rud of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47032

Simplified Night Sky Display System

A document describes a simple night sky display system that is portable, lightweight, and includes, at most, four components in its simplest configuration. The total volume of this system is no more than 10^6 cm^3 in a disassembled state, and weighs no more than 20 kilograms. The four basic components are a computer, a projector, a spherical

light-reflecting first surface and mount, and a spherical second surface for display. The computer has temporary or permanent memory that contains at least one signal representing one or more images of a portion of the sky when viewed from an arbitrary position, and at a selected time. The first surface reflector is spherical and receives and reflects the image from the projector onto the second surface, which is shaped like a hemisphere.

This system may be used to simulate selected portions of the night sky, preserving the appearance and kinesthetic sense of the celestial sphere surrounding the Earth or any other point in space. These points will then show motions of planets, stars, galaxies, nebulae, and comets that are visible from that position. The images may be motionless, or move with the passage of time. The array of images presented, and vantage points in space, are limited only by the computer software that is available, or can be developed.

An optional approach is to have the screen (second surface) self-inflate by means of gas within the enclosed volume, and then self-regulate that gas in order to support itself without any other mechanical support.

This work was done by Timothy P. Castellano of Ames Research Center. Further information is contained in a TSP (see page 1).

This invention has been patented by NASA (U.S. Patent No. 7,438,422). Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-5761. Refer to ARC-15437-1.