around each pixel, which is defined as the maximum peak-to-peak deviation from the plane perpendicular to the surface normal at that pixel.

The marsslope program takes a surface normal file as input and derives one of several slope-like outputs from it. The outputs include slope, slope rover direction (a measure of slope radially away from the rover), slope heading, slope magnitude, northerly tilt, and solar energy (compares the slope with the Sun's location at local noon).

The marsuvwproj program projects a surface normal onto an arbitrary plane in space, resulting in a normalized 3D vector, which is constrained to lie in the plane. The marsuvwrot program rotates the vectors in a surface normal file, generating a new surface normal file. It also can change coordinate systems for an existing surface normal file.

While the algorithms behind this suite are not particularly unique, what makes the programs useful is their integration into the larger *in situ* image processing system via the PIG library. They work directly with space *in situ* data, understanding the appropriate image metadata fields and updating them properly.

The secondary programs (marsuvwproj, marsuvwrot) were originally developed to deal with anomalous situations on Opportunity and Spirit, respectively, but may have more general applicability.

This work was done by Robert G. Deen, Patrick C. Leger, and Igor Yanovsky of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47724.

Ndarts

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Ndarts software provides algorithms for computing quantities associated with the dynamics of articulated, rigid-link, multibody systems. It is designed as a general-purpose dynamics library that can be used for the modeling of robotic platforms, space vehicles, molecular dynamics, and other such applications. The architecture and algorithms in Ndarts are based on the Spatial Operator Algebra (SOA) theory for computational multibody and robot dynamics developed at JPL. It uses minimal, internal coordinate models. The algorithms are low-order, recursive scatter/gather algorithms.

In comparison with the earlier Darts++ software, this version has a more general and cleaner design needed to support a larger class of computational dynamics needs. It includes a frames infrastructure, allows algorithms to operate on subgraphs of the system, and implements lazy and deferred computation for better efficiency.

Dynamics modeling modules such as Ndarts are core building blocks of control and simulation software for space, robotic, mechanism, bio-molecular, and material systems modeling.

This work was done by Abhinandan Jain of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47703.