Three Dimensional Landmark Templates

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Three-dimensional surface templates are being used to identify and locate landmarks on Mars and Phobos. They can be aligned both with images and the MOLA map to help tie these two data types together. The Martian templates form a control network of well-defined and easily identified landmarks. For small bodies, templates covering larger areas can be woven together to provide a dense shape model, a single template providing thousands of body-fixed surface vectors.

Since errors exist in estimates of body-fixed landmark location, camera orientation and spacecraft location, there will be residuals between predicted and measured landmark locations. Minimizing the mean square residuals of a single landmark over many images, and possibly the MOLA map, refines the estimate of landmark location. Minimizing the mean square residuals of many landmarks in a single image refines the estimates of camera orientation and spacecraft location.

Each surface template is represented by a pixelized array of heights, surface slopes (height gradients), and albedos, by a local coordinate system with unit vectors in the south, east and vertical (height) directions, and by a body-fixed vector from the center of the parent body to the origin of the local coordinate system.

The albedo and slope at each map pixel predicts the relative surface brightness for a given illumination and camera angle. Minimizing the mean-square residuals between this prediction and the appropriately projected imaging data over many pictures refines the estimates of slope and relative albedo. The slopes are then integrated, with a sparse set of seed heights from MOLA or surrounding templates, to provide a new set of heights. The new template is again aligned with imaging or MOLA data to begin a new estimation cycle.