

Correlation techniques as applied to pose estimation in space station docking

J. Michael Rollins

*Hernandez Engineering
Houston, TX 77058*

Richard D. Juday

*Mail Code ER5
NASA Johnson Space Center
Houston, TX 77058
(Retired)*

Stanley E. Monroe, Jr.

*Lockheed Martin Space Operations
2400 NASA Road 1
Houston, TX 77058*

ABSTRACT

The telerobotic assembly of space-station components has become the method of choice for the International Space Station (ISS) because it offers a safe alternative to the more hazardous option of space walks. The disadvantage of telerobotic assembly is that it does not provide for direct arbitrary views of mating interfaces for the teleoperator. Unless cameras are present very close to the interface positions, such views must be generated graphically, based on calculated pose relationships derived from images. To assist in this photogrammetric pose estimation, circular targets, or spots, of high contrast have been affixed on each connecting module at carefully surveyed positions. The appearance of a subset of spots essentially must form a constellation of specific relative positions in the incoming digital image stream in order for the docking to proceed. Spot positions are expressed in terms of their apparent centroids in an image. The precision of centroid estimation is required to be as fine as $1/20^{\text{th}}$ pixel, in some cases. This paper presents an approach to spot centroid estimation using cross correlation between spot images and synthetic spot models of precise centration. Techniques for obtaining sub-pixel accuracy and for shadow, obscuration and lighting irregularity compensation are discussed.

Submitted to **Signal and Data Processing of Small Targets** (Drummond), SPIE/Orlando April 2002, for *oral delivery*.