

ABSTRACT

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OPTICAL PHASE MEASURING SENSORS  
FOR AUTOMATED RENDEZVOUS AND CAPTURE

BY

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A technique is described for sensing relative spatial orientations of approach and target vehicles, using optical phase mensuration (in the interferometric sense, as opposed to LIDAR), in place of the more conventional intensity, image, or transit time measurements. This approach permits the parameters to be measured with great accuracy with relatively simple, small sensors having no moving components. A suite of sensors operating on this principle can produce all desired data using either active detection on the target or passive retroreflection to the detectors on the approach vehicle.

These optical phase measurements can be applied to determine bearing angle (location of the target vehicle in the approach vehicle coordinates), range, and attitude (orientation of the target vehicle with respect to the line-of-sight). The first two quantities require the approach vehicle to project a modulated interference pattern into space. The bearing angle is determined for a selected point on the target by measuring the phase of the interference pattern at that point using either a detector on the target or a retroreflector on the target and a detector at the transmitter. The range is found by measuring differential bearing angles to predetermined relative instrumentation sites. Two interferometers, a coarse and a fine ranger are required to resolve the  $2\pi$  ambiguity.

Determination of the attitude requires two interferometers (one each for pitch and yaw) to be mounted on the target vehicle. The approach vehicle projects a laser beam (with the modulation imposed on one polarization) instead of a fringe pattern with the interference generated with the same technique, only at the target. Once again, detection can be done either locally or back at the transmitter via retroreflection.

The interferometers themselves are of a simple design using birefringent Savart plates. They depend on photoelastic modulation of one polarization state to extract the phase of the signal using Fourier analysis of the detected radiation. This technique was initially developed under the Monocle Relay Mirror Control Concepts and Technology Demonstration Program (USASDC

contract DASG60-85-C-0024) to serve as the figure sensor for a large space based relay mirror. It was implemented as a set of grazing incidence interferometers with 40mm diameter optics and thoroughly tested in a series of experiments in vacuo. The phases of the measured wavefronts were determined to accuracies in excess of 1 part in 2000.

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