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ABSTRACT

Title: Approach Range and Velocity Determination Using Laser Sensors and Retroreflector Targets.

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Technical Details: Laser Sensors can be used to provide range and velocity determination for the Cargo Transfer Vehicle (CTV) while in proximity to Space Station Freedom (SSF). These new design sensors combine a random-modulation continuous wave diode laser with a binary optical scanner to provide a low-power, eye-safe alternative to conventional laser systems.

History: These results are based on continuing studies to define automated tracking, rendezvous, station keeping, and berthing/capture systems. The studies were initiated, by Rockwell electro-optical specialists, in response to the space shuttle requirement for automatic docking systems.

Current Status: A demonstration unit design is underway. Ongoing simulation and modeling are further defining system operational parameters. Specific range, accuracy, and reliability issues are under consideration relating to the CTV application.

Funding: The investigation is funded by Rockwell at $200,000 per year.

Rockwell International is conducting an ongoing program to develop Laser Docking Sensors (LDS) that provide high performance and high intrinsic value while meeting all mission objectives. These LDS systems are now being required to aid future spacecraft docking, station keeping, and berthing/capture systems. Improved automated tracking, rendezvous, soft docking, and capture will be required in the construction and support of SSF and future orbiting platforms. The development of a practical LDS requires an easy-to-operate, low-cost, compact system. The current LDS program draws on a number of internally funded programs. Support from internal research and development (IR&D) funding is currently budgeted at $200,000 in FY'92.

A wide range of options for laser range detection equipment, ranging from commercial technology to specialized military systems, has been evaluated. This evaluation focused on both direct applicability of existing systems and usability of specific technologies contained in these systems. From these efforts it was determined that a new approach provided the greatest promise of fulfilling all mission requirements at the lowest life-cycle cost.

This new LDS approach combines a random-modulation continuous wave diode laser with a binary optical scanner. It requires only a low input power level and provides eye-safe operation. The target is a conventional design retroreflector. The current design incorporates smart, autonomous on-board processing using techniques of pattern recognition and automatic ranging and alignment to provide high performance in a compact, low-cost system. Use of retroreflectors minimizes the equipment that must be placed on SSF.

Current performance analysis indicates range errors and velocity errors will both be less than one percent. Maximum range will be in excess of 500 feet with longer ranges possible if required in the CTV design. All components are based on existing technology and are space qualifiable. Operation does not produce, and is not affected by radio frequency interference.

In the CTV application, attitude information can be obtained by triangulation to multiple targets. In a normal operating mode, each of three LDS systems would track its own target. This configuration provides maximum update rates while allowing each system to remain in lock on its target. To support graceful degradation it is possible to track multiple targets with the same LDS if the lower update rate and time to reacquire each target between measurements are allowed by a lesser closing velocity between the CTV and SSF.

Open study issues remain on definition of exact ranges required for the CTV mission. Consideration of long-term space effects on the optical surfaces retroreflectors is also required with consideration of alternative material technologies most likely to resolve this issue.