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CATEGORY 1 - HARDWARE SYSTEMS

Coherent Doppler Lidar for Automated Space Vehicle Rendezvous, Stationkeeping and Capture
by James Bilbro, MSFC

The inherent spatial resolution of laser radar makes lidar or lidar an attractive candidate for Automated Rendezvous and Capture application. Previous applications were based on incoherent lidar techniques, requiring retro-reflectors on the target vehicle. Technology improvements (reduced size, no cryogenic cooling requirement) have greatly enhanced the construction of coherent lidar systems. Coherent lidar permits the acquisition of non-cooperative targets at ranges that are limited by the detection capability rather than by the signal-to-noise ratio (SNR) requirements. The sensor can provide translational state information (range, velocity and angle) by direct measurement and, when used with an array detector, also can provide attitude information by doppler imaging techniques. Identification of the target is accomplished by scanning with a high pulse repetition frequency (dependent on the SNR). The system performance is independent of range and should not be constrained by sun angle. An initial effort to characterize a multi-element detection system has resulted in a system that is expected to work to a minimum range of 1 meter. The system size, weight and power requirements are dependent on the operating range; 10 km range requires a diameter of 3 centimeters with overall size at 3x3x15 to 30 cm, while 100 km range requires a 30 cm diameter.

Video Guidance Sensor
by Richard Howard, MSFC

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A Martin-Marietta study comparing the application of laser, video, or RF sensors was conducted in 1982. The study concluded that video was the most attractive sensor (the video also could be used for operator monitoring). The Retro-Reflector Field Tracker from the Solar Array Flight Experiment was chosen as a "first generation" sensor and integrated with guidance algorithms for evaluation on the air-bearing vehicle. Results indicated that this sensor was not applicable for the noise environment posed by the multi-layer insulation used on most spacecraft. A "second generation" sensor was developed to be used with a modified RMS target. This sensor utilized two sets of laser diodes to acquire three optically filtered targets. The targets were illuminated first with a 780 nanometer diode, followed by illumination with a 830 nm diode. The second digitized picture was subtracted from the first to get a low-noise image. The centroids of the retroreflectors were used then to uniquely derive target attitude and range. The sensor presently operates to 80 feet and within ± 40 degrees in pitch and yaw. Sensor operability is a concern if the sun is within a ± 40 degree cone angle of the target. The present sensor performance characteristics are less than 1% range error and less than 1 degree angle error. Future sensor development is anticipated to extend the operating range to 150 feet and reduce the cone angle of sensor inoperability to within ± 10 degrees of direct sunlight. Performance improvements also are anticipated. TRW currently is developing a system that utilizes dual cameras with simultaneous diode illumination. Although further development is being pursued, the basic system has proven sound and the sensor is essentially ready for application.

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Approach Range and Velocity Determination Using Laser Sensors and Retroreflector Targets
by W. J. Donovan, Rockwell International

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A laser docking sensor study currently is in the third year of development. The design concept is considered to be validated. The concept is based on using standard radar techniques to provide

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