ware facilitates access to multiple sources of data on an event of scientific interest, enables coordinated use of multiple sensors in rapid reaction to detection of an event, and facilitates the tracking of spacecraft operations, including tracking of the acquisition, processing, and downlinking of requested data.

This program was written by Robert Sherwood, Benjamin Cichy, Daniel Tran, Steve Chien, Gregg Rabideau, Ashley Davies, Rebecca Castaño, Stuart Frye, Dan Mandl, Seth Shulman, and Sandy Grosvenor of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

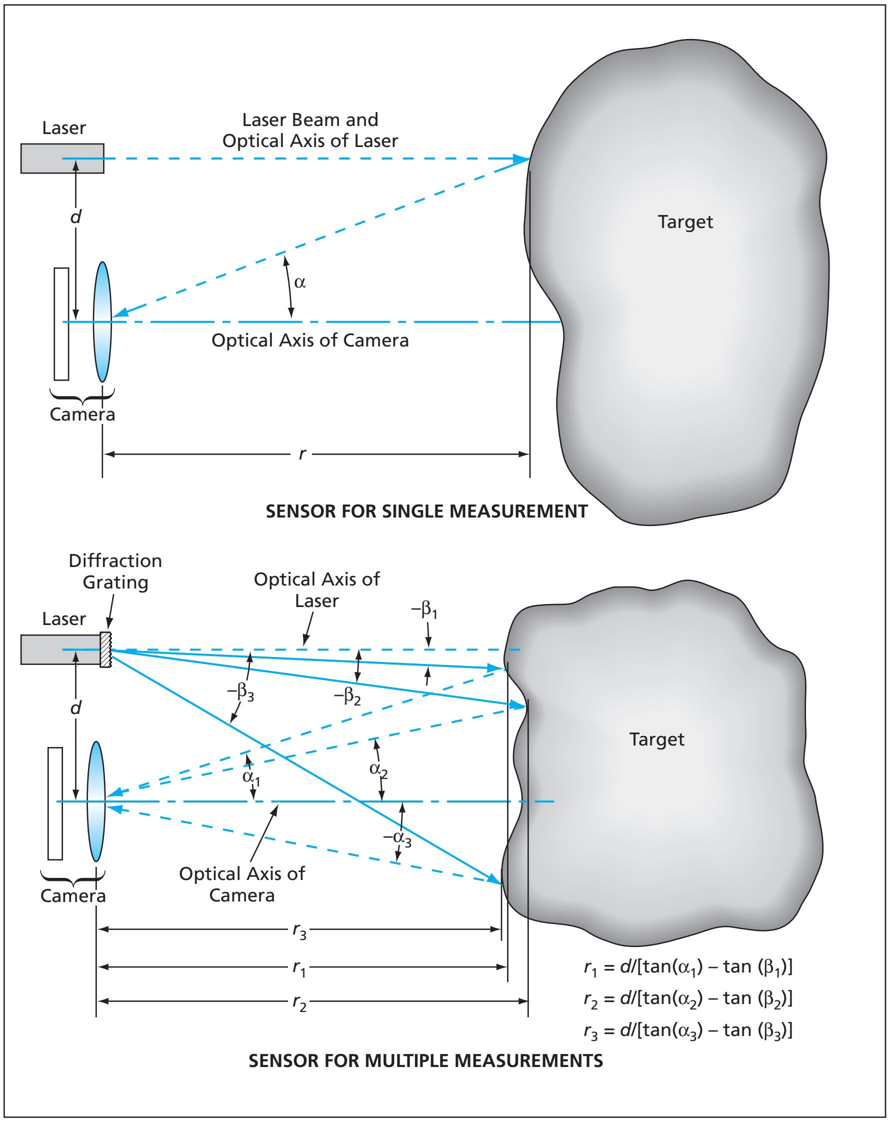
This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42523.

Range-Measuring Video Sensors

Distances would be measured by three-dimensional triangulation.

Marshall Space Flight Center, Alabama

Optoelectronic sensors of a proposed type would perform the functions of both electronic cameras and triangulation-type laser range finders. That is to say, these sensors would both (1) generate ordinary video or snapshot digital images and (2) measure the distances to selected spots in the images. These sensors would be well suited to use on robots that are required to measure distances to targets in their work spaces. In addition, these sensors could be used for all the purposes for which electronic cameras have been used heretofore.



These **Two Sensors** would utilize triangulation to measure ranges. The simpler sensor is shown at the top, mainly to help explain the basic principle of operation. The more complex sensor shown at the bottom would likely be preferable in practice.

The simplest sensor of this type, illustrated schematically in the upper part of the figure, would include a laser, an electronic camera (either video or snapshot), a frame-grabber/image-capturing circuit, an image-data-storage memory circuit, and an image-data processor. There would be no moving parts. The laser would be positioned at a lateral distance d to one side of the camera and would be aimed parallel to the optical axis of the camera. When the range of a target in the field of view of the camera was required, the laser would be turned on and an image of the target would be stored and preprocessed to locate the angle (α) between the optical axis and the line of sight to the centroid of the laser spot. Then the range, r (more precisely, the length of the optical-axis component of the range vector) of the laser-illuminated spot on the target would be given by

$$r = d/\tan(\alpha).$$

The lower part of the figure depicts a more complex sensor that could measure the ranges of multiple targets or multiple spots on the same target. The basic optical arrangement would be as described above, except that a diffraction grating would split the laser beam into multiple beams, each at a different angle in the plane defined by the camera and laser optical axes. In this case, the range of the spot illuminated by the ith laser beam would be given by

$$r_i = d/[\tan(\alpha_i) - \tan(\beta_i)],$$

where β_i is the angle of the ith beam and all angles are measured as positive above or negative below the horizontal optical axes in the figure.

This work was done by Richard T. Howard, Jeri M. Briscoe, Eric L. Corder, and David Broderick of **Marshall Space Flight Center**. *Further information is contained in a TSP (see page 1). MFS-31891-1*