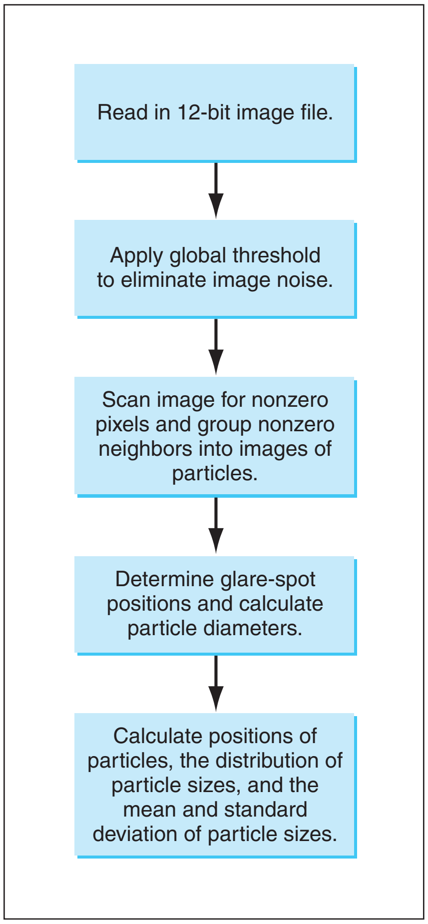

The **Algorithm of the Proposed Method** would process DPIV data to extract information on particle sizes. The size information would be in addition to the velocity information extracted from the data by use of previously developed DPIV software.

charge-coupled device (CCD) camera aimed along a line perpendicular to the illuminated plane. Unlike in DPIV as practiced heretofore, care would be taken to polarize the laser beam so that its electric field would lie in the illuminated plane, for the reason explained in the next paragraph.

The proposed method applies, more specifically, to transparent or semitransparent spherical particles that have an index of refraction different from that of the fluid in which they are entrained. The method is based on the established Mie theory, which describes the scattering of light by diffraction, refraction, and specular reflection of light by such particles. In the case of a particle illuminated by polarized light and observed in the arrangement described in the preceding paragraph, the Mie theory shows that the image of the particle on the focal plane of the CCD camera includes two glare spots: one attributable to light reflected toward the camera and one attributable to light refracted toward the camera. The distance between the glare spots is a known function of the size of the particle, the indices of refraction of the particle material, and design parameters of the camera optics. Hence, the size of a particle can be determined from the distance between the glare spots.

The proposed method would be implemented in an algorithm that would automatically identify, and measure the distance between, the glare spots for each particle for which a suitable image has been captured in a DPIV image frame. The algorithm (see figure) would begin with thresholding of data from the entire image frame to reduce noise, thereby facilitating discrimination of particle images from the background and aiding in the separation of overlapping particles. It is important not to pick a threshold level so high that the light intensity between a given pair of glare spots does not fall below the threshold value, leaving the glare spots disconnected.

The image would then be scanned in a sequence of rows and columns of pixels to identify groups of adjacent pixels that contain nonzero brightnesses and that are surrounded by pixels of zero brightness. Each such group would be assumed to constitute the image of one particle. Each such group would be further analyzed to determine whether the image was saturated; saturated particle images must be rejected because the locations of glare spots in saturated images cannot accurately be determined. Within each unsaturated particle image, the centroids (deemed to be the locations) of the glare spots would be determined by means of gradients of brightness distributions and three-point horizontal and three-point vertical Gaussian estimates based on the brightness values of the brightest pixels and the pixels adjacent to them. If the brightness of a given particle image contained only one peak, then it would be assumed that a second glare spot did not exist and that image would be rejected.

Once the centroids had been estimated for all particle images for which it was possible to do so, the positions of the particles and the distances between their centroids would be computed. As described above, the size of each particle would then be computed from the distance between its centroids. Finally, the distribution, mean, and standard deviation of sizes would be computed for the collection of particle images that survived to the final stage of the centroid-estimation process.

This work was done by M. P. Wernet of **Glenn Research Center** *and A. Mielke and J. R. Kadambi of Case Western Reserve University. Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17340.

Faster Processing for Inverting GPS Occultation Data

NASA's Jet Propulsion Laboratory, Pasadena, California

A document outlines a computational method that can be incorporated into two prior methods used to invert Global Positioning System (GPS) occultation data [signal data acquired by a low-Earth-orbiting satellite as either this or the GPS satellite rises above or falls below the horizon] to obtain information on altitude-dependent properties of the atmosphere. The two prior inversion methods, known as back propagation and canonical transform, are computationally expensive because for each occultation, they involve numerical evaluation of a large number of diffraction-like spatial integrals. The present method involves an angular-spectrum-based phase-extrapolation approximation in which each data point is associated with a plane-wave component that propagates in a unique direction from the orbit of the receiving satellite to intersect a straight line tangent to the orbit at a nearby point. This approximation enables the use of fast Fourier transforms (FFTs), which apply only to data collected along a straight-line trajectory. The computation of the diffraction-like integrals in the angular-spectrum domain by use of FFTs takes only seconds, whereas previously, it took minutes.

This work was done by Chi Ao of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

The software used in this innovation is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-30791.