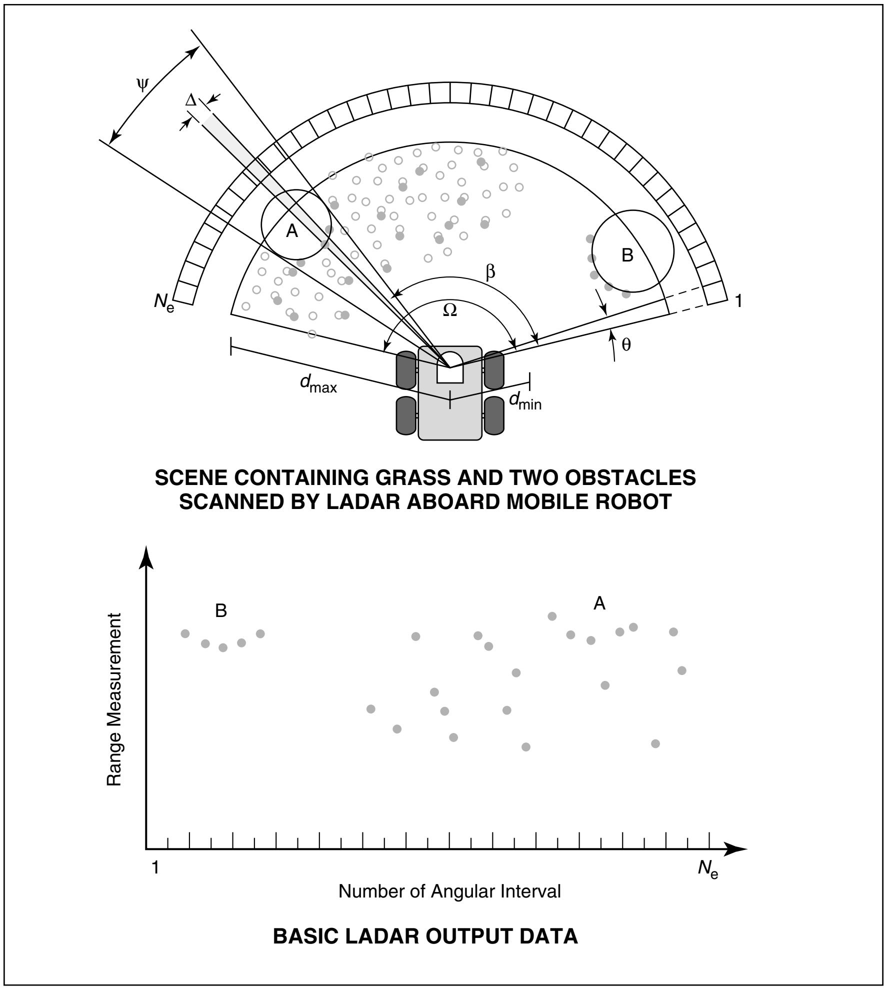

SCENE CONTAINING GRASS AND TWO OBSTACLES SCANNED BY LADAR ABOARD MOBILE ROBOT

BASIC LADAR OUTPUT DATA

Ladar Aboard a Robotic Vehicle scans through a fan-shaped area to measure distances to nearby objects, which are represented here by circles. The small circles represent stalks of grass. Large circle A represents a tree trunk partly hidden by grass; large circle B represents a tree trunk in the clear.

scans the beam through a relatively wide angular range of Ω in a horizontal plane at a suitable small height above the ground. Successive scans are performed at time intervals of τ seconds. During each scan, the laser beam is fired at relatively small angular intervals of θ radians to make range measurements, so that the total number of range measurements acquired in a scan is $N_e = \Omega/\theta$.

The basic ladar output data for each scan consist of a range measurement for each of the N_e angular intervals. These data are processed by an algorithm that classifies objects as either foliage (that is, grass stalks) or not foliage (that is, obstacles). Objects to which the algorithm cannot assign the classification "foliage" with a sufficiently high degree of confidence are conservatively classified as "not foliage" to ensure avoidance of obstacles.

The classification is made on the basis of three locality principles that are here described by reference to object A at scan angle β in the figure. The first principle is one of locality in both space and time: If A is an obstacle and is found at angle β at time t, then it will be found at an angle near β at time $t + \tau$. The second principle is that if A is an obstacle, it must subtend a substantial angle ψ and all laser-beam directions that intersect A must lie within the angular range $\beta\pm\psi$. The third principle is one of spatial locality of the gaps between grass stalks that enable the laser beam to penetrate the foliage and reach object A: If the laser beam penetrates the foliage and hits A when aimed at angle β, then it is also likely to do so when aimed at angle $\beta\pm\Delta$. These locality principles hold for any combination of motions of the robot and the obstacles, as long as the angular sampling interval (θ) and the time between consecutive scans (τ) are sufficiently small.

This work was done by Andres Castano of Caltech for **NASA's Jet Propulsion Laboratory***. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com****.*
NPO-30597

Books and Reports

Survivable Failure Data Recorders for Spacecraft

A spacecraft may be unable to communicate critical data associated with a serious or catastrophic failure. A brief report proposes a system, somewhat like a commercial aircraft "black box," for retrieving these data. A microspacecraft attached to the prime spacecraft would continually store recent critical data from that spacecraft. If either spacecraft detected certain serious conditions of the prime spacecraft, the microspacecraft would separate from the prime spacecraft and independently transmit the stored data to Earth. Supplemental data, acquired from sensors onboard the microspacecraft, could be added to this transmission. For example, the orientation and angular rates of the prime spacecraft immediately before separation as well as pictures taken of the prime spacecraft after separation could be included. Functional enhancements over aircraft black boxes include the separation from the prime vehicle (which gains independence from the fate of that vehicle), wireless transmission of data (making physical black box recovery unnecessary), and the optional acquisition of supplemental sensor data.

This work was carried out by John Carraway and David Collins of Caltech for **NASA's Jet Propulsion Laboratory***. To obtain a copy of the report "Spacecraft 'Black Box' Flight Recorder," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com****. NPO-20842*