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Extending robotics capabilities

Survey of collision avoidance and ranging sensors for mobile robots

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Abstract

The past few years have brought a tremendous rise in the envisioned potential of robotic systems, and a correspondingly significant increase in the number of proposed applications. In the nonindustrial arena, numerous programs have evolved, each intending to harness some of this promise in hopes of solving some particular application need. Most of these efforts are government-sponsored, aimed at the development of systems for fighting fires, handling ammunition, transporting materials, conducting underwater search and inspection operations, and patrolling warehouses and storage areas, to name but a few. Many of the resulting prototypes, which were initially perceived as logical extensions of the traditional industrial robotic scenarios, have met with unexpected difficulty due to an insufficient supporting technology base.

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One such problem area common to many of these efforts arises from the need of a mobile system to interact with the physical objects and entities in its environment. The platform must be able to navigate from a known position to a desired new location and orientation, at the same time avoiding any contact with fixed or moving objects while enroute. There has been quite a tendency in many cases to oversimplify these issues, and assume that the natural growth of technology will provide the needed solutions. While this ultimately will come to pass, it is important to pace the development of the platform with a parallel development of the needed collision avoidance and navigation technology. Fundamental in this regard are the required sensors with which to acquire high resolution data describing the robot's physical surroundings, in a timely yet practical fashion in keeping with the limited onboard energy and computational resources of a mobile vehicle.

This document is intended to provide some basic background on the various noncontact distance measurement techniques available, with related discussion of their implementation in the acoustical, optical, and electromagnetic portions of the energy spectrum. An overview of candidate systems, both commercially available and under development, is provided, followed by a brief summary of interesting research currently underway in support of the collision avoidance and noncontact ranging needs of a mobile robot.

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Keywords

Sensors; Non-contact ranging; Stereopsis; Proximity sensors; Ultrasonic ranging; Triangulation; Phase modulation; Frequency modulation; Interferometry; Swept focus; Lasers; Structured light; Microwave ranging; Millimeter wave ranging; Time-of-flight ranging; Sonar; Imaging systems; Video systems; Collision avoidance

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In December, 1982 he was assigned to the Naval Sea Systems Command in Washington, DC, and designated VADM Earl B. Fowler's Special Assistant for Robotics. He then served as the Director of the NAVSEA Office of Robotics and Autonomous systems, where he was responsible for coordinating the introduction of robotic technology into all aspects of ship and weapon system manufacturing, repair, and operations.

CDR Everett is currently assigned to the Advanced Systems Division, Code 5303, at the Naval Ocean Systems Center, San Diego, CA, where he oversees work on several robotic development efforts for Navy and Marine Corps applications. He has been personally active in the field of mobile robot research for many years, and is a member of Sigma Xi, IEEE, Robotics International of SME, and the SNAME Ship Production Committee Panel SP-10 (Flexible Automation).

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