ARK: Autonomous Robot for a Known Environment

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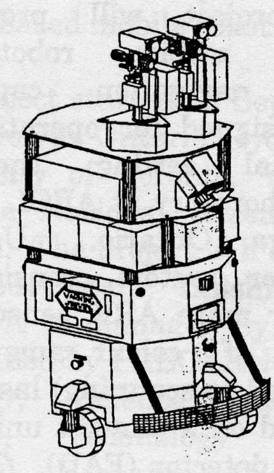
Abstract

The ARK (Autonomous Robot for a Known Environment) Project is a precompetitive research project involving Ontario Hydro, AECL, the University of Toronto, York University and the National Research Council of Canada. The project started in September 1991 and will be completed in August 1995. The technical objective of the project is to develop a sensor-based mobile robot that can navigate in an industrial environment.

The applications of mobile robots in industry have been limited because of our inability to give robots sufficient intelligence to sense, think about, and act on their environment in the same way as humans, without the aid of humans.

There are many types of industrial activities where the use of mobile robots would reduce hazards to humans, or increase productivity. An example would be the continuous inspection for spills, leaks, or unusual sounds in large



ARK-2 Conceptual design

industrial facilities. Other examples would be underground mining, materials handling in computer integrated manufacturing environments, and the carrying out of inspections, the cleaning up of spills, or the carrying out of repairs

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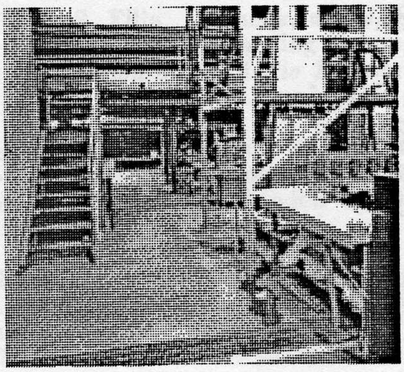
in the radioactive areas of nuclear plants- leading to increased safety by reducing radioactive dose to workers.



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The ARK project will produce a self-contained mobile robot with sensor-based navigation capabilities specifically designed for operation in a real industrial setting: the large engineering laboratory at AECL CANDU in Mississauga, Ontario. Using its onboard sensor system, consisting of sonars; one or more ARK sensor heads each consisting of a colour camera and a spot (as opposed to scanning) laser range finder mounted on a pan-tilt unit; and a floor anomaly detector (FAD). The pan, tilt, camera zoom, camera focus and laser distance reading of the ARK sensor head will all be computer controlled, with the laser distance reading taken along the optical axis of the camera lens. The FAD, which is based on the NRC BIRIS sensor, will be able to detect objects on the floor that cannot be detected by the sonar system and are too large for ARK to traverse. The types of objects that FAD will be able to cope with include hoses, drains and spilled liquids.

ARK will be able to find its own way from one place to another, with no help from a human operator and no engineering of the environment through radio beacons, bar codes on the walls or magnetic strips beneath the floors. As it moves about, the robot will compare a partial internal representation of its environment, in the form of the location and nature of landmarks, with the images from its cameras and other sensors to determine its position and to help it plan its movements. ARK will avoid any objects in its path, whether or not the objects are stationary or moving, and whether or not the objects are part of the internal representation.

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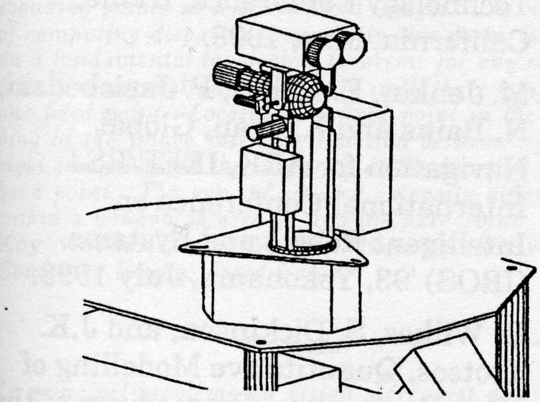
The difficulties that ARK will have to face in the AECL Engineering Laboratory environment that the robots of most other mobile robotics projects do not address, and which make the ARK project unique, include: the lack of vertical flat walls; a grey environment with not much colour; large open spaces (the main isle is 400' long) as well as small cramped spaces; high ceilings (50'); large windows near the ceiling resulting in time dependant and weather dependant lighting conditions, a large variation in light intensity, as well as highlights and glare; a large number of temporary and



ARK sensor head

semi-permanent structures; many (some very large) metallic structures; people and forklifts moving about; oil and water spills on the floor; floor drains (sometimes open); hoses and piping on the floor; chains hanging down from above and protruding structures at just the right height to sheer off ARK sensor heads. Ideally, ARK will be able to cope with all of these problems.

Two ARK prototypes are being built: one at the University of Toronto and the other at AECL. ARK-1 (at Toronto) is being jointly constructed by university and industry personnel. It will be used to test the ideas, sensors and algorithms that will ultimately be used on ARK-2. The computing for ARK-1 will be done mainly off-board while that for ARK-2 will be done mainly on-board. As well, ARK-2 will have a real time operating system.

A strength of the ARK project is that the industrial participants, by working closely with the researchers from the University of Toronto, York University and the National Research Council, are able to learn from their experience and acquire the results of their excellent research in computer vision and sensor-based mobile robotics.

The project started on September 3, 1991 and involves Ontario Hydro, AECL, the University of Toronto, York University and the National Research Council of Canada. The project will cost $9.5 million over four years, finishing in August, 1995. It is managed by Ontario Hydro and funded by PRECARN Associates Inc., Industry, Science and Technology Canada, Technology Ontario, the National Research Council, Ontario Hydro and Atomic Energy of Canada Ltd.

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