Chapter 4

Mobile Robots Navigation

The four papers of this chapter deal with indoor and outdoor mobile robots navigation.

The paper by Maeyama, Ohya and Yuta presents the basic concept behind the navigational system for the small Yamabiko robot. It is the hallmark of Professor Shinichi Yuta's laboratory at the University of Tsukuba. The robot was human guided, learning long path segments in outdoor, flat terrain environments. The subsequent autonomous repetition of these paths by playback allows to recognize and learn navigation cues. A multi-agent architecture was used to recognize and match vision and ultrasonic cues (extracted during training) with natural landmarks during the autonomous repetition stage. Path segments totaling approximately 2 km are the target of this functional system which carries all sensors, computational support, motion control electronics and power sources onboard a differentially steered vehicle weighing approximately 12 kg.

The paper by Ray Jarvis reported work on extending a previously constructed indoor mobile robot navigation system by replacing an umbilical cable by a radio ethernet link to a wired LAN of Silicon Graphics Work Stations. The navigation system is capable of relatively brisk navigation from a nominated start point to a specified goal position in an initially unknown and relatively unstructured environment and can accommodate environmental variability. A Denning bar-code beacon-based localizer and a Erwin Sick time-of-flight scanning range finder were the only two sensors used. A distance transform based global path planner is used in continuous mode to update the best remaining path plan as the unknown and perhaps changing environment is being mapped and updated. There are no computing resources on-board except those embedded in the radio ethernet unit, the serial line server and the micro-controller used for wheel control. Standard wheelchair motor/gear sets were used in differentially steered mode. The system is very robust and can carry a payload of up to 150 kg for up to 6 hours between rechargings of the on-board batteries. The system shows considerable commercial viability and can be delivered complete for approximately US$25K.

Cozman and Krotkov present a mobile robot operating in space. The main interest is the interface that aids human operators to teleoperate rovers by localizing the position of the mobile. The position estimation algorithm using a constructed figure of merit that reflects the effect of disturbances in the image and can include information about a priori knowledge about position.
The paper by Hait, Simeon and Taix deal with the problem of combining terrain modeling with 3D motion planning using specified landmarks. Both the validity constraints concerning the climbing viability and stability of the six wheeled, articulated body, Russian built vehicle and the visibility constraints concerning the view ability of the landmarks, were taken into account. A global planner defines sub-goals, transfers between which are then handled by a local planner which calculates and chooses between feasible trajectories. Edge costs evaluated during optimal path selection include both path length and terrain difficulty. This project was undertaken within the framework of the EDEN project at LAAS-CNRR in Toulouse, France. The system is capable of fully autonomous navigation in very rugged and obstacle cluttered environments. A number of simulated results were shown to illustrate the method. The motion planner presented is currently being integrated into the EDEN experimental test-bed. A Marsokhod vehicle, called LAMA, equipped with a range finder and stereo vision system, will be used.