

Intelligent Guidance and Obstacle Avoidance of an Autonomous Mobile Robot

Muhammad Athar Syed, Aslam Pervez, Muhammad Saleem Koul,
Farhan Ullah, Shaista Batool Naqvi And Muhammad Anwar

Informatics Complex (ICCC) P.O. Box No. 2191, H-8
Islamabad, Pakistan.

Extended Abstract

One of the objectives of current robotic research is to develop the mobile robots capable of navigating in unstructured environments. An autonomous mobile robot ICMR-1 (*Informatics Complex Mobile Robot-1*) has been designed and developed at Informatics Complex as a test-bed for studying various control strategies. This paper discusses the techniques for reactive behaviour control of mobile robots from the point of view of the on-line intelligent guidance and obstacle avoidance of ICMR-1 in unstructured environment, where no a-priori knowledge of the obstacles' location is available.

Two techniques for reactive behaviour control are compared that are based, respectively, on the artificial potential field and the fuzzy logic. In the first technique [1], the mobile robot is assumed as a particle in configuration space, under the influence of an artificially created potential field. The values of the field at different configurations are represented by the potential functions that depend upon the robot's target position and its distance to obstacle located in the environment. The potential functions are converted into corresponding force vectors and the later are translated into motion controller commands. The second technique applies the fuzzy logic [2] for modelling the uncertainties and ambiguities encountered in the environment. In this technique, the reactive behaviour is formulated by fuzzy sets and a rule-base. In the rule-base, three types of rules for reactive behaviour are defined for obstacle avoidance, following edges and target steer, respectively. The conflicts and competition among different types of reactive behaviour are coordinated by fuzzy reasoning [3].

The simulation results of the techniques delineated above, have indicated the local minima problem where mobile robot fails to escape from inside the curved obstacles. To avoid the robot trapping in a local minima, an improved technique based on the fuzzy logic is developed. In this technique, the time-of-flight based sonar sensors are used for building the planer map of each obstacle's boundary as a set of points in the operational space. Soon after avoiding an obstacle, if there are no more obstacles in the vicinity of the mobile robot, the slope between the robot and the target is obtained. This slope is compared with the slope between each point of the obstacle's map and the obstacle. The location of the mobile robot, where the values of two slopes are same, corresponds to the point that generally leads again towards the obstacle that has already been avoided. The wheel odometry based dead reckoning system is implemented for the discrete time navigation to estimate the location of the mobile robot. The computer simulation results are detailed that provide the effectiveness of the proposed technique. This technique is successfully implemented on ICMR-1 and the experimental results are presented.

References

1. O. Khatib, "Real time obstacle avoidance for manipulators and mobile robots," *International Journal of Robotics Research*, vol. 5, no. 1, pp. 90-96, 1986.
2. L. A. Zadeh, "Fuzzy sets," *Information and Control*, vol. 8, pp. 338-353, 1965.
3. W. Li, "Fuzzy -logic-based reactive behaviour control of an autonomous mobile system in unknown environment," *Engineering Applications of Artificial Intelligence*, vol. 7, no. 5, pp. 521-531, 1994.