Chapter 6
Support Vector Machine Based Mobile Robot Motion Control and Obstacle Avoidance

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ABSTRACT

Considering the noise effect during the navigation of a two wheeled mobile robot, SVM and LS-SVM based control schemes are discussed under the measured information with uncertainty, and in the different environments. The noise effect is defined as uncertainty in the measured data. One of them focuses on using a potential function and constructing a plane surface for avoiding the local minima in the static environments, where the controller is based on Lyapunov function candidate. Another one addresses to use a potential function and to define a new detouring virtual force for escaping from the local minima in the dynamic environments. Stability of the control system can be guaranteed. However, the motion control of the mobile robot would be affected by the noise effect. The SVM and LS-SVM for function estimation are used for estimating the parameter in the proposed controllers. With the estimated parameter, the noise effect during the navigation of the mobile robot can be reduced.

INTRODUCTION

In a general way, the types of robots are divided into robot manipulators, wheeled mobile robots, aerial robots, underwater robots and humanoid robots etc. Wheeled mobile robots increasingly are applied in industrial and service robotics,

particularly when flexible motion capabilities are required on reasonably smooth grounds and surfaces. In general, path planning and controller design of the mobile robot are being given much attention, which aim at enabling robots attain the goal without collision with other objects in given environments, therewith path planning has been a central topic in robotics for several decades and many path planning algorithms have been

presented in the literatures. In some studies of path planning and control, collision free motion of the mobile robot has been discussed while there exist obstacles.

The potential fields typically proceed optimum path planning by defining an artificial repulsive field (which acts to steer the robot away from obstacles) and an artificial attractive field (which acts to pull the robot toward the goal configuration) (Latombe, 1991). The potential field method is computationally much less expensive. It is particularly attractive because of its elegant mathematical analysis and simplicity. Therefore the research activity in this field has been increasing. The developments of constructing potential field for robot navigation are also being given much attention correspondingly (Rimon, 1992; Hwang, 1992; Louste, 2002; Ge, 2002; Luh, 2007). Usually, the potential field function is defined over the robot's space, with a global minimum at the goal. In the presence of obstacles, local minima appear in the potential field. The mobile robot may run into one of them and cannot attain the goal. Therefore, the issue of local minima problem and obstacle avoidance have also been addressed by many researchers (Koren, 1991; Okuma, 2004; Mabrouk, 2008).

In fact, constructing potential fields for robot navigation are considered in given environments. The static environments are with unmoved obstacles and unmoved target (AL-Taharwa, 2008). In the static environments, Rimon (1992) has proposed a navigation function for the mobile robot path planning and control, in which the obstacles are modelled with arbitrary shapes in a generalized sphere world with simplification of the shape of the objects. At the same time, Lyapunov function candidate based methods are presented for the robot path planning (Tsuchiya, 1999; Dixon, 2000; Okuma, 2004; Deng, 2008). Okuma (2004) proposed a state feedback controller for collision avoidance of the mobile robot by a suitable choice of the Lyapunov function.

Meanwhile, Deng (2008) showed a potential field method based on Lyapunov function candidate for the case of unmoved obstacle and target in the static environments. For this case, a compensating function based on maximum point information of Lyapunov function candidate is designed for canceling the local minima and avoiding the obstacles. However, the Lyapunov compensation function is difficult to design with the moving obstacle and the moving target. In the dynamic environments, the obstacle and the target are moving and their velocities are known. In the dynamic environments, Ge (2000; 2002) introduced an artificial potential method in the dynamic environments which consist of moving target and moving obstacle. Loizou (2003) considered the navigation for the mobile robot moving amongst the moving obstacles. Luh (2007) discussed the motion planning for the mobile robot in the dynamic environments using a potential field immune network. However, in real application, the measured data is with uncertain noise, the observation information is uncertain. The uncertainty in the measured data is not considered in the mentioned methods. In general, sensing is not perfect either and does not provide an exact knowledge of the robot's current configuration during execution. Hence, a fundamental difficulty is that uncertainty exists not only at planning time, but also at execution time. The above case imposes a restriction on the existed methods. The desired control results are difficult to obtain because of uncertainty in the measured data. The need for reducing the noise effect arises because the noise would affect the motion of the mobile robot, as well as the control accuracy of the mobile robot.

On the other hand, a computational learning method based on the statistical learning theory is introduced for reducing the noise effect during the navigation of the mobile robot. Support vector machine (SVM) which is based on the idea of structural risk minimization has recently been presented for solving various classification

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