Obstacle Avoidance of Mobile Robot by Fuzzy Logic System

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Abstract. The fuzzy logic system has widely used in many industrial fields. In this paper we propose an obstacle avoidance algorithm for a path planning in unknown environment of a mobile robot. The ultrasonic sensors are employed for detecting the position and distance recognition of obstacles. An angular velocity control for left and right wheels is implemented by a fuzzy logic system. Simulation results show that the proposed method presents good performance in the view of obstacle avoidance and path creating.

Keywords: fuzzy logic system, mobile robot, obstacle avoidance.

1 Introduction

In this paper we propose a fuzzy logic based control system for path tracking of an indoor mobile robot. Here the left and right wheels' angular velocities are controlled by a fuzzy logic system. The ultrasonic sensors are used for positioning and identifying an obstacle. The fuzzification and reasoning method in the fuzzy logic system are singleton and Mamdani's method, respectively. In the case of the conventional fuzzy logic system, the number of control rules is twenty-four for each wheel. Simulation examples are shown in Section 4.

2 Architecture of Mobile Robot System

The kinematics model of a mobile robot was shown in Figure 1. We assume that the contact between the wheels and the ground is pure rolling and non-slipping [4]. Accelerations of left and right wheels are ω_L and ω_R , respectively. The velocities for left and right wheels are Eq. (1), where r is radius of the wheel. Linear velocity of the mobile robot is V. Linear velocities for the left and right wheels are V_L and V_R, respectively.

$$V_L = r\omega_L \quad \text{and} \quad V_R = r\omega_R \tag{1}$$

$$\omega = (V_R - V_L)/L = r(\omega_R - \omega_L)/L \qquad V = (V_R + V_L)/2 = r(\omega_R + \omega_L)/2 \tag{2}$$

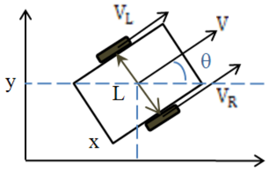

Fig.1. Kinematics Model of the Robot.

3 Design of Fuzzy Logic System

The conventional fuzzy logic system includes fuzzification, knowledge base, fuzzy reasoning engine and defuzzification. The inputs are distances measured from the obstacle to some sensors and the rotation angle of the robot. The sensors are located at left, right, and front side of the robot. The rotation angle means an angle between robot's orientation and target's one. The output variables are velocities of the left and right wheels. Eight conditions are defined by the location of the obstacles like Table 1. "L" and "mid" stand for "Little" and "middle", respectively. The membership functions are shown in Figure 2. The control rules can be induced by empirical knowledge. They are shown in Table 2 for left and right wheels, respectively. We here use the center of gravity for defuzzification.

Table1. Eight conditions according to the position of the obstacle.

	D1	D2	D3	D4	D5	D6	D7	D8
left-obstacle	near	near	near	near	near	near	near	near
front- obstacle	near	near	near	near	near	near	near	near
right- obstacle	near	near	near	near	near	near	near	near

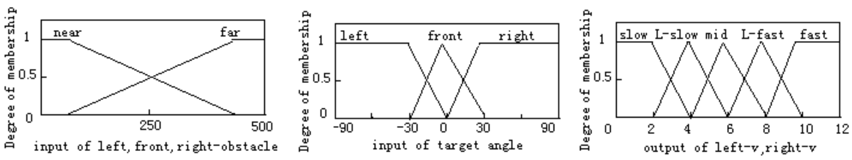

Fig.2. Membership functions for fuzzy logic system.

Table 2. Fuzzy control rules for the left and right wheel

	D1	D2	D3	D4	D5	D6	D7	D8
Left	**Slow**	**L-Slow**	**Mid**	**L- Slow**	**Slow**	**Slow**	**Mid**	**L-Fast**
	L-Slow	Slow	Mid	Slow	L-Slow	L- low	L-Fast	Fast
Front	**L-Slow**	**L-Slow**	**L-Fast**	**Mid**	**Slow**	**L- low**	**L-Slow**	**Fast**
	Slow	Slow	L-Fast	L-Slow	L-Slow	Slow	Mid	Fast
Right	**L-Slow**	**L-Slow**	**Mid**	**L-Fast**	**Slow**	**L-low**	**Slow**	**Fast**
	Slow	Slow	Mid	Mid	L-Slow	Slow	L-Slow	L-Fast

4 Simulation Study and Conclusions

The starting position of the robot and its goal are (0, 0) and (25, 25), respectively. Then the robot moves along the bold path by the conventional fuzzy logic system designed in Section 3. The environment used in the simulation was shown in Figure 3. We obtained some facts that the mobile robot can avoid the obstacle safely.

In this paper, we studied an obstacle avoidance system of mobile robot by using fuzzy logic control system. The proposed control system showed a good performance. We could also get some properties that the fuzzy control system is powerful in view of the short reaction time and quick decision-making of an obstacle avoidance course. The simulation results demonstrated the effectiveness of the obstacle avoidance capability in an unknown environment using proposed fuzzy control strategies.

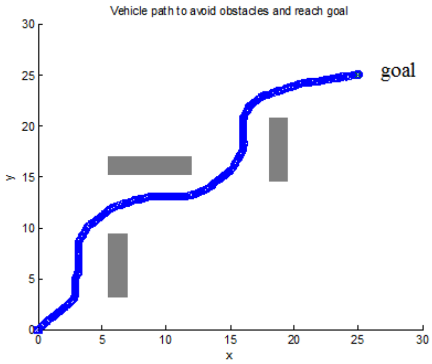

Fig. 3. Simulation results of obstacle avoidance

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