Obstacle avoidance plan of autonomous mobile robot using fuzzy control

Kyung-Seok Park, Kyung-Woong Yi, *Han-Soo Choi

Dept. of Control and Instrumentation Eng. Grad. School Chosun Univ.
Tel : +82-62-230-7765, Email : pakyse@hanmail.net
*Division of Information, Control and Instrumentation Eng. Chosun Univ.

Abstract : In this paper, We designed the local path planning direction algorithmusing fuzzy controller applied fuzzy logic. Algorithm decieded a direction angle by theposition of obstacle, the distance with obstacle, the progress direction of robot, the speed of vehicles and the perception area of sensor.

The robot designed with proposed algorithm carried out soft moving without any particular operation, and we could observe that it had very soft curved moving as if an expert drove.

1. Introduction

The autonomous mobile robot has achieved technical development in a hardware system of a mobile robot, environment recognition performance and an autonomous moving performance autonomous moving performance. after development of an autonomous mobile robot was attempted in 1969 by Nilson[1].

Therefore robots for work are developed in the medical world[2], guidance, delivery[3], monitoring about main facilities[4], the expedition that faced since it was not known, a dangerous region in addition to the production spot.

Thus, path planning is needed with the moving course which is the most efficient in a workspace in order to finish a given work and the recognition ability about an obstacle to exist in working environment.

As for the existing, virtual force field method, vector field histogram method, artificial potential field method[5]-[7] have advantage that there is a merit to react to a change of environment sensitively. but There are problems such as the modeling requesting large calculation and readjustment a paramet er according to working environment, it is incorrect with a path planning way for real-time moving of a mobile robot in environment to be unknown because it is algorithm of these forms that is renewed an environment map through sensor data having environment information.

In this paper, we tried to make stable moving and select the shortest path using the direct indicator which applied fuzzy controller.

The robot synthesized information about input external environment from

each sensor, designs algorithm of the direction indicator which can decide on a direction of a path and direction of a mobile robot. The proposed direction indicator can evade a collision with an obstacle and travel and can get a real-time process and a strong adaptability about an external change.

we does in order to show utility of the way that proposed with confirming these results through simulation experiment.

2. Configuration of a fuzzy controller

The fuzzy controller which used fuzzy logic does not lead a characteristic equation about a system, uses expressed rules with linguistic a little value, and can control. It is used extensively in case of nonlinear, a hard mathematical modelling of plant and a diffcult that.[5]

It is proceeded in servo motor control, car speed control, the formula system that are the word that used fuzzy pattern matching, number recognition using fuzzy logic, a lot of study is performed because of simple control process and tenacity.

Also, it is suitable for the system that is difficult to analyze dynamically.

Fuzzy controller consists of linguistic a few formal control rule, and it spreads, and it is become a compound rule control input decision[6]. fuzzy controller must exchange a ration for the value which let there be a few at first if any vague error input value comes, decides on the control value which it passes through a lot of procedures next, and can control a process.

A Figure 2-1 shows basic structure of a fuzzy controller.

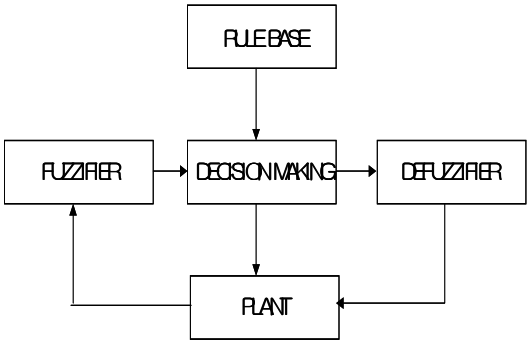

fig. 2-1 Basic structure of fuzzy controller

Performance of a fuzzy controller is decided by configuration and choice of rule base, membership function, fuzzy inference and input·output gain factor

3 Design of a fuzzy controller

Fuzzy control algorithm used in this study decided the direction angle of a robot applying position of obstacle, distance with obstacle, Progress direction of robot, speed of vehicles and perception area of sensor.

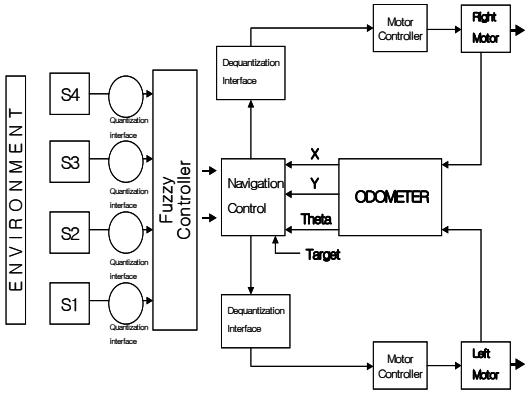

fig. 3-1 AMR block diagram

A Figure 3-1 is block diagram of an autonomous mobile robot used in this study.

A robot perceives the environment where a robot is surrounding through four sets optical sensors of two one set. The perceived data is quantized and the data are sent to the fuzzy controller that is spread outleft, right, and it is become the reasoning. and it is sent output value from a fuzzy controller to a motor controller of an each wheel. We controlled it using the velocity defference of left, right side

A linguistic variable of fuzzy controller used in this study is as follows.

- OA(Obstacle Angle) = OLB(left big), MA(medium), ORB(right big)
- OD(Obstacle Distance) = NE(near), ME(medium), FA(far)
- RS(Robot Speed) = SL(slow), MD(medium), FT(fast)
- SA(Steering Angle) = LB(left big), LM(left medium), LS(left small), ZO(zero), RS(right small), RM(right medium), RB(right big)

The table 3-1, 3-2, 3-3 express the distance from an obstacle as a input variable, steering angle and obstacle angle linguestically.

From the picture 3-2 to 3-4, It shows the member functions about each input/output variables. The picture 3-5 shows output value.

Table 3-1 Linguistic expression for obstacle distance

Distance	Range
NE	0 - 0.5
ME	0.3 - 0.8
FA	0.5 - 1.0

Table 3-2 Linguistic expression for obstacle angle

Obstacle Angle	Range
OLB	-30
MA	30 - -30
ORB	30 -

Tble 3-3. Linguistic expression for steering angle

Steering angle	Range
LB	-60 - -30
LM	-40 - -20
LS	-30 - 0
ZA	0
RS	0- 30
RM	20 - 40
RB	30 - 60

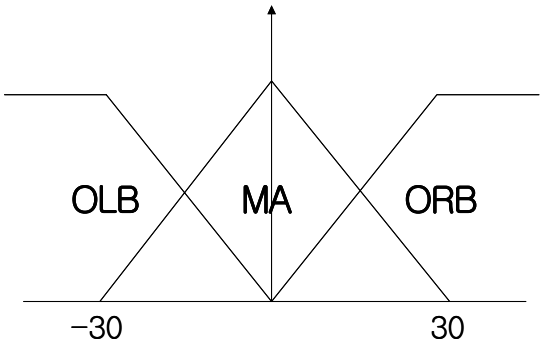

fig. 3-2 Obstacle angle

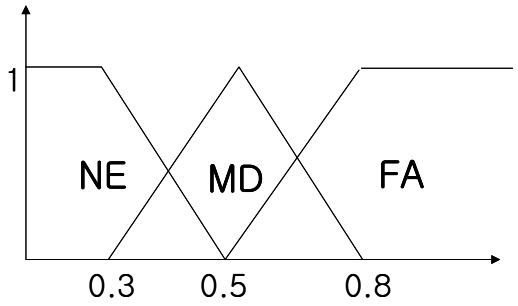

fig. 3-3 obstacle distance

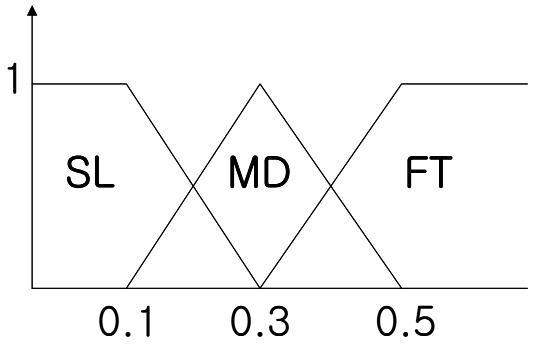

fig. 3-4 speed of robot

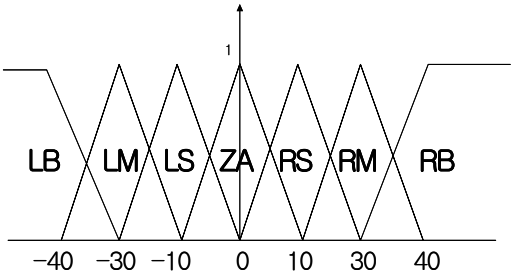

fig. 3-5 steering angle

A fuzzy control rule to adjust direction angle shows as an IF-THEN format as follows.

IF OA(Obstacle Angle) is LB(Left Big) and OD(Obstacle Distance) is NE and VS is SS THEN SA is RS

The reasoning way used in fuzzy controller for an obstacle evasion and a trajectory return of a vehicle used largest - minimum law proposed by Mamdani. Reasoned value must pass through a defuzzifier process to exchange for clear value so that it is used input of an actual control system.

4. Simulation Experiment

It was experimented on computer simulation for performance evaluation of a fuzzy controller designed in this study. we could observe that it had very soft curved moving as if an expert drove.

it runs a low speed in a narrow aisle, kept a schedule distance with an obstacle, keeps the largest speed in a wide space without an obstacle, we were able to see travel while achieving a revision of direction angle by controller toward target point. An obstacle stood to a lot of halls, it planned an evasion if it found an obstacle, and revised an attitude and went out. Also, it was able to confirm that it did not bump against a wall in random working environment either and went to find it way by a target spot in a fixed passage.

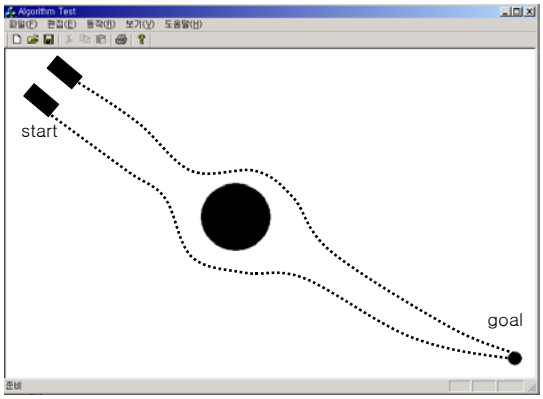

fig. 4-1 Computer simulation1

A mobile robot selected a path

without particular operation passably as it can confirm in the experiment results even if environment was changed, and revised an attitude and went out.

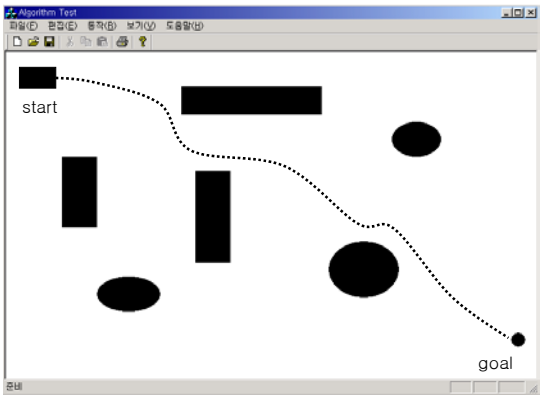

fig. 4-2 Computer simulation2

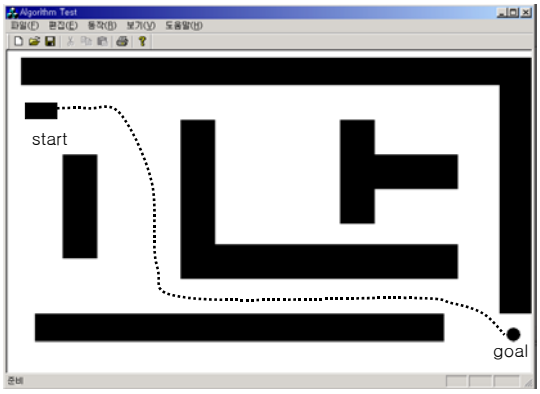

fig 4-3 Computer simulation3

5. Conclusion

we proposed moving algorithm of the autonomous mobile robot that used fuzzy control in this study.

We were able to observe that robot carried out soft moving without particular operation with proposed algorithm. but Because of a change of a position and a direction by a slip of a wheel, reinforcement study about this is necessary. and because considers surrounding environment of a too mobile obstacle and increases by a medical charge geometric series enemy of a control rule

Development of direction algorithm of the mobile robot which used neuro-fuzzy control which was equipped with own education function in order to reinforce a generation of a strong adaptive control technique about him and stronger adaptability is necessary.

[REFERENCES]

[1] Nilson, N. J. "A Mobile Automation : An Application of Artificial Intelligence Technique, "Processding of 1st IJCAI, 1969

[2] Neveryd, H. and Blomsjo, G, "WALKY an ultrasonic navigating mobile robot for the disabled" The European Context for Assitive Technology. IOS press, 1995

[3] Bleding, W. Lee, J, Wu, A, Bidlack,C. and Rogers, s. "Mobile robot explorati on and Navigation of indoor spaces using sonar and Vision," In Confer ence on Intelligent robots. In Field, Factory, Service and Space, March 1994

[4] Crowley, J. L. "Coordination of Action and Perception in a Surveill ance Robot "IEEE Expert, 1987

[5] Khatib, O. "Real-time obstacle avoida nce for manipulators and mobile rob ots" The International Journal of Robotics Rearch5(1), spring 1986

[6] Borestein J. and Koren, Y. " Real-time Obstacle Avoidance for Fast Mobile robot," IEEE Transaction on

SMC19(5):1179-1187, Sep./Oct. 1989.
[7] Hwang, Y. K. and Ahuja, n. “A Potential fields approach to path planning.” IEEE Transaction on Robotics and Automation 8(1):23-32, Feb. 1992.
[8] Park kee-doo, "Navigation algorithm for autonomous mobile robot using fuzzy controller",1997
[9] Lim young-do, Lee sang-boo "Fuzzy, Neural network, Genetic Evolution", pp78-79 Insolmedia, 1992