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Short Communication

# APPLICATION OF INTELLIGENT TECHNIQUE ON MOBILE ROBOT NAVIGATION

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**Abstract:** This paper presents a fuzzy controller technique in navigation to avoid obstacles and collision path of mobile robot. Obstacles avoidance is the first requirement for any autonomous mobile robot. Fuzzy logic technique is used to control the navigation of mobile robot as it avoids the presence of obstacles along its path to the destination. The information required about the robot environment is the goal, the distance between the robot, and obstacles. Obstacles avoidance and goal can be achieved by changing the heading angle of the mobile robot. This heading angle can be achieved with the help of the fuzzy logic controller (FLC). To the development of FIS, it regulates the vision based mobile robot for obstacle avoidance and desired goal approximation.
**Keywords: -** Autonomous mobile robot, Obstacles, Fuzzy logic controller.

## Introduction

Sensor based mobile robot navigation systems typically relied on ultrasonic sensors or laser scanners providing one dimensional distance outlines. The major advantage of this type of sensors results from their ability to directly provide the distance information required for collision avoidance. Ultrasonic sensors or one dimensional laser rangefinders, which have been widely, used for transportation and navigation tasks of an autonomous mobile robot [1]. In the area of robotics, one of the main areas of research is to construct an autonomous intelligent mobile robots, which can plan own motion during navigation through two-dimensional or three dimensional terrains. In order to be able to find that path, the robot needs to run a suitable path planning algorithm, to calculate the path between any two points [2]. Fuzzy logic control is characterized by the use of linguistic rules to manipulate and implement human knowledge in control systems so as to handle the uncertainty present in the environment [3]. Navigation and obstacle avoidance are very important task for the successful employment of an autonomous mobile robot. When the environment of the mobile robot is obstacle free, the problem occur less complex to handle. But as far as the environment becomes complex, motion planning needs much more computations to

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allow the mobile robot to move between its current and final configuration without any collision with the surrounding environment [4].Fuzzy based controls concepts are useful in both global and local path planning tasks for autonomous mobile robot. The search for an optimal decision table to be used as the inference engine in fuzzy based planning and navigation algorithms is highly important. Fuzzy controllers for both navigation and obstacle avoidance have been developed must require [6].

Muthu *et al.* present the performance of a low cost, fuzzy logic based controller for autonomous navigation in which the controller makes the system move through obstacles without human intervention in an efficient manner. Further, in this correspondence, we present the way we developed the fuzzy logic controller along with liquid crystal display (LCD) controller, universal asynchronous receiver transmitter (UART) [10]. Foudil *et al.* defined Autonomous mobile robotics is providing robots with some level of intelligence and ability to perform desired tasks without continuous human guidance. Fuzzy logic has become a mean of receiving human knowledge and experience and dealing with uncertainties in the control process difficulties. Now, fuzzy logic is becoming a very popular topic in control engineering fields [12].

**Fuzzy Logic Method**

The mobile robot turns around obstacle our projected navigation method supplies the robot with the turning point for avoiding the obstacle and moving on the collision free path. The inputs of the fuzzy approach consist of obstacles which stand on the front, right and left of a robot in each input variables has three triangular membership function (MF) close, medium and away as shown in Fig. 1. The fuzzy controller as shown in Fig. 3 uses various sensors based information such as front obstacle distance (F_O_D), right obstacle distance (R_O_D), and left obstacle distance (L_O_D), and heading angle (H_A) for select the path while moving near to goal. The fuzzy position function commands the robot moves to particular position for defending obstacles. The fuzzy logic rules for obstacle avoidance as follows.

*If (L_O_D is close and R_O_D is close and F_O_D is close), Then (heading angle is negative).*

*If (L_O_D is close and R_O_D is close and F_O_D is medium), Then (heading angle is negative).*

*If (L_O_D is away and R_O_D is medium and F_O_D is away), Then (heading angle is positive).*

*If (L_O_D is medium and R_O_D is away and F_O_D is medium), Then (heading angle is positive).*

*If (L_O_D is away and R_O_D is away and F_O_D is away), Then (heading angle is zero).*

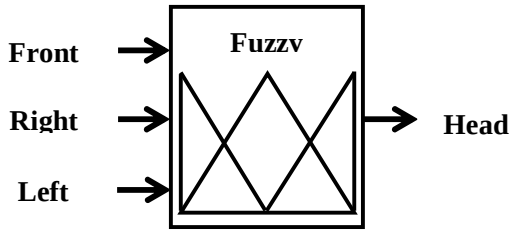


**Fig. 1. Fuzzy logic controller**

Fuzzy logic control is safely suited for controlling a mobile robot because it is capable of making interferences even under uncertainty. It helps rule generation and decision making. It uses set of linguistic fuzzy rules to implement expert intelligence under different conditions. Fuzzy logic system is specially designed with two main reasons- obstacle avoidance and goal seeking in any environment. In this proposed fuzzy model, a mobile robot avoids obstacles and generated the path towards the goal. The fuzzy evaluation implies to access the possible path of a robot on the basis of information whether the future location of robot is in the possible driving path or not.

**Mobile Robot Navigation Algorithm**

The distance 'D' can be calculated by applying the distance formula using the two values of 'Dx' and 'Dy'. Where 'Dx' and 'Dy' are the distance between the mobile robot and the goal point in 'x' and 'y' coordinates, respectively. The formula for calculating the distance:

$$D = \sqrt{(tarx - x)^2 + (tary - y)^2}$$

Where 'tarx' and 'tary' are the goal point 'x' and 'y' coordinates respectively.
Finding the angle 'θ' at each point of a given path and then calculating the updated robot positions are specified formula below:

$$\theta = \tan^{-1}\left(\frac{tary - y}{tarx - x}\right)$$

The fuzzy logic control system scheme consist of a heading angle between a robot and the specified target and the distance between the mobile robot and the obstacles to left, front and right locations. The set of fuzzy rules will allow us to control and to select different position of an autonomous mobile robot in different circumstances. The problem of driving a mobile robot to a destination in an unknown environment is formulated as a fuzzy logic control problem in which local information is used to make eight logic rules by using two membership functions as shown in Table 1.

**Table 1 Fuzzy control rules for obstacle avoidance using two membership Function**

| Fuzzy rule no. | Obstacle distance 1 | Obstacle distance 2 | Obstacle distance 3 | Thetaf |
|---|---|---|---|---|
| 1 | away | close | close | Positive |
| 2 | away | close | away | Negative |
| 3 | away | away | close | Positive |
| 4 | away | away | away | Positive |
| 5 | close | close | close | Positive |
| 6 | close | close | away | Negative |
| 7 | close | away | close | Positive |
| 8 | close | away | away | Positive |

**Simulation Results and Discussion**

The simulation experiment shows that the proposed fuzzy controller, using MATLAB, can perform robot navigation in known or partially known environments. The trajectory of mobile robot navigation in unknown environment with one, two and three obstacle(s) as shown in Fig. 2 respectively, the beside table on this figures are show that the starting point, obstacle(s), heading angle, and goal point of a robot. The simulation program offers an excellent alternative based on navigation methods with a fraction of the processing requirements result a fast responding reliable application. The goal which the robot should reach is known, but the geometry and the location of the obstacles are unknown.

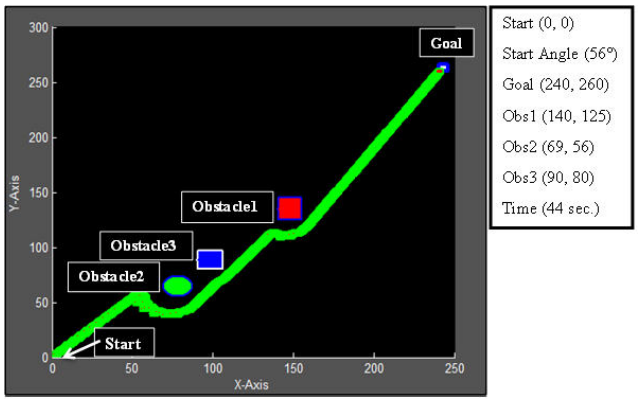


**Fig. 7. Trajectory of the singlemobile robot with 3 obstacles**

**Conclusions**

The heading angle of the robot's movement is determined by the direction of the goal and obstacle distance. Finally the simulation results for mobile robot navigation are given. This simulation results behind that implementing obstacle avoidance uses a fuzzy logic approach and is conducted an autonomous mobile robot platform which can modify to include sensors. The current research work is to be extended for multiple mobile robots instead of single mobile robot.

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