Algorithm Proposed Algorithm

In this work, a new method of mobile robot path planning based on neurofuzzy controller is presented and its efficiency has been measured based on type 1, 2, and 3 fuzzy sets.

A Novel Mobile Robot path planning Method based on Neuro-Fuzzy Controller

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Introduction

Nowadays, mobile robots, due to their ability to humans in many applications are growing up very fast. Autonomous mobile robots usually have to be in environments where there is no prior information. This requires the robot to have an intelligent decision-maker based on sensor information to be able to plan its motion in an uncertain environment. Fuzzy controller is a suitable decision-making system for many applications. Different types of fuzzy sets have expanded in last years.

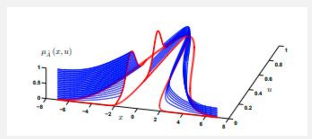

Fig.1.general type-2 fuzzy set

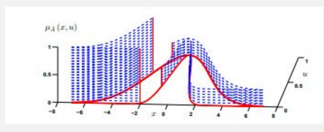

Fig.2.interval type-2 fuzzy set

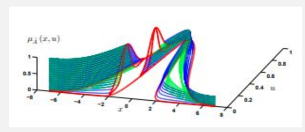

Fig.3.interval type-3 fuzzy set

Methods

For the proposed sensor-based motion planning algorithm, the pseudo-code is presented as follows:

Require: goal position
Ensure: a safe path from start to goal
while the robot does not reach the target **do**
<Check the distance of the robot from the obstacles and the target in time steps>
if <there is no obstacle in the distance of less than one meter>
then <1-Set priority parameter to zero
2- Calculate the direction of the robot by 1 equation and apply it to the robot
3-Calculate the linear velocity by related Anfis and apply it to the robot >
else
<1-Calculate the priority and parameter by related Anfis
2-Calculate the direction of the robot by 1 equation and apply it to the robot,
3-Moving the robot with a constant linear speed of 0.9 m/s>
endif
end while

$$\varphi = (1 - priority)(\arctan 2(y_{goal} - y_{robot}, x_{goal} - x_{robot})) + (priority)\theta \qquad (1)$$

Θ and priority parameters are calculated by related anfis.

Table 1. Rules for generating the priority parameter dataset.

FS(distance normalized to one meter)	RS(distance normalized to one meter)	LS(distance normalized to one meter)	Priority
0.2	0.2	1	0.89
0.2	1	0.2	0.86
1	1	0.1	0.74
0.25	0.5	0.75	0.76
0.4	0.6	1	0.7
0.15	1	1	0.71
0.25	1	0.5	0.75
0.15	0.15	0.15	0.92
0.5	0.15	0.15	0.9
0.2	0.1	0.1	0.93
1	0.15	0.15	0.87
0.25	0.1	0.1	0.92
1	1	0.15	0.74
1	1	1	0

Results

The tests were done using the Turtlebot robot in the gazebo simulator. The ANFIS controllers with type-1, type-2, and type-3 fuzzy sets were trained with the Tlbo algorithm with population and number of iterations of 50.

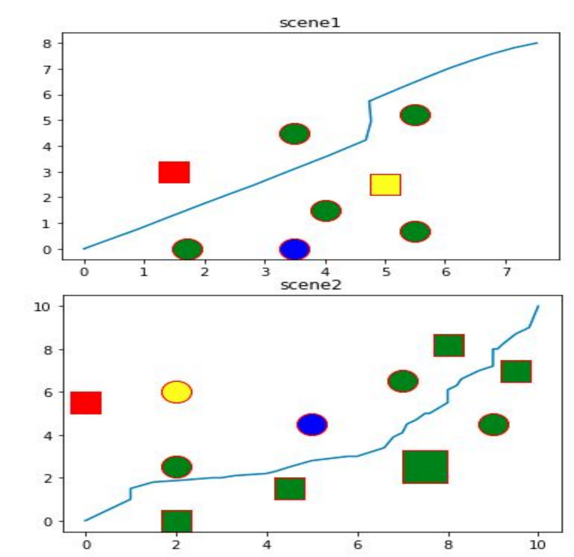

Fig. 4. Results for fuzzy type-1

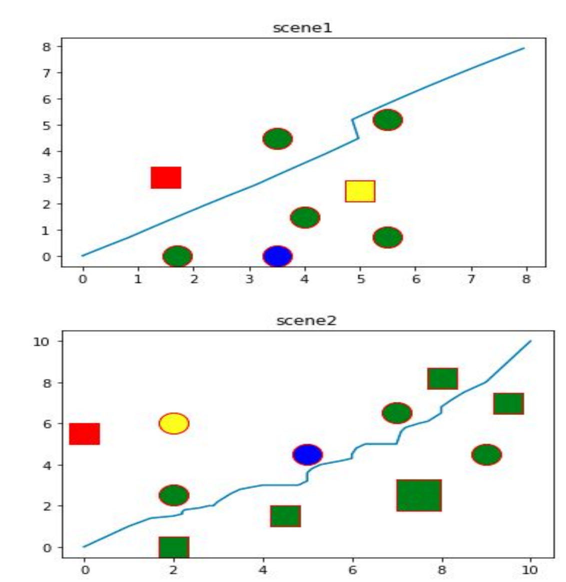

Fig. 5. Results for fuzzy type-2

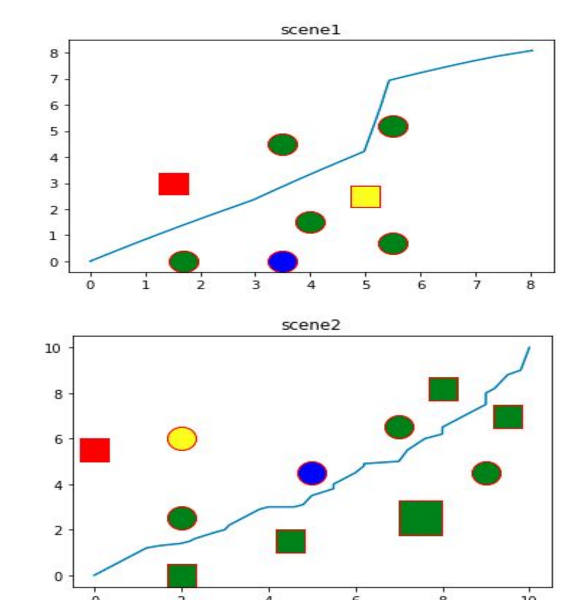

Fig. 7. Results for fuzzy type-3

Table 4. Results for the proposed algorithm with different types of fuzzy sets

Algorithm		Scene1	Scene2
Type-1	Runtime	1.57	3.18
	Path length	11.58m	15.84m
Type-2	Runtime	1.48	3.09
	Path length	11.55m	15.52m
Type-3	Runtime	1.41	3.02
	Path length	12.14m	15.33m

Conclusion

The new proposed structure was implemented using only a range finder sensor in unknown environments. The proposed structure was implemented using three different types of fuzzy sets. Three membership functions of low, medium, and high were considered for each ANFIS used. The proposed structure using all three types of fuzzy sets types 1, 2 and 3 is safe, fast, and short in terms of distance. But in general, it can be said that fuzzy type- 3 performed better.