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Mobile Robot Navigation Using Fuzzy Logic in Static Environments

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Abstract

In ours paper, we have developed a Mamdani Fuzzy interference system in MATLAB R2014a for mobile robot navigation in static environment. Inputs of the fuzzy inference system are the angle between the robot orientation and the robot target orientation (i.e. robot rotation angle) and the distance measured by the ultrasonic sensor from the obstacle to the orientation. The robot can reach the target with less bending energy, minimum time and shortest path with obstacle avoidance in static environment. The proposed system takes minimum inputs and rules to avoid the clustered obstacles in the static environments. It also calculate the angular velocities of two wheels of the mobile robot. The efficiency of the proposed method is verified by the simulation and experimental results.

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1. Main text

Mobile robot navigation is the challenging problem in the field of the robotics. In the path planning problem there is two main divisions i.e. obstacles avoidance and the energy saving or less time to reach the destination. In order to

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solve these problems many researchers have developed different techniques which includes A* algorithm, Artificial Potential Fields, Fuzzy logic, Neural networks, Genetic algorithms, Ant colony optimization, etc. In [1], a comparative study of soft computing techniques for mobile robot navigation in unstructured environment is performed in four different scenarios using four parameters i.e. distance travelled, travelling time, bending energy and average speed. A hybrid of genetic algorithm and fuzzy logic gives the best result in terms of travelling time and average speed. In [2], an effective algorithm for the real time optimal path planning of humanoid robot in unknown complex environment by mixing Markov decision processes and fuzzy interference system is introduced. The exact distance, shape and size of obstacles are calculated by using reward function. In [3], a simple adaptive fuzzy logic-based controller is proposed, which utilizes a fuzzy logic system for estimating the unknown robot parameters for tracking control of wheel mobile robot and it required only position measurement. In [4], they have also used fuzzy logic alone to avoid collisions when the paths for the mobile robot are blocked by obstacles. In [5], they have developed an ordinal FLC with special tailored GA which optimized the structure FLC and implemented for obstacle avoidance of Khepera mobile robot. The design structure FLC enabled of managing high-dimensional problem with multiple input and output variables interpretability the set of rules. In [6], they have developed a fuzzy controller to navigate the mobile robot without any obstacles avoidance. In [7], they have presented a hybrid method for path planning of mobile robot in static environments. In this paper we have introduced a technique of mobile robot navigation using Fuzzy Computing. Fuzzy Computing is used for obstacle avoidance to generate a collision free path due to blockage of obstacles. Results show that the combined Fuzzy Computing technique gives optimal path with less computational time as compared to other approaches.

Section 2 describe the kinematic model of mobile robot. Fuzzy Logic Controller is explained in Section 3. Simulation result is presented in Section 4. Finally, the conclusion is given in Section 5.

2. Kinematic Model of Mobile Robot

The mobile robot has two drive wheels mounted on the same axis and we have assumed that each wheel is perpendicular to the ground. The velocity of center of mass of the mobile robot is orthogonal to the wheel axis.

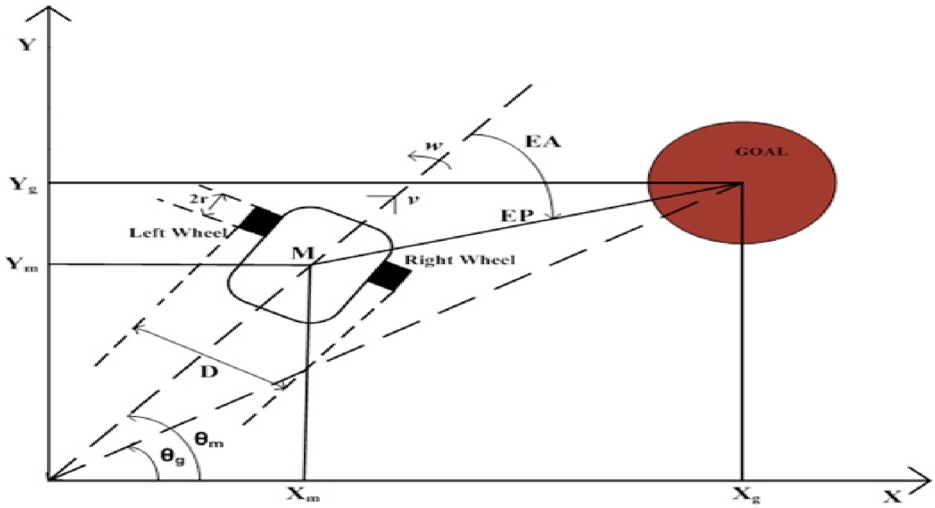

Fig. 1. Kinematic model of mobile robot.

The coordinates of the mass center of mobile robot are x and y, θ_m is the angle that represents the current orientation of the robot, v and w are the linear and angular velocities of the robot, V_R and V_L are the angular velocities of the right and left wheels respectively, r is the wheels radius and D is the distance between the two wheels centers. From [8], the kinematic model of mobile robot is showed in Fig. 1. The relationship between angular velocity and linear velocity of the wheels are given by:

$$V_R = rw_L\ ,\ \ V_L = rw_R \tag{1}$$