Chapter 18
Fuzzy Logic Based Path Planning for Industrial Robot

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ABSTRACT

This article describes how industrial robots are generally used to perform different tasks in industries, such as pick and place, and many more operations in industries. Among these, pick and place is a very common and frequently used task. Path planning is the most important thing in order to make any process more economical. The main focus of the research is to design a fuzzy control system for path planning for industrial robots using artificial intelligence using fuzzy logic. For the analysis, ten different tasks are tested. For fuzzy logic systems, three membership functions are analyzed and compared to find the best result. From the research, it has been found that a Gaussian membership function gives more accurate result in comparison to the other two membership functions.

1. INTRODUCTION

The path planning for a particular task of six axis industrial robots can be described by number of methods and fuzzy logic (FL) is one of them. Fuzzy logic is a soft computing method which defines the fuzziness. It is a method of soft computing that is based on degree of truth rather than defining true or false. In many complex industrial environments, FLS has been commonly used.

Abd et al. (2012) proposed a fuzzy sequencing rule for robotic flexible assembly cells. The fuzzy rules have been developed by combining different input parameters. Li and Choi (2013) worked on mobile robot for path planning and proposed the algorithm for obstacle avoidance by designing a fuzzy control system. It generated a path with faster travelling time by avoiding obstacles. Vascak et al. (2014) described the need of robot control system with robot navigation, stabilization of movement, action selection and evaluation of path cost using fuzzy logic. Pande et al. (2014) designed a fuzzy logic controller with

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minimum rule base for navigation of robot with mamdani type fuzzy method with three inputs and one output is used. The navigation system tested in simulation is of good results. Jarrah et al. (2015) used probabilistic neuro-fuzzy for multiple mobile robots and presented the path following and coordination. The presented probabilistic fuzzy approach improves the performance of navigation system and which make the system more robust. Razali et al. (2015) used fuzzy logic controller with MATLAB for intelligent guidance of robot path by controlling the steering angle. There are two inputs given for a single output in fuzzy with nine fuzzy rules and proved the capability of fuzzy logic controller for intelligent path guidance. Bajrami et al. (2015) combined the fuzzy logic and artificial neuronal fuzzy logic for the autonomous navigation of mobile robot. The algorithm developed for second one that is for the artificial neural fuzzy logic is found to give better result in comparison to first one. Yerubandi et al (2015) described the capability of navigation of autonomous robot for real time environment. The ultrasonic and infrared sensors are used for fast and cost-effective distance measurement along with the use of FL. Samant et al. (2016) used fuzzy logic to develop autonomous humanoid robot control. They proposed a new method for the interaction between robots in a competitive environment and implemented in experiment. By using fuzzy based control system the motion execution has been achieved designed fuzzy fractional order control. Masmoudi et al. (2016) worked on omnidirectional robot navigation system and designed a fuzzy control system. They also did the optimization, simulation and experimental test for fuzzy PI controller with one, two and three obstacles. Abiyev et al. (2017) described the fuzzy control system for an omnidirectional robot. They implemented the designed control system for the position and orientation angle to control linear and angular speed. The designed control system minimizes the difference between the reference trajectory and the current output. Ali et al. (2017) presented a vibration mitigation process for single link manipulator. Manually and experimentally the classical proportional controller is tested by taking two piezoelectric transducers to act as actuator and sensor. They have combined fuzzy–P and Fuzzy-PI controller.

2. METHODOLOGY

The problem of finding the optimal path is the greatest problem in industries using industrial robots. The main problem arises to find the path when the cycle time is concerned. For the design of path planning, the layout of the path has major influence. The path with shortest path length and with minimum cycle time is taken as the optimal path. Therefore, it is necessary to have clear idea about all the paths in order to design for path planning. For the simulation of this particular analysis of industrial robot ten tasks has been given to the robot and robot is allowed to move from any starting task, passing through all the task and end with the last task. The task arrangement is shown in the Figure 1 and is specified by numbers from 1 to 10. In industries industrial robots are used for many operations such as drilling holes using the drilling tools by replacing the griper. To increases the performance of robot it has to travel each and every object by performing the required operation and move to the next and complete the task with minimum time period.

The robot griper is allowed to move from its home position, passing through all the tasks and returns back to its home position which is show in the Figure 2. The tasks are shown in blue color and the blue line in the Figure 2 shows the particular path followed by the robot. For each path movement the cycle time taken is noted. As in this analysis ten tasks are taken, there will be a bunch of possible paths.