Mobile Robot using Fuzzy Logic

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Introduction

Fuzzy logic controllers have gained popularity in the past few decades with highly successful implementation in many fields. Fuzzy logic enables designers to control complex systems more effectively than traditional methods. This article presents a low-cost educational microcontroller-based tool for fuzzy logic controlled, line following mobile robot.

Traditional methods to control any dynamic system require the use of some knowledge, or model, of the system to be controlled. An accurate model is crucial for the successful implementation of a control algorithm. Unfortunately, most systems in real life are nonlinear, highly complex, and too difficult or impossible to model accurately. Fuzzy logic is a mathematical system which helps to reduce the complexity of controlling nonlinear systems (pierreguillemin, 1996) (vamsimohanperi, 2002) (Nhivekar*et et al.*, 2011). Fuzzy logic expresses operational laws of a control system in linguistic terms instead of the traditionally used mathematical equations. The linguistic terms are most often expressed in the form of logical expressions, such as IF_THEN (Nhivekar*et et al.*, 2011).

The line following robot presented here follows a black line drawn over white surface. When the curve path comes ahead the speed is reduced using fuzzy logic control algorithms. The inputs for the robot were obtained from infrared sensors mounted on the robot platform. These inputs were sent to a Microchip PIC16F877 microcontroller on the robot, which analyses the dataand provides the necessary control signal. A fuzzy logic controller is used to control the robot's motion along the predefined path. The robot algorithm was first done in Matlab and the fuzzy logic rules were optimized for the results possible. Later the microcontroller was programmed in C language using a PIC C-compiler and tested (Nhivekar *et al*, 2011). Experimental results are presented to show the performance of the controller.

Methodology

First, the sensor array using IR transmitter and receiver, indicator and logic control circuits were designed using PCB Wizard software. Then designs were printed on copper board and soldered the components. Two wheels were made out of the nylon cylinder block and connected with 12V two gear motors. For the front tire the spherical nozzle in the clone bottle was used for smooth movement. The robot parts were assembled and powered using 12V battery. Finally the fuzzy logic algorithm was developed using MATLAB software and inserted into microcontroller.

Result and Discussion

In order to find the results of line following, the mobile robot has been tested in a white paper where the black line has been drawn on paper .The sensor array was tuned to distinguish black and white surfaces using the 10kΩ preset. For the straight line path the performance of the robot was successful, however the path wasn't very smooth. The mobile robot did the best and fairly smooth movement in the bend by reducing the speed. For more curvature the speed of the motor was reduced much more. The robot had the best performance with the fuzzy control compared to the motion of the same robot without the fuzzy control.

Conclusions

Fuzzy logic controllers have become popular in recent decades with successful implementation in many diverse fields. By using fuzzy logic control, one can simplify the design of complex and nonlinear control systems without having a model of the system. This project has described the development of a low-cost fuzzy logic mobile robot system for a line following robot. The system enables students to implement various control algorithms by simply programming in a high-level language. Results show that we could easily develop fuzzy logic control algorithms to move the robot to follow a line. Robot movements were smooth both in the forward track and at the corners.

References

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