

A Practical Fuzzy Logic Controller for Sumo Robot Competition

Hamit Erdem

Baskent University, 06530 Ankara, Turkey
herdem@baskent.edu.tr
<http://www.baskent.edu.tr/~herdem/>

Abstract. This paper describes the design of fuzzy logic based sumo wrestling robot. The designed robot has a simple control algorithm and single fuzzy microcontroller is used in hardware implementation. The designed robot meets the specifications needed to compete in a sumo robot competition. The main difference of the designed system with earlier sumo robots is in control algorithms. A simple fuzzy logic controller is developed for detection and tracking of opponent in competition ring. Three infrared (IR) sharp sensors are used for target detection. Fuzzy microcontroller fuses the sensor data's and provides the necessary control signal to motors for heading robot toward the opponent. The fuzzy rules were optimized for the best results possible in software which are loaded in fuzzy controller. The implemented control algorithm shows better performance and executes the opponent detection algorithm in less time in comparison with conventional sumo robot algorithm. Design procedure and experimental results are presented to show the performance of the intelligent controller in designed system.

1 Introduction

Mobile robots provide an attractive platform for combining mechanical, electronic, computer, control and communication systems to create an integrated system for education and research. Mobile robots are mechanical devices capable of moving in an environment with a certain degree of autonomy. Autonomous navigation is associated with the availability of external sensors that capture information from the environment through different sensors. Motion autonomy in robotics may be defined as the ability for a robot to perform a given movement without any external intervention. Performing the task in best way is depended on performance of sensors and control algorithm. Fuzzy logic controller (FL) as nonlinear control method is used for sensor outputs reasoning and control of robot navigation in many works. FL is used to overcome the difficulties of modeling the unstructured, dynamically changing environment, which is difficult to express using mathematical equations [1,2,3]. Fuzzy logic is simple sensor fusion method for combining sensor outputs. Sumo wrestling robot is one of important field to attract student attention for engineering science. The Sumo Robot competition has become more popular around the world [4,5]. Similar to traditional sumo wrestling, the main objective is to force the competitor out of the

ring while staying in the ring. In sumo robot competition an autonomous mobile robot tries to find the opponent inside the wrestling board by using different sensors and force the opponent robot out of the ring. There are two main factors which effect wrestling result, faster opponent detection and applying more force to competitor. This work suggests FLC solution for first factor. This paper describes the design of a fuzzy logic controlled (FLC) sumo robot with considering the specifications needed to compete in a sumo robot competition. Fuzzy logic is used for opponent detection and tracking. This paper is organized as follows. Section II presents the Problem definition and discussion of sumo operation. Section III defines the developed control algorithm and FLC. Section IV describes the application of FLC to sumo robot and tracking of opponent problem. The performance of designed robot and applied control algorithm are discussed based on experimental results in last section.

2 Problem Definition and Discussion of Sumo Operation

Based on the specifications needed to compete in a sumo robot competition a simple mobile robot is designed. Generally there are four operation modes must be considered in design of sumo robot. These modes are;

Search or hunting mode: The robot moves around and its range sensors scans across the ring for sensing the opponent Opponent facing mode: The opponent has been sensed before and robot tries to face the opponent directly. Attack mode: Robot drive straight ahead at full power to push the opponent off the ring. Survive mode: The robot enters this state when it detects the ring border line. Its goal is to survive by not going off the competition ring.

In sumo robot competition, there are two main factor must be considered for wining. The first factor is the effective algorithm for facing and directing to target after sensing of opponent. The second factor is applying maximum power to motors during attack mode which dependent on motors power. This work suggests FLC solution for first factor. With consideration of above operation modes a sumo robot is designed. The main block diagram and structure of the robot are shown in Figure 1. Main parts of designed system are:

- Ring border line detection sensor (IR sensor)
- Opponent detection sensors (Sharp IR sensors: S1, S2, S3)
- Touch sensor (mechanical sensor)
- Right and left DC motors
- Main controller (ST52F513 fuzzy microcontroller)
- Motor driver
- Display (LCD)

Main controller receives inputs from touch, ring line border and target detection sensors and generate control signals for differential drive motion system. As shown in Figure 1, three Sharp GP2D12 infrared range sensors are used to sense the opponent. These sensors are mounted on the left, right and middle front of the robot. Target detection sensors generate an analog voltage. The voltage is