Chapter 1

Introduction

This thesis presents the implementation of robot's behavior based on fuzzy perception. The behavior was based on the sensory input of obstacle distance measurement. The obstacles, that surround the robot, were mapped into an image coordinate system. Reactions of the robot, after the presence of obstacles was determined, were influenced by a set of fuzzy rules that were easy to modify and customize.

The robot used in the implementation of this thesis was called Scorpion Robot [Evolution, 2004e]. It was a two wheeled robot, each wheel was a differential wheel that able to move at different speed. The Scorpion Robot was also equipped with infrared range sensors.

The implementation of behavior on Scorpion Robot was accomplished by using Evolution Robotics Software Platform (ERSP) [Evolution, 2004d] and OpenCV library from Intel [Bradski, 2008].

1.1 Background and Motivation

Fuzzy logic, so far, has been widely used to control a system, because it provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information. This kind of approach can also be used and implemented to controls a robot's behavior, by imitating a human on making a decisions in a faster fashion.

Behavior of a robot is one of important aspects on building an autonomous robot. By incorporating sets of fuzzy rules, a behavior of a robot can be defined, from a simple behavior to a more complex behavior, based on real-time interaction with the world (sensory inputs). More than one behavior can be implemented on a robot, in order to complete certain task or to react to a certain real-time condition, such as described in [Laue, 2004] and [Wolfer, 2006].

Therefore, a fuzzy rule based on behavior to control Scorpion Robot's movement and reaction, was implemented. Interaction between robot Scorpion and real-time world situation, relied only on sensory inputs from thirteen infrared range sensors. The reaction of the robot, basically, was based on the current situation of mapped obstacles within certain region. This reaction could be controlled by a single fuzzy rule or a composition of several sets of fuzzy rules, which could be easily modified and customized.

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1.2 Objective

The objectives of implementation in this thesis were:

1. Mapping obstacles, that surround Scorpion Robot, based on infrared range sensors measurements. All detected obstacles should be mapped into a single map.
2. Incorporating odometry measurement to preserve old mapping information. Odometry information is used to transform (translating and rotating) previous mapping information to a current robot location and orientation.
3. Implementing customizable and flexible robot behavior, based on predefined fuzzy rule statement. Each behavior of robot movement is defined by a single rule, thus, composition of more than one rule creates new behavior.

1.3 Problem Limitation

The implementation in this thesis was specifically designed for Scorpion Robot. Only thirteen sensors were used in the implementation, and all of them were facing outward. Mount position and location of the sensors of Scorpion Robot can be found in "ERSP Scorpion - User Manual" [Evolution, 2004e].

In this implementation, the robot was moving in a plain and completely horizontal terrain. Thus, the distance, location and robot heading can always be estimated by Odometry module provided by ERSP. Rough terrain and a slope were not considered.

All obstacle used in the experiment had a minimum height, which was equal to sensor's height, so that the infrared could be reflected by that obstacle. Any obstacle with height below the sensor's height could not be detected. This kind of obstacle were also not considered.

1.4 Thesis Organization

This thesis is divided into 6 main chapters.

Chapter 1 introduces the background, motivation and the organization of the whole thesis.

Chapter 2 specifies the theoretical background, related to the implementation. This chapter, briefly mentions about fuzzy logic, matrix transformation and some important fact about ERSP and Scorpion Robot.

Chapter 3 gives a short overview of the implemented system. A complete composite system configuration is presented in this chapter.

Chapter 4 describes all implemented subsystem in this thesis. There are six subsystem: Build-Map subsystem, Odo-Map subsystem, Check-Region subsystem, Command subsystem, Add-Image subsystem, and Movement subsystem. The description, the implementation approach, and the testing of all implemented subsystem are presented.

Chapter 5 presents the results of all experiments from different scenarios and with different fuzzy rule configurations. The experiment is divided into there category: simple movement experiments, enhanced movement experiments, and complex movement experiments.

Chapter 6 summarizes the implementation and concludes the result of all experiments. Suggestion for future works is also included in this conclusion chapter.