Fuzzy Logic Controller for Mobile Robot Navigation

MECH523
Intelligent Control

Gamini Siriwardana

Department of Mechanical Engineering
The University of British Columbia
April 2008
**Mobile Robots**

- **HELPMATE** is a mobile robot used in hospitals for transportation tasks. It has various on board sensors for autonomous navigation in the corridors. The main sensor for localization is a camera looking to the ceiling. It can detect the lamps on the ceiling as reference (landmark).

[http://www.ntplx.net/~helpmate/]
Presentation Outline

- Introduction & Mobile Robot Navigation
- Problem Definition and Project Objective
- Navigation Control
- Proposed Navigation Controller
- Sensors and Actuator
Mobile Robots

The three key questions in Mobile Robotics

- Where am I?
- Where am I going?
- How do I get there?

To answer these questions the robot has to

- Have a model of the environment (given or autonomously built)
- Understand and analyze the environment
- Find its position within the environment
- Plan and execute the movement

This presentation will deal with Navigation
Problem Definition

Mobile Robot Navigation controller for an unknown/unstructured dynamic environment

Objective:

Design a Navigation Controller for Mobile Robot System using Fuzzy Logic.
Mobile Robots Navigation System
The Key for Navigation

- Environment Representation
- Environment Modeling

Environment Representation
- Continues Metric -> x, y, θ
- Discrete Metric -> metric grid
- Discrete Topological -> topological grid

Environment Modeling
- Raw sensor data, e.g. laser range data, grayscale images
- Low level features, e.g. line other geometric features
- High level features, e.g. doors, a car, the Eiffel tower
Intelligent Controller

Introduce fuzzy Logic controller for mobile robot navigation system

**Input:**
According to the information acquired by the robots using their sensors
LD - Left obstacle distance
RD - Right obstacle distance
FD - Front obstacle distance
HA - Heading angle with respect to the target

**Output:**
Control the velocities of the driving wheels of the robots.
LV - Velocity of the left wheel of each robot
RV - Velocity of the right wheel of each robot
Intelligent Controller

Schematic Diagram of Fuzzy Logic Controller

LD
FD
RD
HA

Project \[ \text{ECH523} \]

LV
RV
If \((LD \text{ is } LD_i \text{ and } FD \text{ is } FD_j \text{ and } RD \text{ is } RD_k \text{ and } HA \text{ is } HA_m)\) then \(LV \text{ is } LV_{ij \ km}\)

and

If \((LD \text{ is } LD_i \text{ and } FD \text{ is } FD_j \text{ and } RD \text{ is } RD_k \text{ and } HA \text{ is } HA_m)\) then \(RV \text{ is } RV_{ij \ km}\)

where; \(i = 1 \text{ to } 3, \ j = 1 \text{ to } 3, \ k = 1 \text{ to } 3 \text{ and } m = 1 \text{ to } 3\)

because \(LD, \ FD, \ RD\) and \(HA\) have three membership functions each.
Intelligent Controller

Fuzzy Membership Functions (Inputs)
Intelligent Controller

Fuzzy Membership Functions (Outputs)
Sensors and Actuators

- **Ultrasonic Sensors**
  - Dynamic Range: 0 - 6 meters (15.5 dB)
  - Frequency: 25 Hz (read every 320 ms)
  - Sensitivity Range: 10 cm to over four meters (-45 dB)
  - Data Representation: Multiplex
  - Coverage: 360 Degrees
  - Four Ultrasonic Arrays

- **Optical Encoder**
  - High Resolution Quadrature Shift Encoder
  - Overcome Noise and Stability Problems

- **DC Motor**
  - Position and Speed Sensing
  - High Speed, Torque and Resolution
Thank You!