

Obstacle Avoidance and Goal Detection Robot using RPi and LRF.

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Overview

Introduction

- Goal

- Architecture

Algorithms

- Transforms

- Bug Algorithms

- Filtering and Mapping

Design Patterns

- Patterns in Use

Development Methodology

- Workflow

References

Goal (Basic)

Given a goal and a robot:

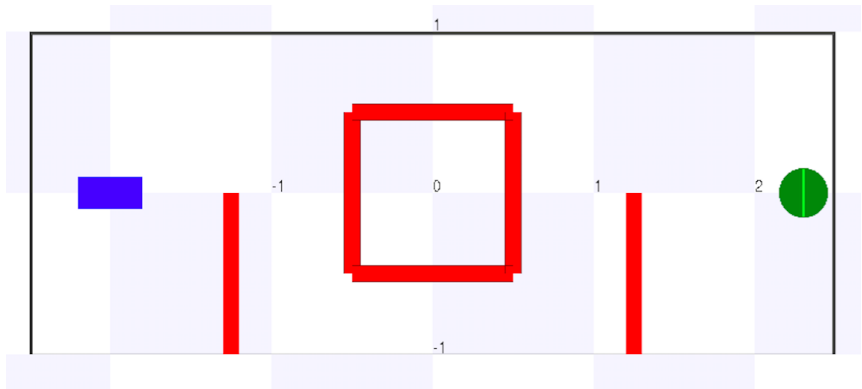
- ▶ Turn the robot around
- ▶ Identify the goal object from LRF input
- ▶ Move towards the goal

Goal (Advanced)

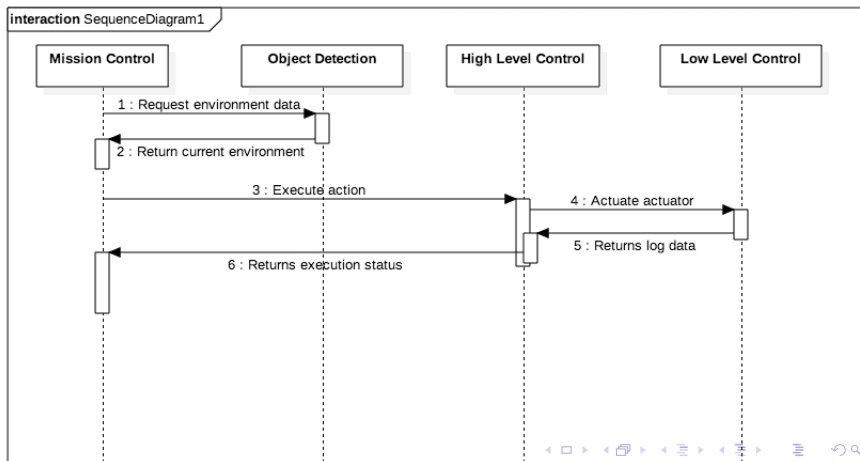
Given a goal, a robot, and a maze:

- ▶ Turn the robot around
- ▶ Follow the walls and avoid obstacles
- ▶ Identify the goal from LRF input
- ▶ Move towards the goal if nothing blocks

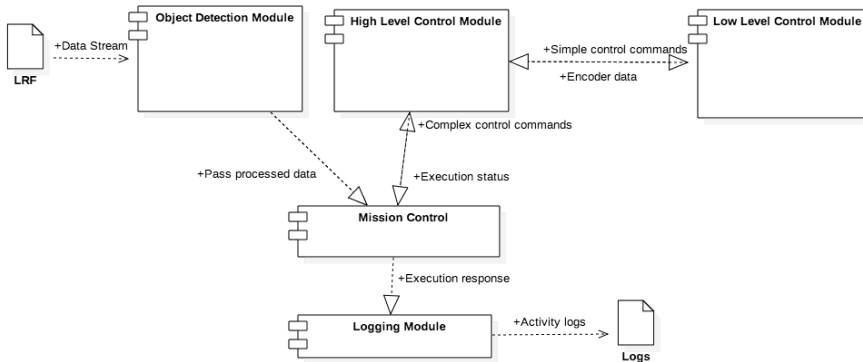
Goal (Advanced)



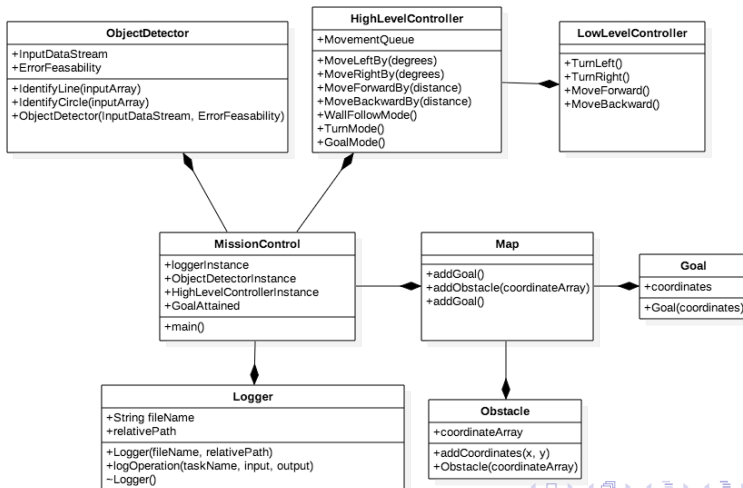
Sequence Diagram



Component Diagram



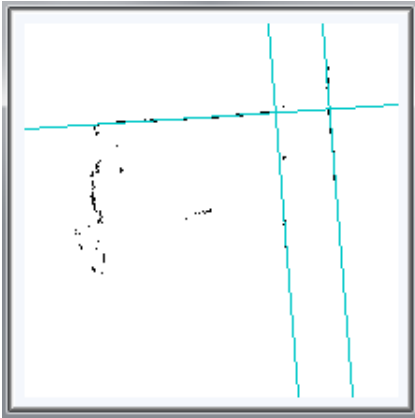
Class Diagram



Hough Transform

- ▶ Algorithm to detect imperfect instances of geometric shapes
- ▶ Reduces the amount of data to be processed
- ▶ Usage
 - ▶ Detect outer walls and obstacles
 - ▶ Detect goal (Semi-Circle)
- ▶ Idea (line detection case)
 - ▶ Calculate the equation of the line through two consecutive points
 - ▶ Coefficients of the equation are added to a counter to record how many times the same equation is calculated
 - ▶ Coefficient calculated often equate to many points being roughly aligned

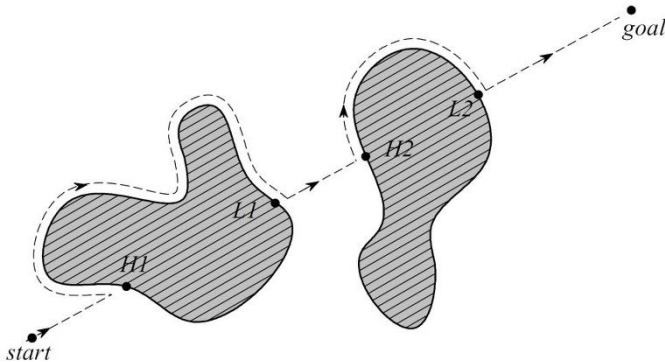
Hough Transform



Bug algorithms

- ▶ Knowledge of local environment and a global goal
- ▶ Assumptions
 - ▶ Known direction and distance to goal
 - ▶ Obstacle detection and encoder data
 - ▶ Finitely many obstacles in finite area
- ▶ Idea
 - ▶ Head towards goal
 - ▶ Follow obstacles until you can head towards goal again
 - ▶ Stop if there is no path to goal

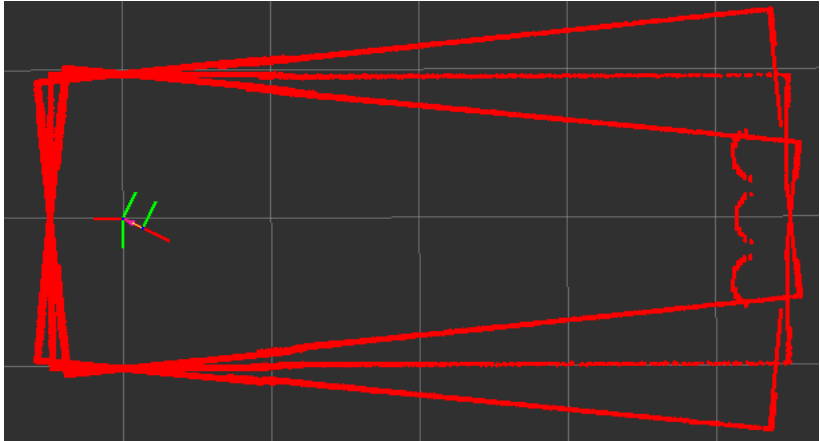
Bug Algorithms



(Modified) Bug algorithms

- ▶ Missing assumptions
 - ▶ Distance to goal is not known
 - ▶ Direction to goal might be imprecise (slippery surface, wrong encoder data)
- ▶ Additional assumptions
 - ▶ Environment has a rectangular shape
- ▶ Greedy approach
 - ▶ Head to the wall you are initially facing
 - ▶ Follow the walls until see the goal
 - ▶ Head to the goal

Noise



Kalman Filtering and Mapping

- ▶ Kalman Filtering (Linear Quadratic Estimation)
 - ▶ Input
 - ▶ A series of measurements of a variable obtained over time
 - ▶ Observations contain statistical noise
 - ▶ Output
 - ▶ Estimates of the values of the variable
 - ▶ These estimates tend to be more precise than one time measurements
- ▶ Mapping
 - ▶ Create a dynamic map of the surrounding environment
 - ▶ Use this map to reach the goal faster after the first iteration
 - ▶ Needs Kalman Filtering to get precise position of gaps, walls and goal

Singleton

- ▶ Comes from the mathematical 'Singleton (a.k.a. Unit set)'
- ▶ Restricts the instantiation of a class to one object
- ▶ Defines a 'getInstance' operation to expose the unique instance
- ▶ Useful when exactly one object needed to coordinate actions
- ▶ getInstance responsible for creating class unique instance

Mediator

- ▶ Behavioural pattern - Can alter the program's running behaviour
- ▶ Communication between objects encapsulated with a mediator object
- ▶ Objects no longer communicate directly with each other
- ▶ Reduces the dependencies between communicating objects, thereby lowering the coupling

Stay Agile! Stay Alive!

- ▶ Biweekly code sprints
- ▶ Trello for task management and tracking backlog
- ▶ Daily standups to keep track of progress and blockers
- ▶ Weekly review and retrospective
- ▶ Coordinated Pair programming sessions
- ▶ End of sprint celebrations (Motivation!)

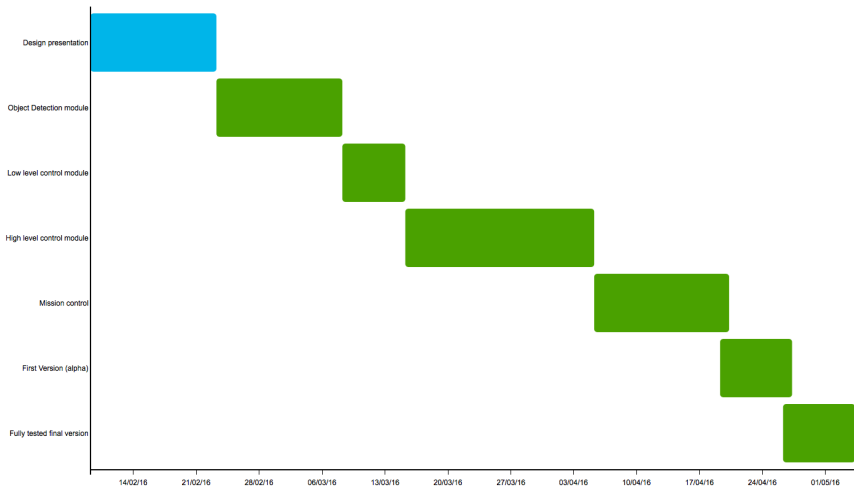
Testing

- ▶ Test Driven Development (TDD)
 - ▶ Write tests before code
 - ▶ Helps clearly plan out program functionality
 - ▶ Reduces debug time drastically
- ▶ Focused on four different domains:
 - ▶ Unit Testing
 - ▶ Integration Testing
 - ▶ System Testing
 - ▶ Stress Testing

Version Control

- ▶ Git (using Github for remote)
- ▶ Divide tasks into issues
- ▶ Branching Model
 - ▶ Each issue to be a separate branch on the remote
 - ▶ To be merged back in to the master after completion of issue
- ▶ Pre commit hooks for code style guideline compliance
- ▶ Post commit hooks for documentation generation from inline documentation

Deliverables and Timeline



References



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