Obstacle Avoidance and Goal Detection Robot using RPi and LRF.

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Overview

Goal (Basic)

Given a goal and a robot:

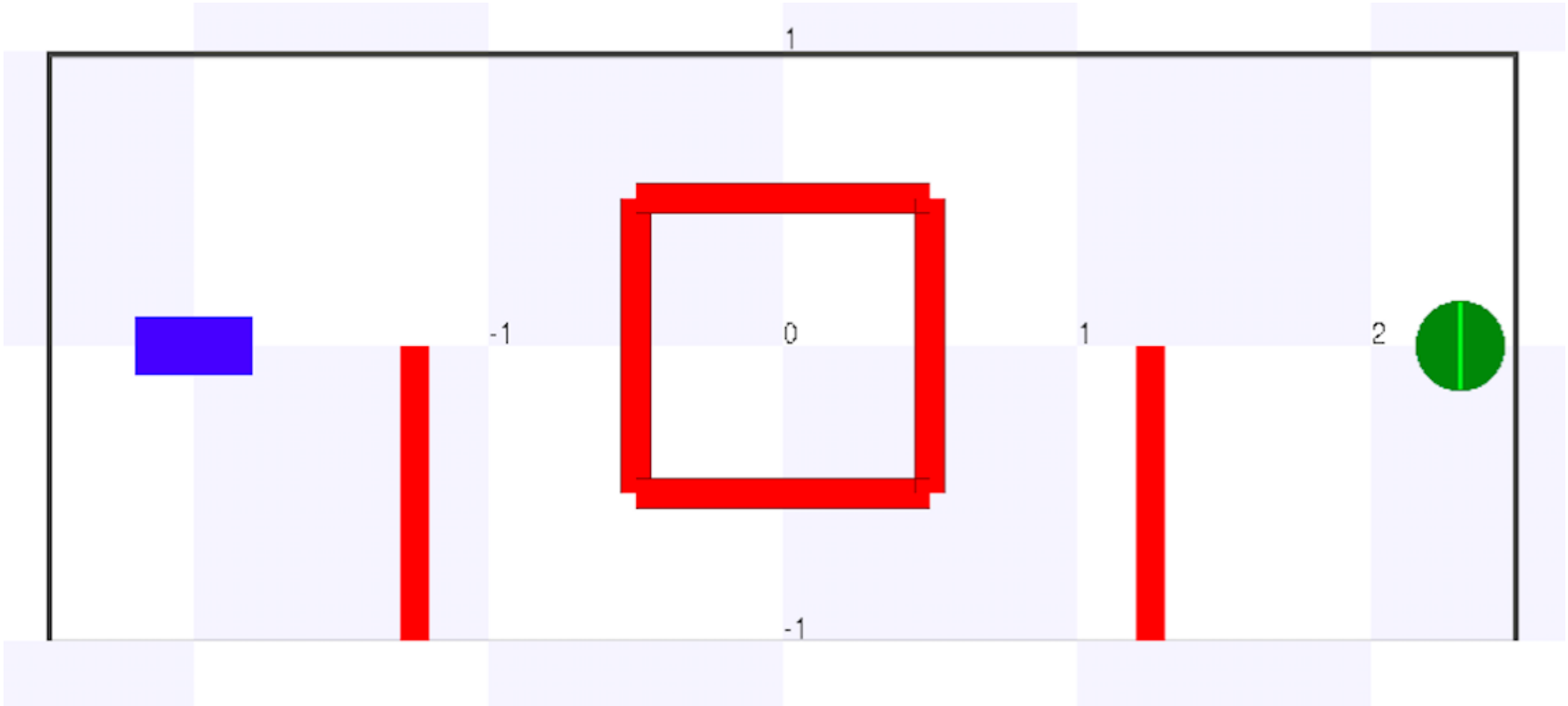
- Turn the robot around
- Identify the goal object from LRF input
- Move towards the goal

Goal (Advanced)

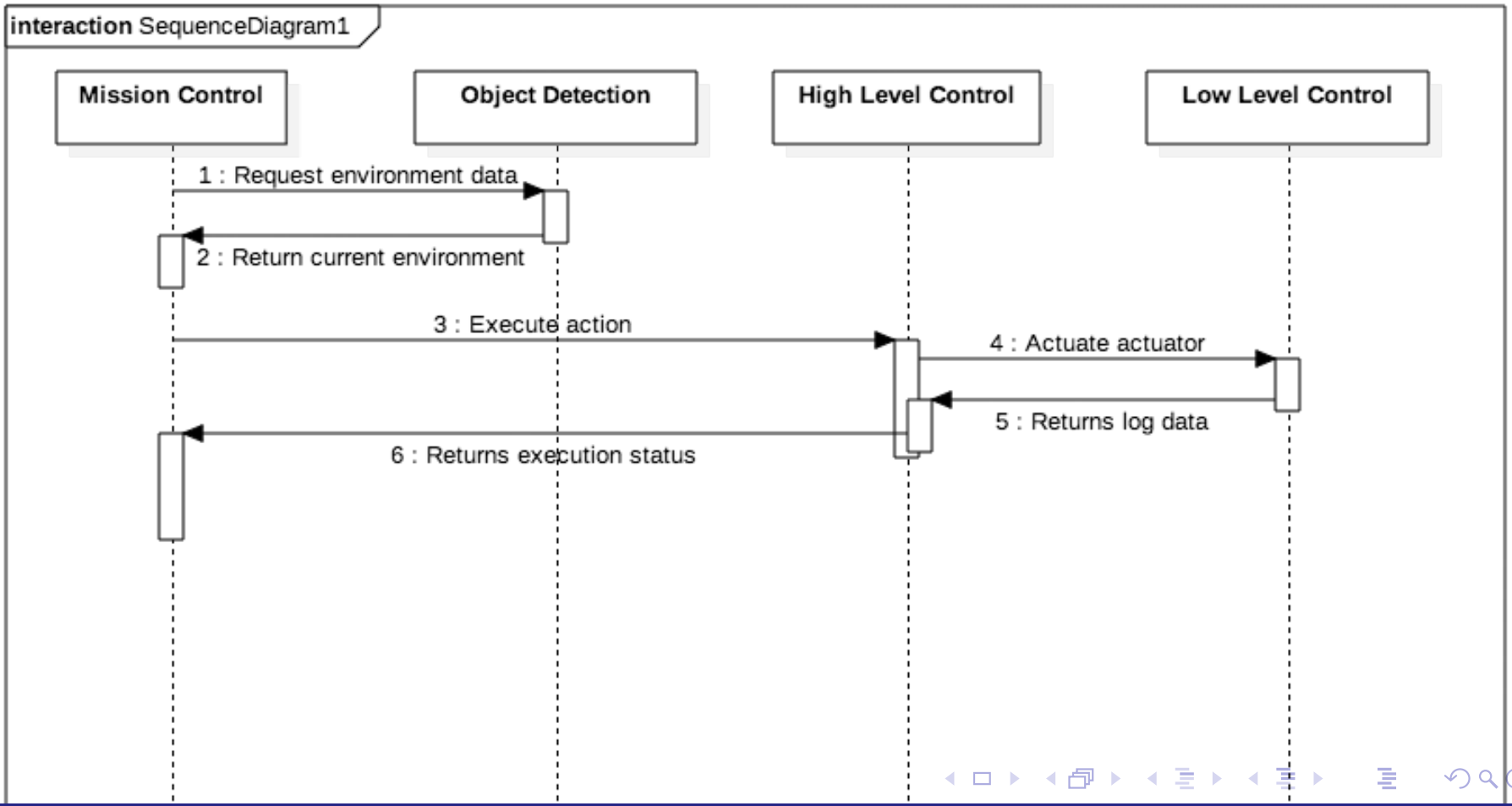
Given a goal, a robot, and a maze:

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

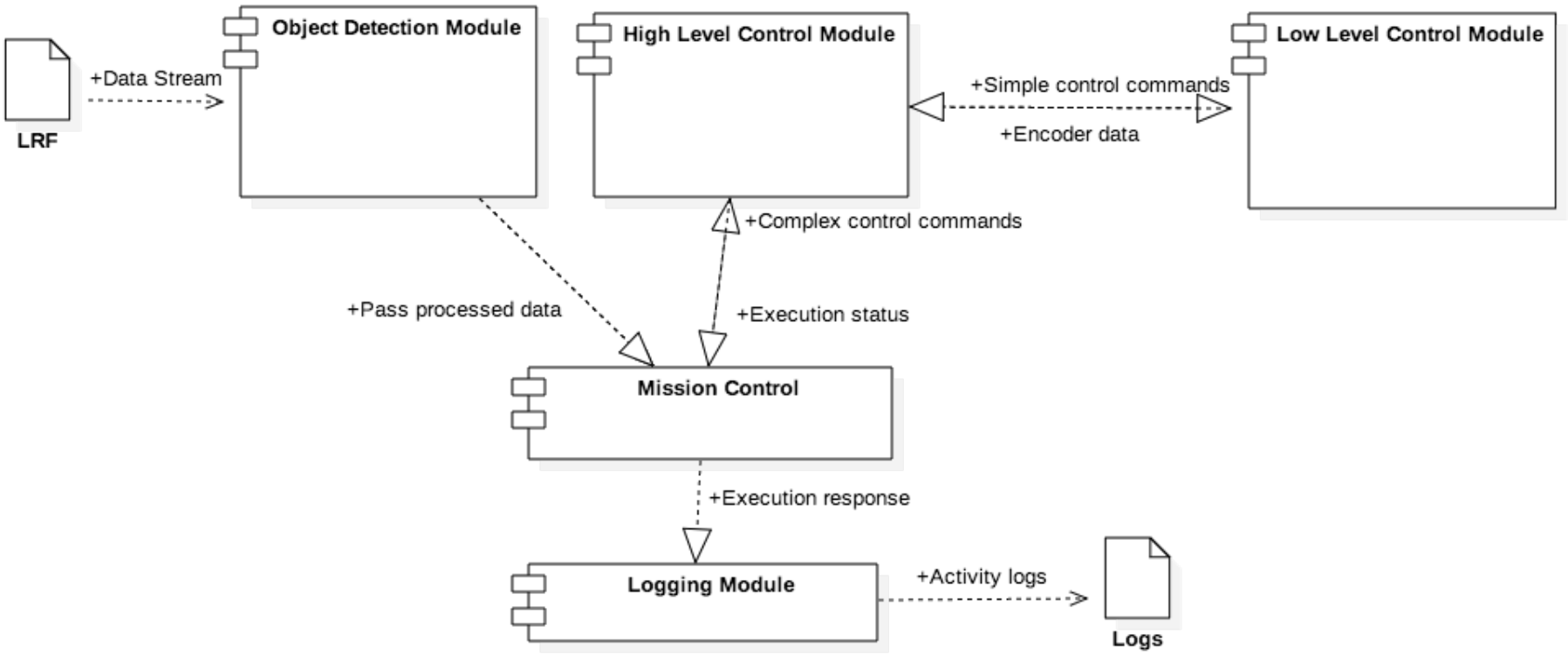
Goal (Advanced)



Sequence Diagram



Component Diagram

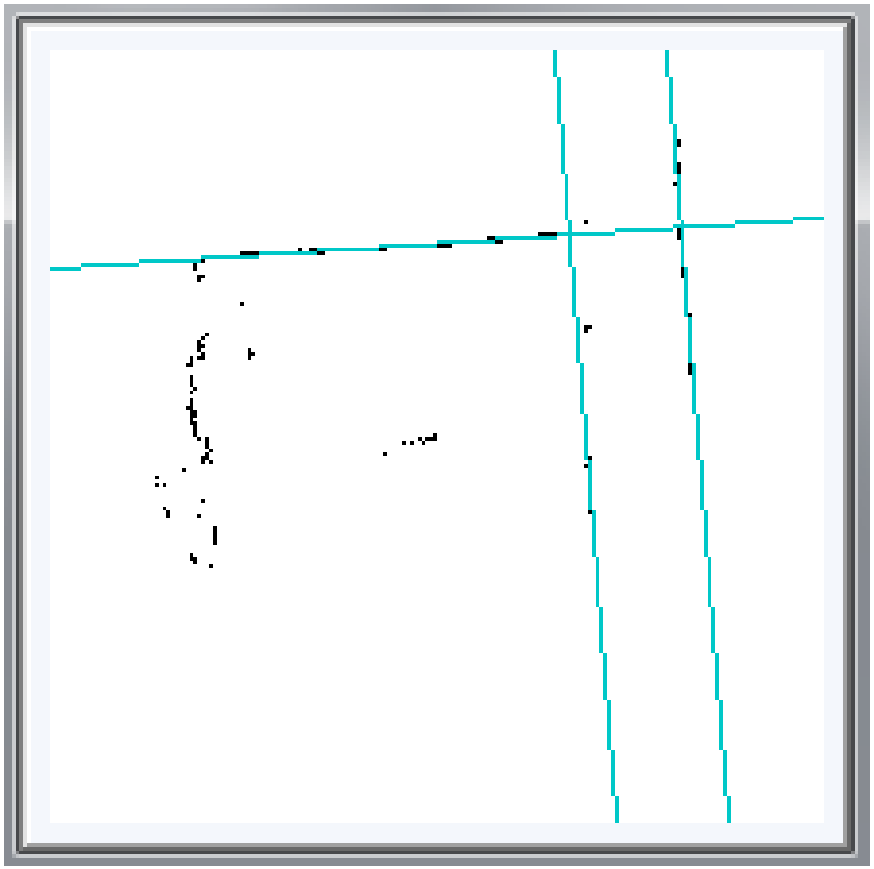


Class Diagram

Hough Transform

- Algorithm to detect imperfect instances of geometric shapes
- Reduces the amount of data to be processes
- 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

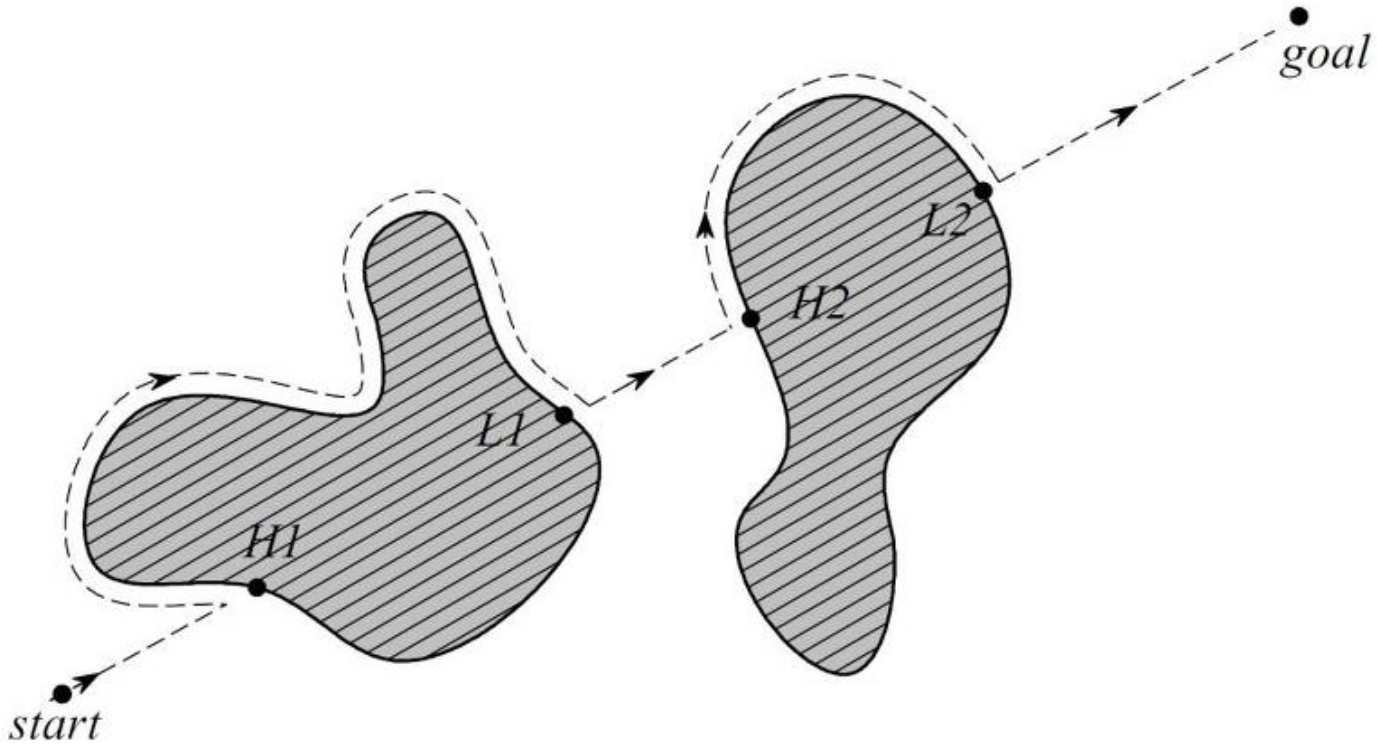
Hough Transform



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

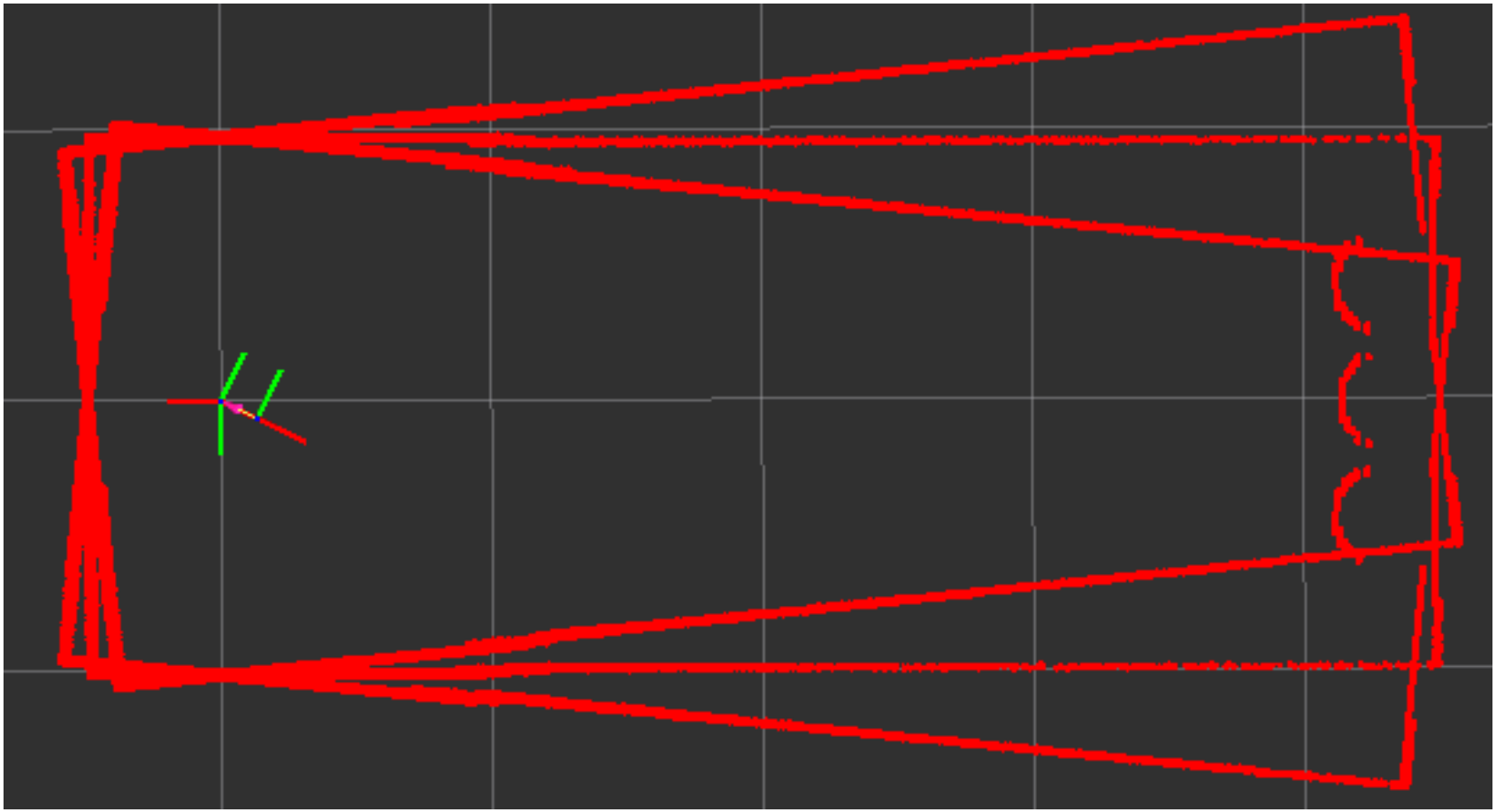
Bug Algorithms



(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!)

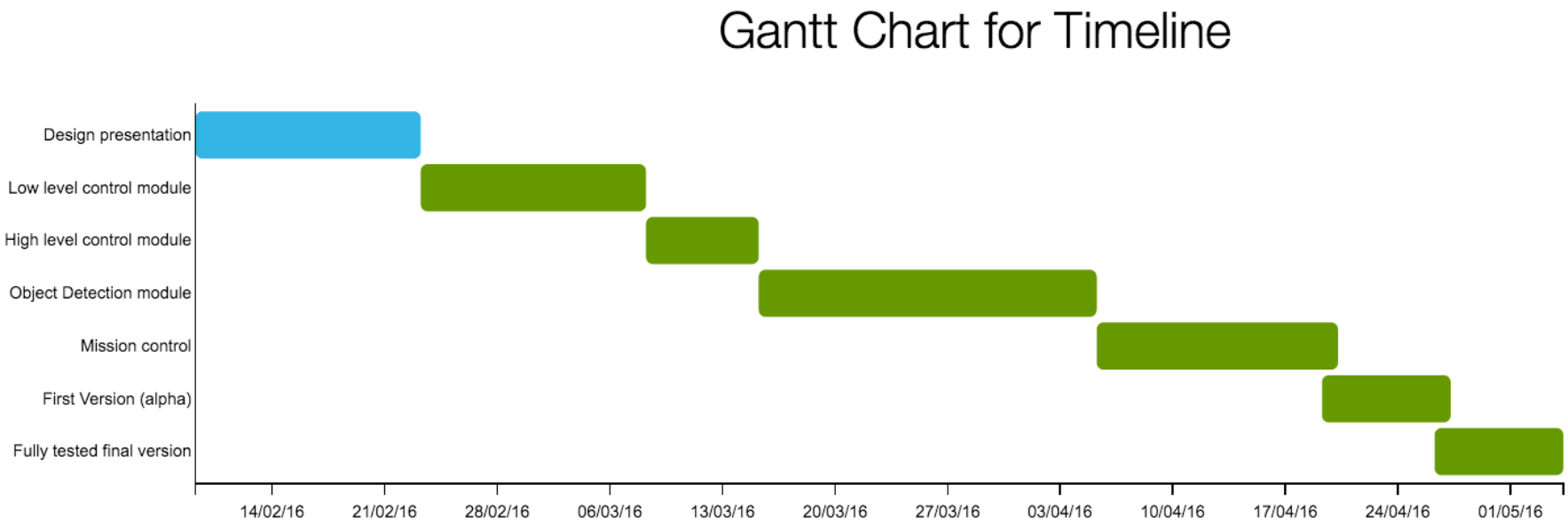
Testing

- 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

Deliverables and Timeline



References

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