CompRobo Final Project Proposal: Robot Navigation

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Main Idea

In this project we will investigate robot navigation. We will focus on path planning and how best to determine the optimal route through a space. Given a map of a space and a destination, we will make the Neato navigate to that destination along the most optimal path. This is an example of a behavior that could be useful for robots in many contexts.

Areas of Exploration

We want to explore pathfinding and adaptability. (We would like the neato to adjust its path if it runs into an unexpected obstacle.)
From initial research, we will most likely be focusing on the A* algorithm for pathfinding, but we may explore some of the others listed below.

- Dijkstra's algorithm
- D*
- Others on Wikipedia's list of Graph Search Algorithms

MVP

A robot that when given a location on a map calculates and then traverses a path to the destination along the shortest possible route.

Stretch Goals

Obstacle Avoidance: A stretch goal we'd especially like to explore is including obstacle avoidance into our pathfinding process. For example, the Neato would calculate and follow it's path until it reaches an unexpected obstacle. Then it would avoid it and recalculate its path and keep going.
Elevator Neato: This system would include maps of two floors of a building (for example the first and second floor of the Olin College Academic Center), and it would know the location of the elevator. If given a destination on the floor it was not currently on, the neato would navigate to the elevator using one map and then switch maps to navigate around the new floor to reach its final destination. It would wait at the elevator for someone to open the elevator doors.
Depending on algorithm - Neato traverses potential path while planning
Traverses path while planning: It would be more efficient for the Neato to compute its path while driving, so we'd like to explore that too.

Timeline

Sunday	4/9 - Proposal!
Tuesday	4/11 - Generate complete map of Academic Center 1st floor
Friday	4/14 - Implement algorithm to plan optimal path
Tuesday	4/18 - Project Story I and working A* algorithm and Neato follows optimal path w/o obstacles
Friday	4/21 - Working A* algorithm and Neato follows optimal path with obstacles
Tuesday	4/25 - Project Story II Working A* algorithm and Neato follows optimal path with obstacles
Thursday	5/4 Progress towards stretch goals and creating documentation. (Elevator Neato!)
Friday	5/5 - Robot Expo

Risks

Some of the biggest risks we are anticipating are outlined below:

- Underestimating complexity of system.
- Challenges in making accurate map of large space. The success of our Neato navigation will depend greatly on the accuracy of our map.
- Incorporating localization. If the robot's estimated current location is incorrect, it will not be able to navigate accurately.
- Handling unexpected obstacles. Our system will rely on our map for localization as well as path planning. If there is an obstacle in the environment that was not originally on the map, it could interfere with both of these processes. We will need to come up with a system to handle this situation.

Yoga Alignment

Paul (YOGA)

- ➔ This project lines up very well with my YOGA, as one of my goals was to explore pathfinding. I also wanted to improve my understanding of ROS and python, as well as algorithms. Because we'll be using built-in ROS packages to create our map, I'll hopefully gain experience there.

Brenna (YOGA)

- ➔ This project lines up well with two of my three learning goals. It could be applied to many interesting contexts and has "real world" applications, and we will be able to put together a great demonstration and strong documentation of our work. In my first phase 0 goal, I was thinking more along the lines of working with a new sensor or actuator, but the opportunity to explore these algorithms and the system of this project will fulfil a slight adaptation of my goal of learning a new technical skill.