

Final project suggestions

First, a few guidelines, the first few of which were covered in the previous handout:

- Project teams may consist of 2 or 3 students. (Obviously, I will expect more from a 3 student team.)
- Projects must implement some algorithm using a real robot.
- You should implement a reasonably general solution to a problem, not a “hack” for a specific situation. Similarly, the environment should require minimal “engineering” for your project to work.
- A project should involve at least one of the following topics: motion planning, mapping, and localization
- A project should involve at least two different components. This could be two of the above, or one of the above and another topic.
- You can (and should) reuse code from the assignments when possible.
- Rudimentary computer vision capabilities will be available (recognizing colored markers). However, keep in mind that sensing using vision will not be 100% reliable.
- We have a number of “cardboard walls” in the lab that you can use to set up a small world boundary inside the lab or to block off part of the hallway outside the lab.
- Being able to display the results of your project is important, but there shouldn't be too much emphasis on user interface. (This is a class on robotics, not on HCI!)
- Projects that involve navigating in the corridor outside the lab will have to be robust to the occasional person walking by.

Here are some project suggestions. You can take one of these and add some details to make it into a final project. If you have other ideas for a project, we can discuss it, but I encourage you to take one of the following topics.

Integrated motion planning and execution

Using a given map, plan a path for the robot from its current location to a goal location and then execute this path. You should monitor the robot's execution, detect when the robot is too far from the nominal path, and replan the path. Another alternative is to apply corrective actions to bring the robot back to the planned path.

Fundamentally, this is a project combining motion planning and localization. I would suggest using the Kalman filter for localizing the robot using the SONAR sensors. Ideally, the robot would be in continuous motion. For the feedback control option, the “pure pursuit” approach would be an appropriate (and simple) choice.

You should demonstrate this project in a more expansive space than the 1lab, most likely in the hallway outside the lab, and be able to arbitrarily specify a start and goal configuration.

Topological mapping

Develop a set of behaviors to navigate in office building environment (e.g. hallways) and use them to create a topological map of an unknown area. This map should be annotated at least with the distance between nodes. You can place markers in the environment (within reason) in order to recognize places.

Once the map has been learned, you should be able to use this map for planning a path for the robot from the robot's current configuration to another location in your map.

Some questions for this project are: How will the robot follow corridors? What assumptions are you making about corridors? How will nodes in the topological graph be recognized?

A three person version of this project should add something to its scope. One possibility would be to recognize doors in the corridor and then being able to navigate to a particular office. Another would be to extend this to implement a topological version of the "kidnapped robot problem." (Of course, if you do this, you cannot place unique markers through the environment.)

Simultaneous localization and mapping

You won't solve the general problem of metric mapping and localization in the next month, but you could tackle some simplified version of that problem. One possibility would be to use the camera to identify landmarks (or perhaps just markers) that can be used to completely or partially localize the robot (possibly using the Kalman filter!) Add basic navigation and obstacle avoidance capabilities for the robot to be able to explore the area completely and avoid obstacles (which might not have markers on them).

Markov localization & navigation

Implement Markov localization using either SONAR or vision sensing. Use this while following a planned path to some goal location. If your location deviates from the planned path, either plan a motion to put you back on the path or just replan the entire path.

There are several variations and extensions on this problem:

- The "kidnapped robot" problem is when the robot is suddenly transported to some location in its map, and then the robot must globally localize itself.
- Give the robot a "homing behavior" that can figure out where the robot is located and take it back to its "docking station."

Project proposals

- Your proposal should be approximately 2 pages in length
- Your proposal should address:
 - what you are going to do: the problem you will address and what you will be able to demonstrate at the end
 - (as specifically as possible) how you are going to do it
 - who will do what on the project
- I highly recommend structuring your project in two or three phases. Each phase can be the development of one component of your project or can be a set of intermediate goals for each component.