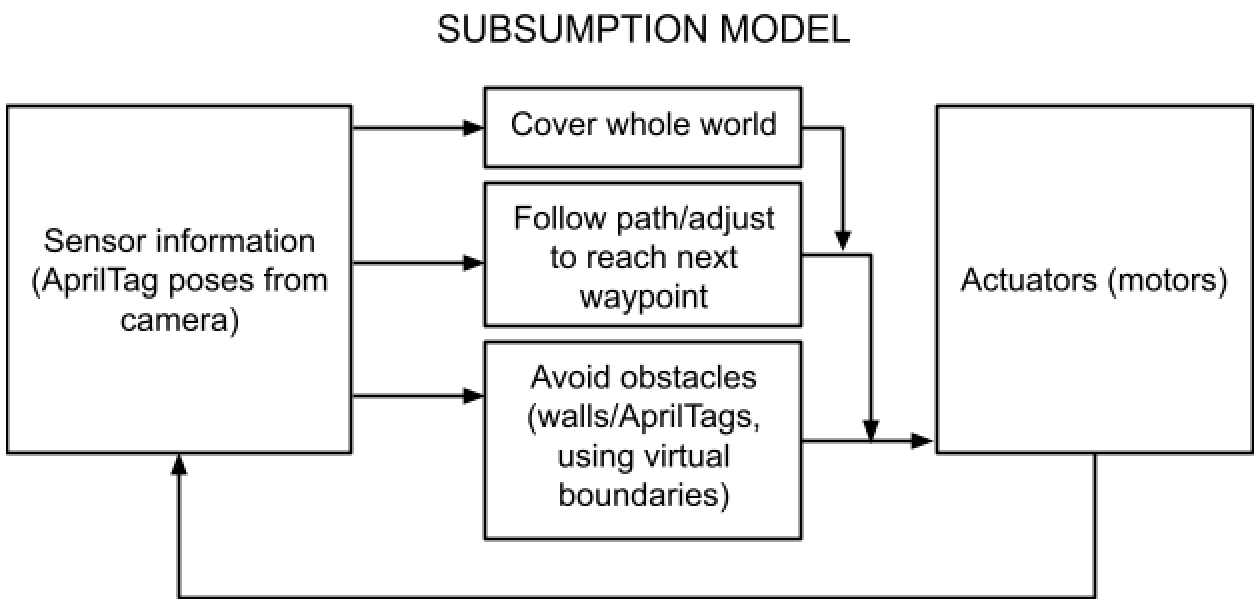
CSE 276A HW 5 Report

Path Planning

We chose the waypoints based on the size of the robot (0.16 m x 0.19 m), using a back-and-forth path that should provide coverage of the entire area. We chose a path in which the robot moved forward across the length of the environment, turned 90 degrees, moved a bit forward, turned another 90 degrees, and then moved forward across the length of the environment again. We believed this approach would grant maximum coverage given we know the map beforehand - it is a square environment where the obstacles lie outside the virtual boundaries of the world and therefore avoidance only occurs at the boundaries. Additionally, we used 8 AprilTags for localization.

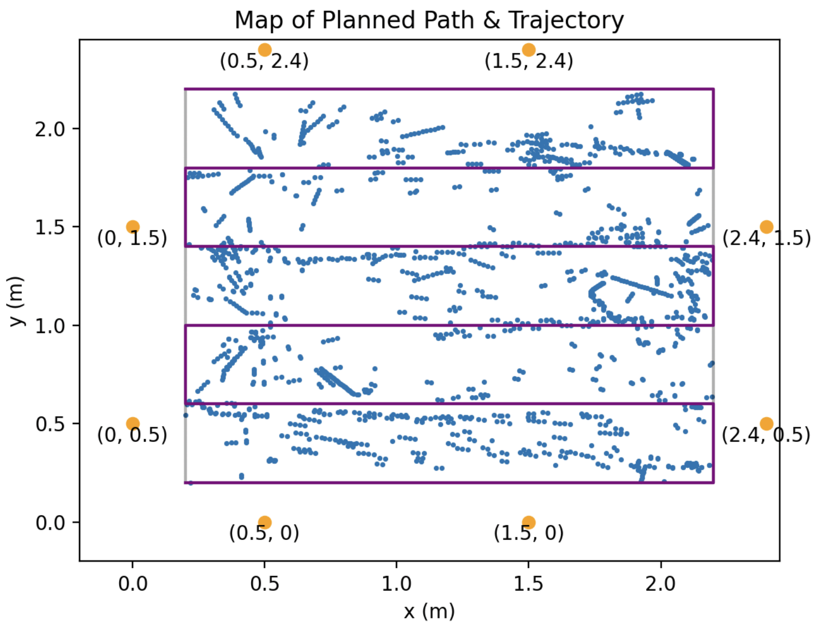
Architecture of System



We chose a subsumption model where the sensor information was the AprilTag poses from the camera and the actuators were the motors of the robot. The behaviors to provide coverage/avoidance include following the provided path to the next waypoint and avoiding obstacles using the virtual boundaries provided. Upon reaching the final waypoint, the robot has coverage of the whole environment. We believed this was a sufficient model for robot behavior when trying to provide coverage of the world space, since we could follow a structured path that covers the entire square environment.

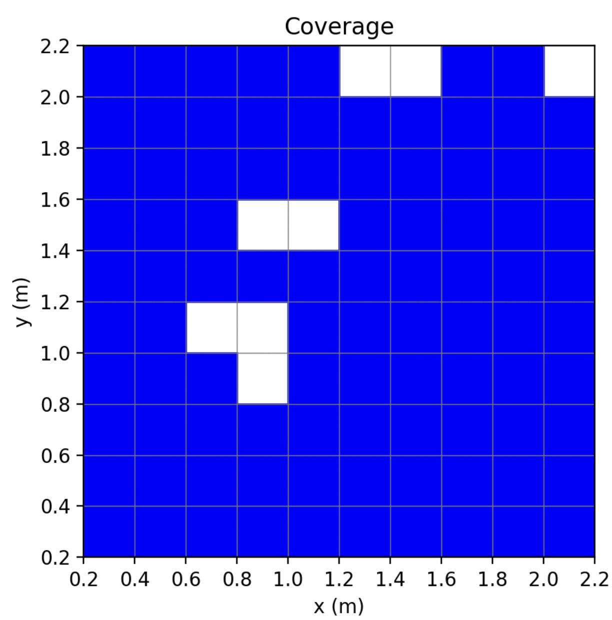
Performance

Trajectory Plot:



*Trajectory includes pose estimates from localization, including any adjustments made; purple path is the planned path.

Coverage:



We defined performance in terms of area coverage of the world. Good performance would therefore be represented by high coverage. Our world area is 2.2 m x 2.2 m (slightly inside total area given virtual boundaries; complete area is 2.4 m x 2.4 m including AprilTag locations). We left 20 cm off the edges for the boundary to account for the size of the robot and the orientation adjustment when turning (since the robot length is 0.19 m). We then split the 2.2 m x 2.2 m area into a grid of squares of size 0.2 m x 0.2 m (based again on the robot length). If the robot world coordinates lie within the grid square, that square is covered. Therefore, the percentage coverage would be how many squares were covered out of the total number of squares.

To obtain our guarantee of performance, we conducted multiple runs (5 to be exact) and retrieved the minimum coverage and average coverage across runs. The minimum coverage was 87% of the world area. The average coverage was 91% of the world area. Given the minimum coverage, we can guarantee that the coverage/performance will be higher than 87% in 80% of future runs. If we performed more runs (e.g. 10, 20, etc.), this guarantee would eventually converge to the (new) minimum coverage value for 100% of future runs. We can also estimate the coverage to be on average 91% in future runs.

Link to Video: https://youtu.be/5L5EgUAdpXI

*We launched hw2_solution.py for our HW 5.