Towards Autonomous Navigation and Assembly: Infrared Detection

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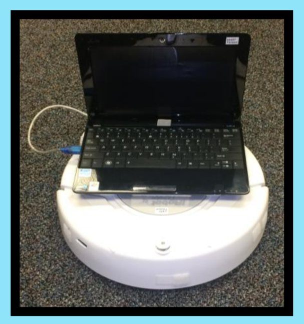
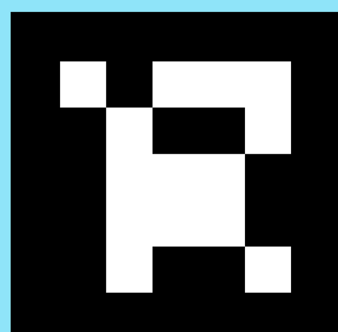
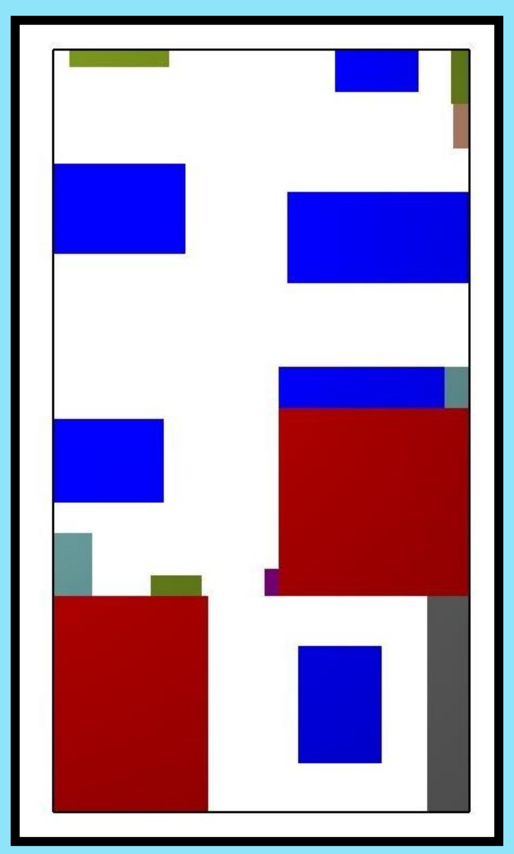
Project Setup



- Robot has a computer mounted on top which is in charge of seeing the markers and sending back their information
- It is in charge of exploring the environment and ultimately assemble the boxes that form the A&M logo



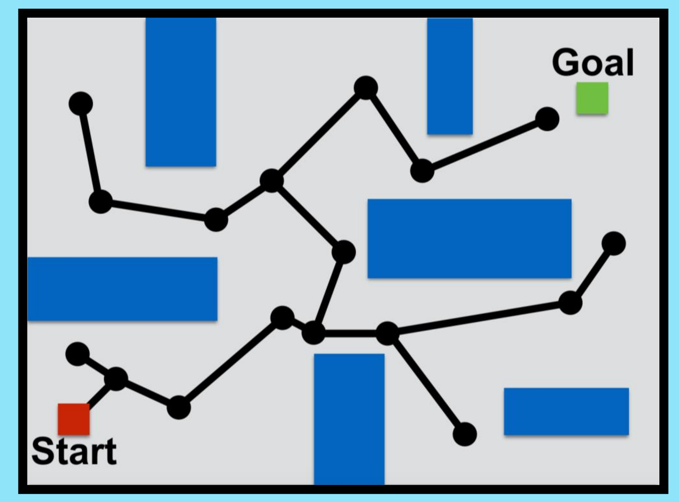
- Markers have unique numbers and positions on the boxes and environment
- They contain x & y coordinates in environment
- Used for robot localization and positioning
- Each contain programmed instructions for robot to follow



- We created a virtual representation of the actual lab where planning takes place
- We placed markers in every corner and wall in the room
- We gathered x & y coordinates as well as the angle orientation of the markers
- Markers were also placed on and around the boxes
- We also measured the x, y, and angle orientation of markers on boxes

What is Motion Planning?

- Motion Planning is the problem of finding a collision-free path from a start to goal configuration.
- Generates random samples to form a roadmap, then extracts the best valid path.



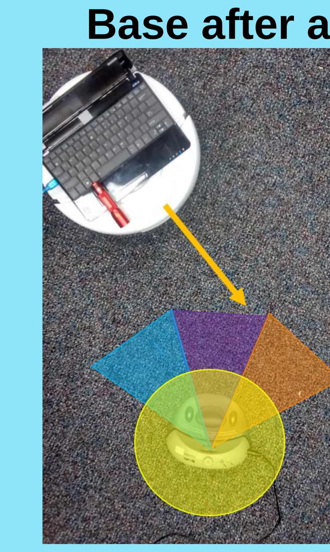
The Goal of the Project

Use Mobile robots to position objects by:

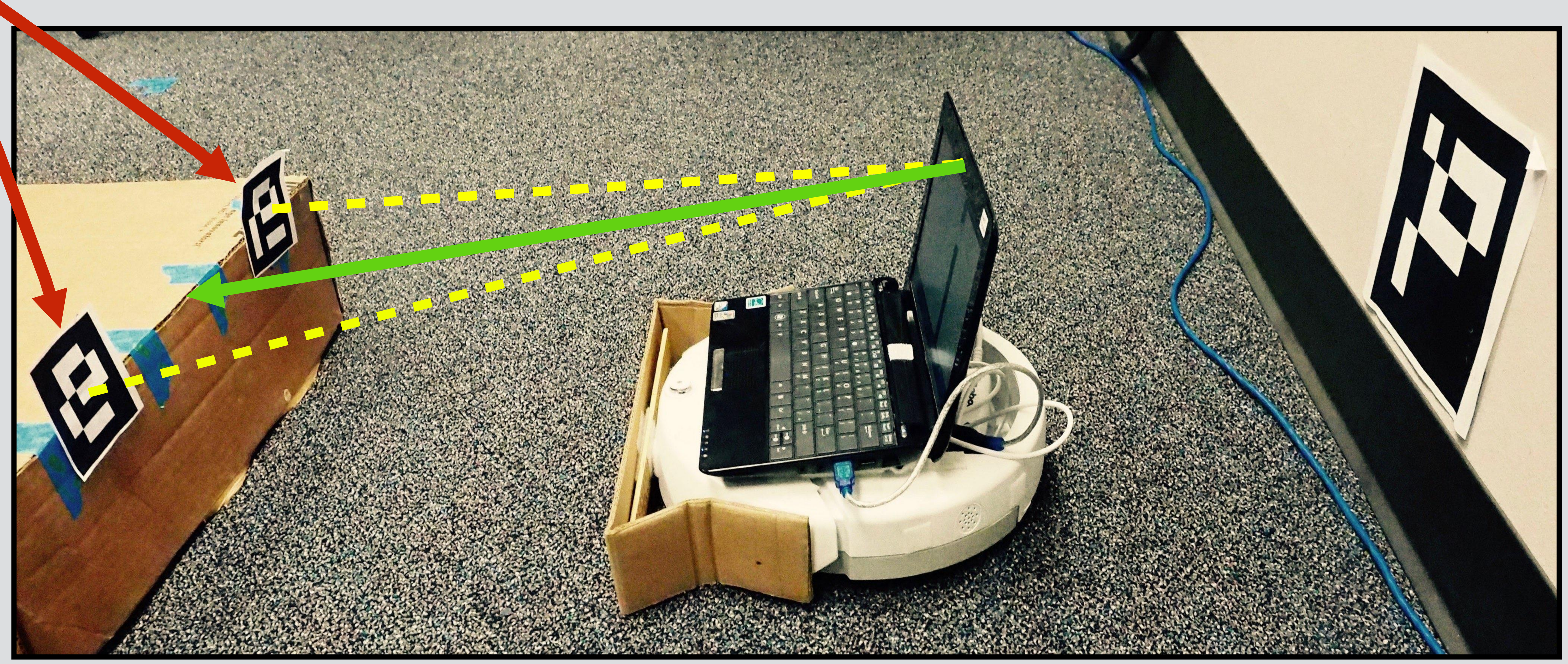
- Using visual aid to localize the robot and boxes
- Planning a path for the robot to take
- Finding appropriate tool to push objects
- Recharging autonomously

Infrared (IR) Sensor Setup

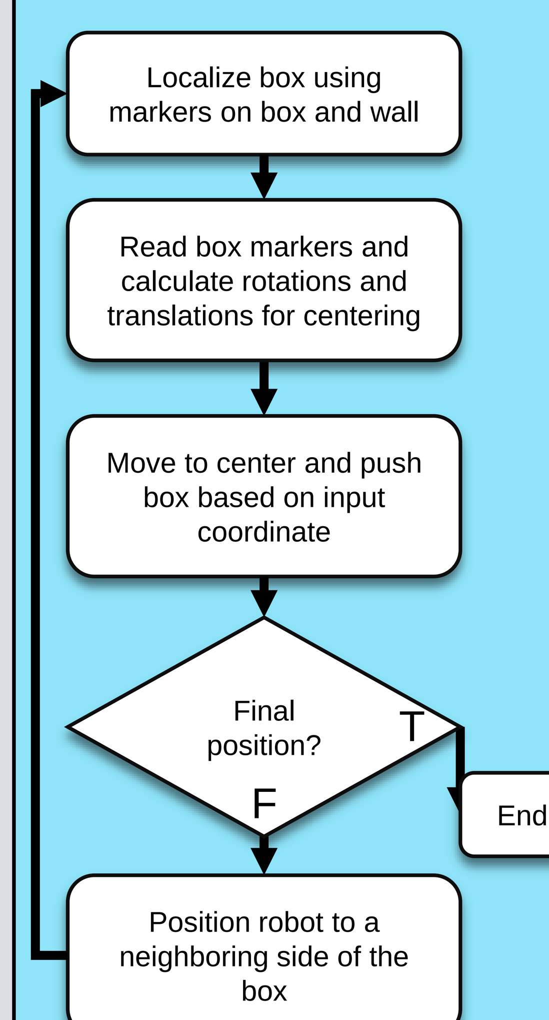
Problem: The robot needs to recharge at the Home Base after assembly or when needing charge



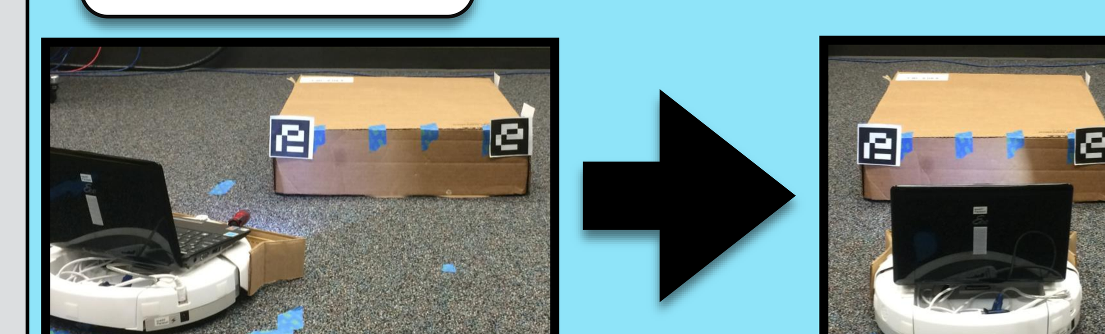
- The Home Base emits infrared signals in fields, including left(blue), middle(purple), right(orange), and a force field(yellow)
- The robot would then use its own infrared sensor to locate itself within the fields of the Home Base

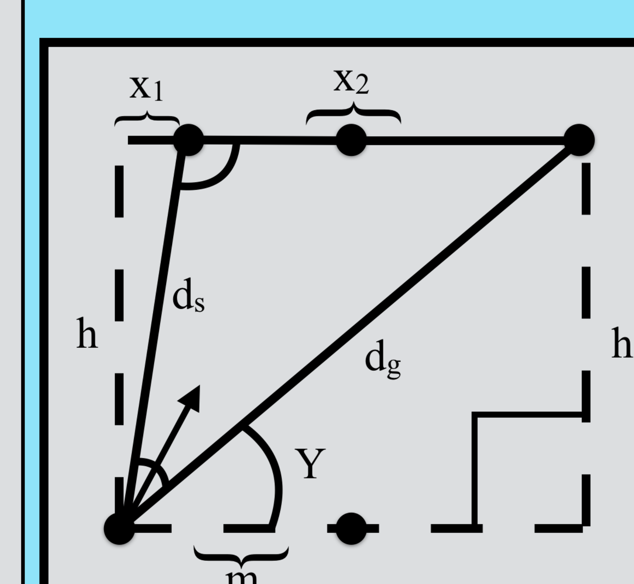


Method



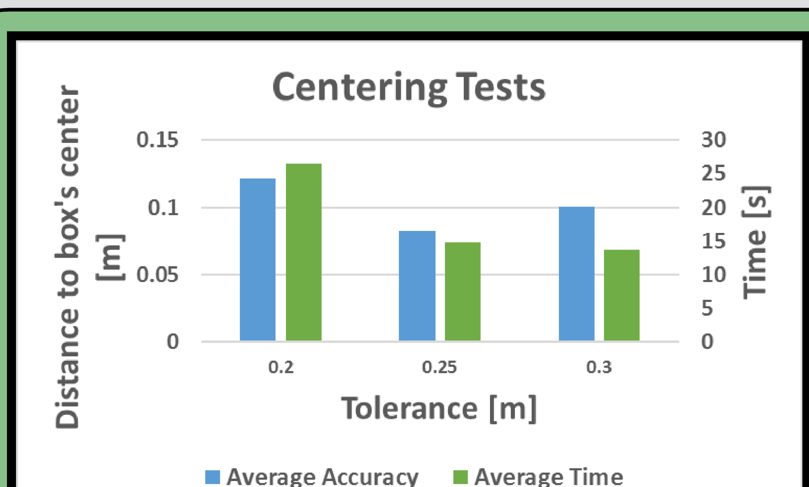
- Able to successfully acquire data from the markers e.g., position of marker, distance and angle to the robot
- Robot can successfully push a box forward a given distance with a margin of error under 5%
- Robot can accurately compute the distance between two markers and wall
- Robot uses trigonometric functions to center itself in front of the box, facing towards it





- We use the law of cosines and basic trigonometry to find h, Y, and m values
- This allows the robot to move to the center of the object precisely

Results



Experiments:

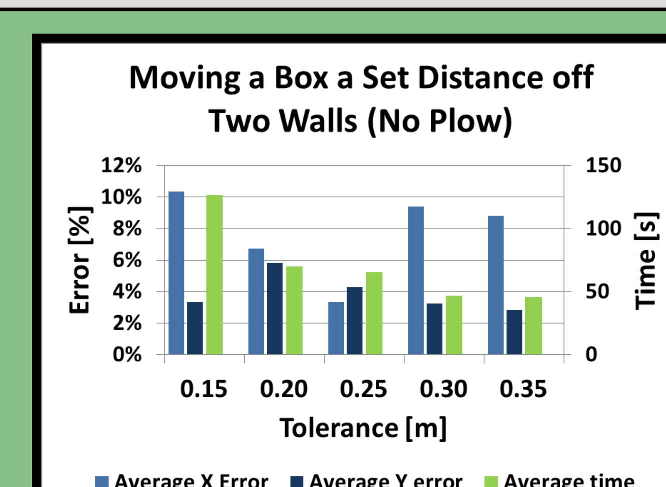
- Centering: positioning the robot behind the center of mass of an object
- Box positioning with and without a planar, pushing surface (plow)

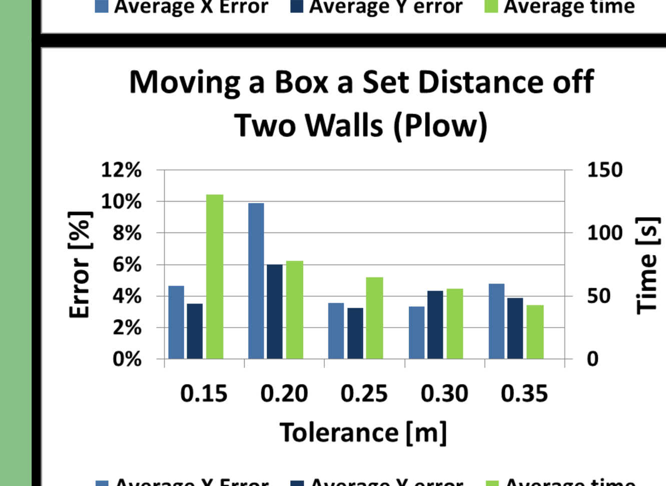
Centering:

- Tested with different tolerances (acceptable range of alignment accuracy)
  - Strict: Continuous adjustments reveal hardware issues
  - Relaxed: Software compromises accuracy to save time
  - Optimal: Point where hardware and software issues are least severe

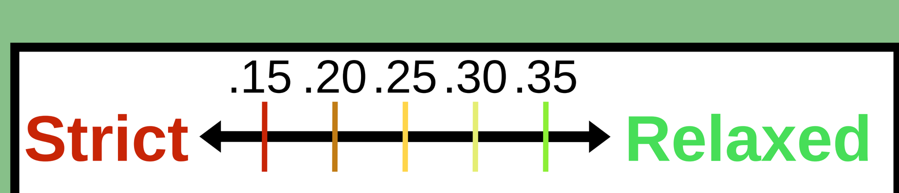
Plow vs. No Plow:

- In second operation, X Error decreased with plow
- %Error & Time were reduced with plow
- Unexpected inverse relationship between tolerance and error due to hardware downfalls





- We found that the optimal tolerance value is .25 because it balances hardware and software error



Conclusion

We were able to localize, push a box to a specified location, and dock with the robot. Performance was improved by adding a plow and refining the tolerance value.

Future work includes extending this method to more complex scenarios with multiple objects and robots.

Acknowledgments

This research supported in part by NSF awards CNS-0551685, CCF 0702765, CCF-0833199, CCF-1439145, CCF-1423111, CCF-0830753, IIS-0916053, IIS-0917266, EFRI-1240483, RI-1217991, by NIH NCI R25 CA090301-11,and by DOE awards DE-AC02-06CH11357, DE-NA0002376, B575363. The work of Pena, Leal, Leal, Rivero, Curran, Rodriguez, Zamora, Martinez, performed at the Parasol Lab during Summer 2016 [and supported in part by the CRA-W Distributed REU (DREU) project].