Towards Autonomous Navigation and Assembly: Environment Modeling

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Parasol
Smarter computing.
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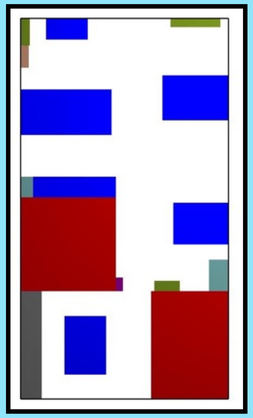
Project Setup

- 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
- Tested the robot with and without a plow to determine if results were affected

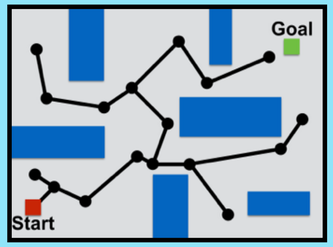
- Markers have unique numbers and positions on the boxes and environment
- Used for robot localization and positioning
- Each contain programmed instructions for robot to follow



- We created a virtual representation of the actual lab where planning takes place
- Placed markers in every corner and wall in the room
- 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.

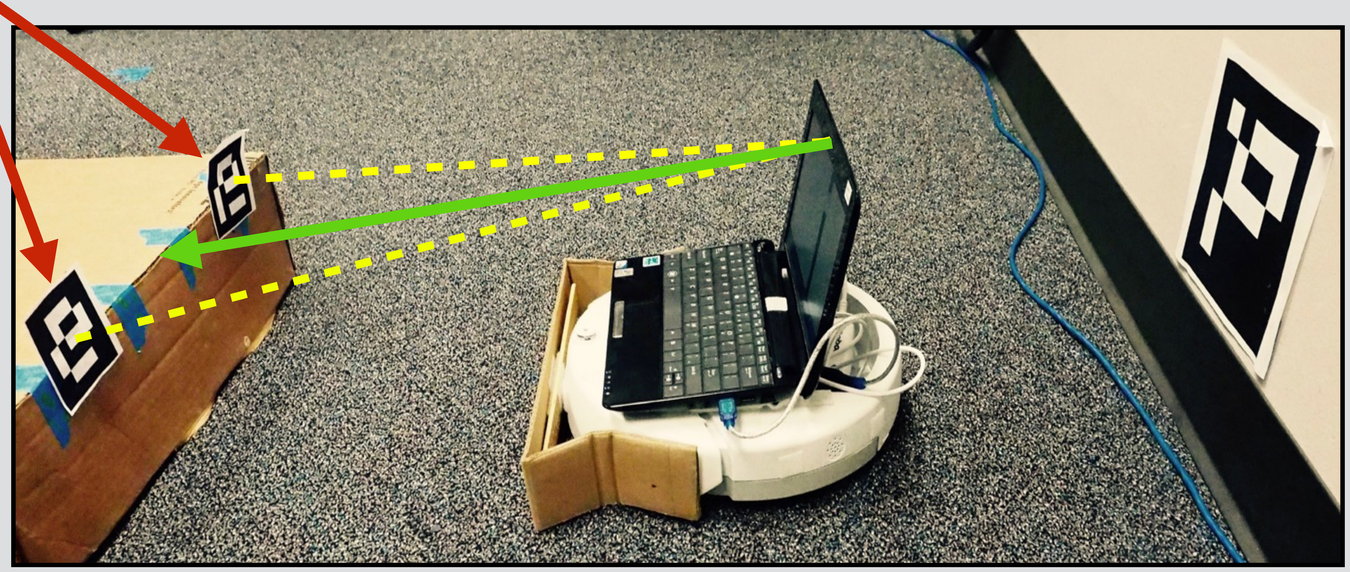


The Goal of the Project

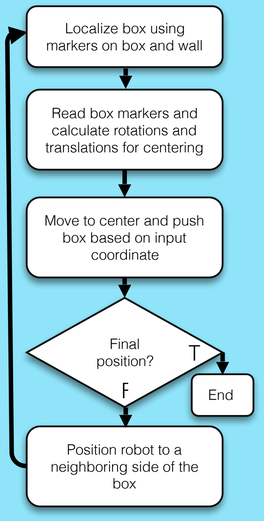
- Use visual aid to localize the robot and boxes
- Plan a path for the robot to take
- Use robot to manipulate the environment
- Recharge autonomously

Environment Setup

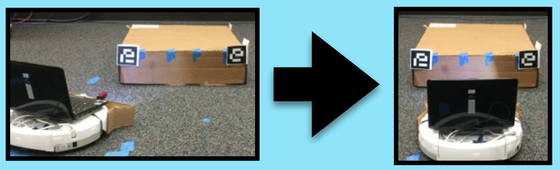
- A total of 158 markers were placed throughout the environment and boxes
- Each has a unique marker ID
- x, y and marker orientation information was inserted into a map for easy retrieval
- Environment Markers: measured x & y coordinates of each marker from the origin
- Object Markers: contain commands for object manipulation

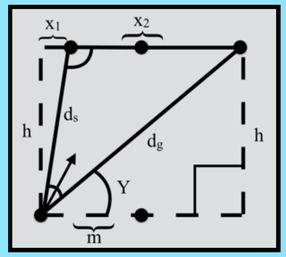


Method

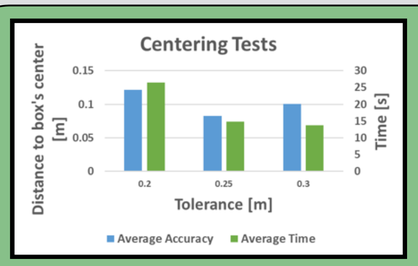


- Able to successfully acquire data from the markers e.g., position of marker, distance and angle to the robot
- Robot can successfully push a box forward a given distance with a margin of error under 5%
- Robot can accurately compute the distance between two markers and wall
- Robot uses trigonometric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

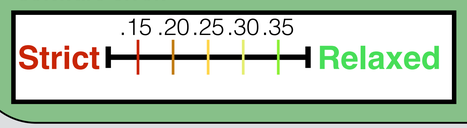




- We use the law of cosines and basic trigonometry to find h, Y, and m values
- This allows the robot to move to the center of the object precisely



- Centering tested with different tolerances (acceptable range of alignment accuracy)
- We found that the optimal tolerance value is .25 because it balances hardware and software error.



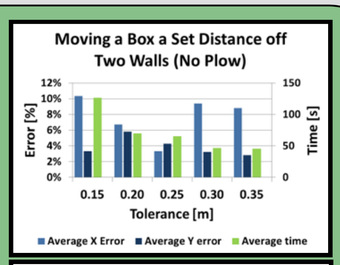
Results

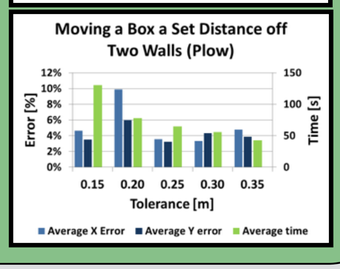
Centering:

- 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

- As second operation, X Error decreased with plow
- Unexpected inverse relationship between tolerance and error with plow
- %Error & Time were reduced with plow





Conclusion

We were able to localize, push, 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.

Acknowledgements

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 [Daniela Puente, Jesus Leal, Daniel Leal, Brandon Martinez, Leonel Pena, Marcos Pena, Bryan Rodriguez and Eli Zamora] performed at the Parasol Lab during Summer 2016 [and supported in part by the CRA-W Distributed REU (DREU) project].