Towards Autonomous Navigation and Assembly: Visual Localization

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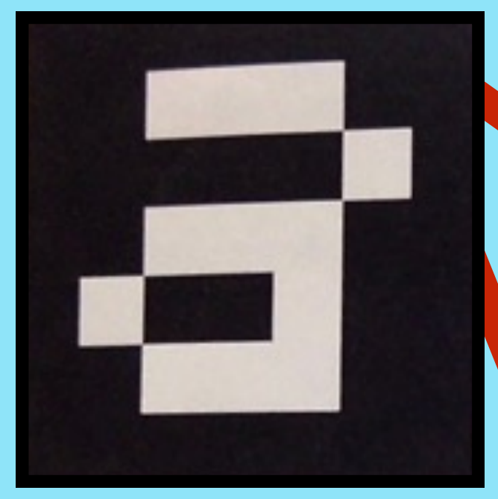
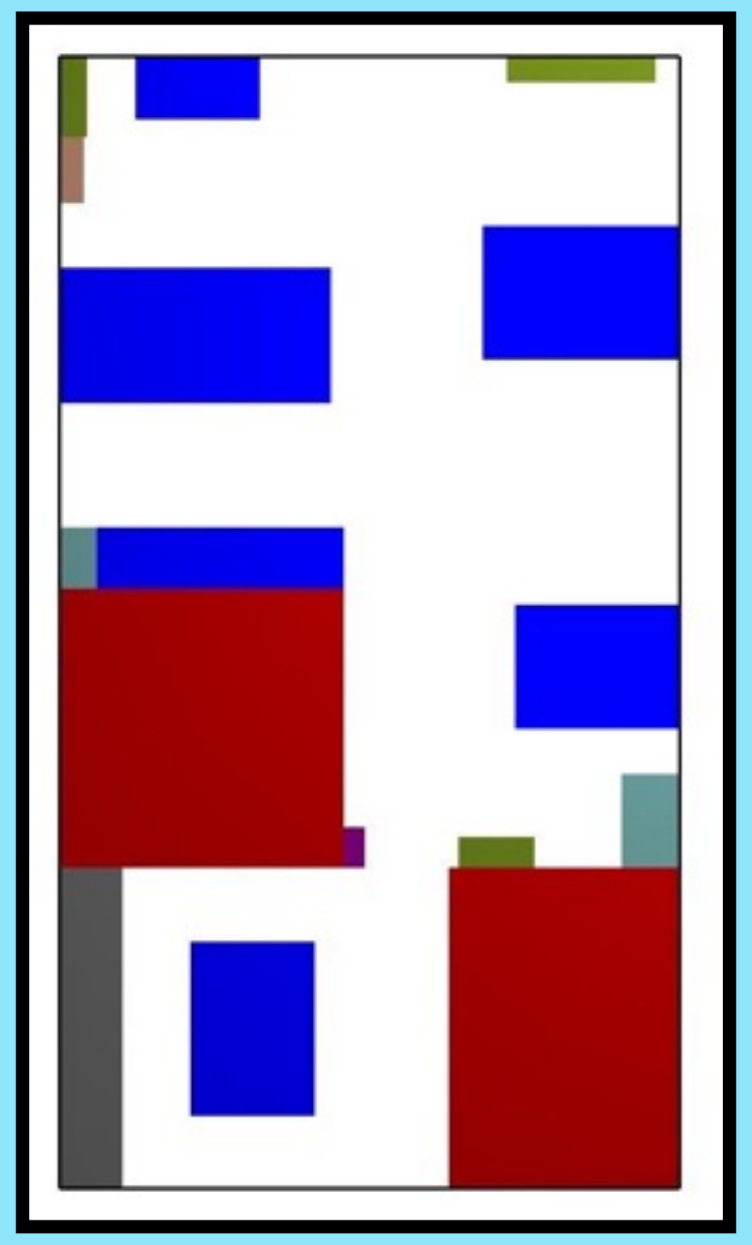
Project Setup

- 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



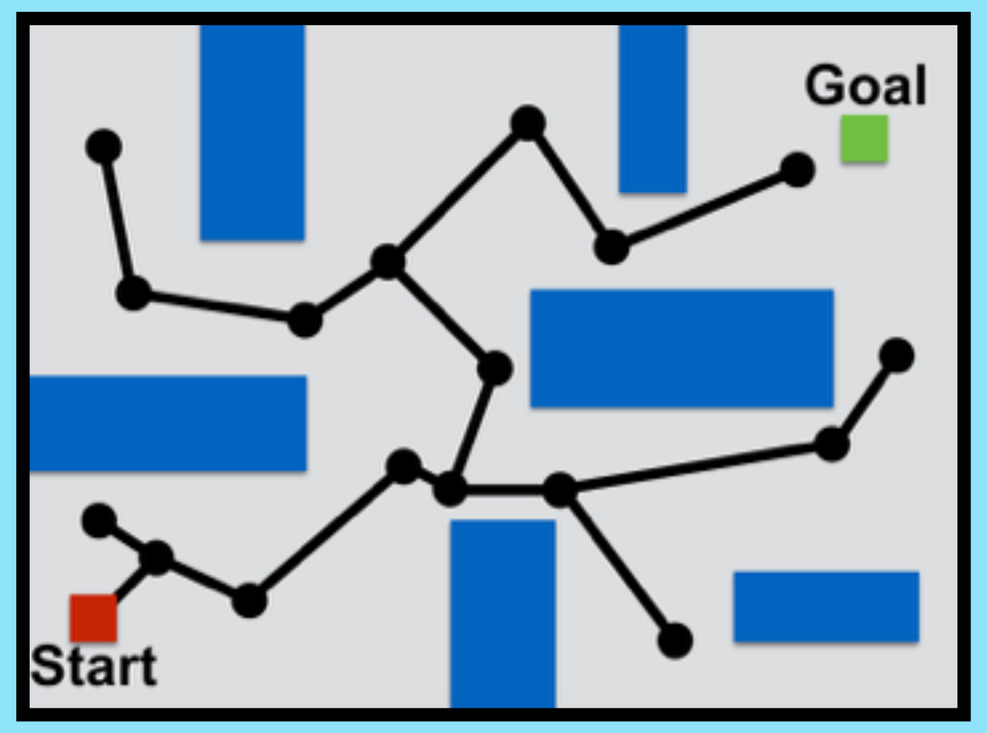
- Markers have unique numbers and positions on the boxes and environment
- Used for robot localization and positioning
- Each contain programmed instructions for robot to follow



- 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
- Measured the x, y, and angle orientation of markers on boxes

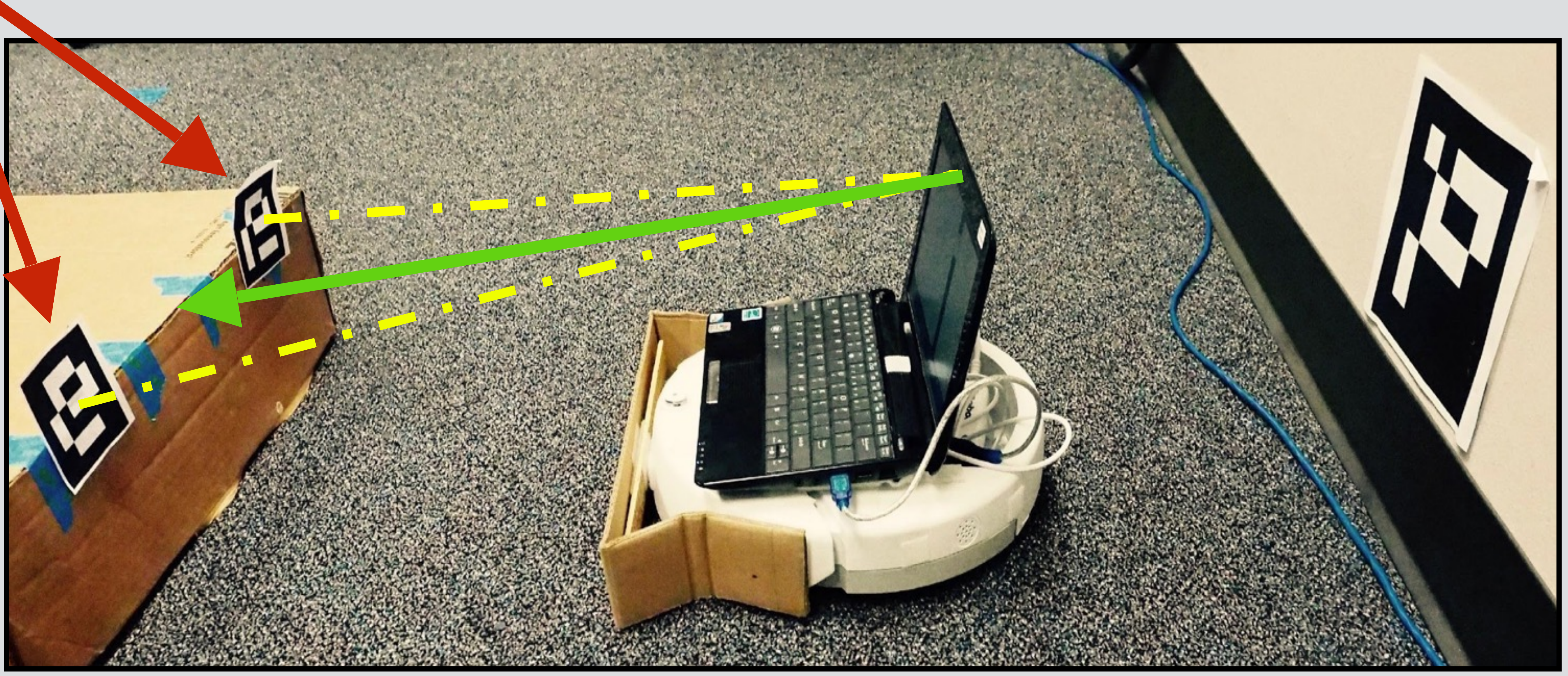
What is Motion Planning?

- 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

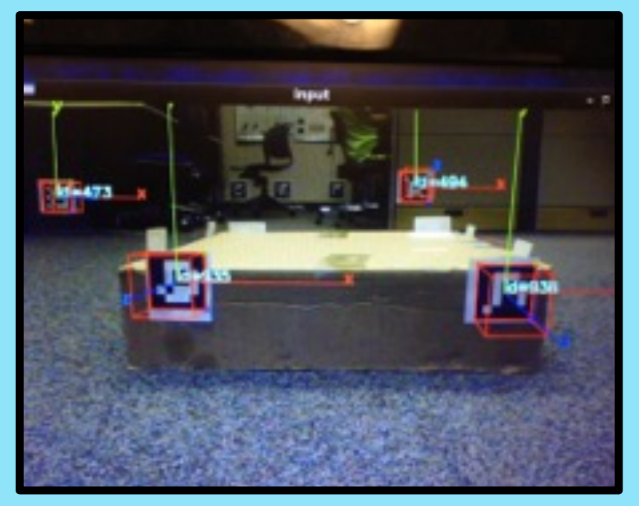


The Goal of the Project

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



Localization Process

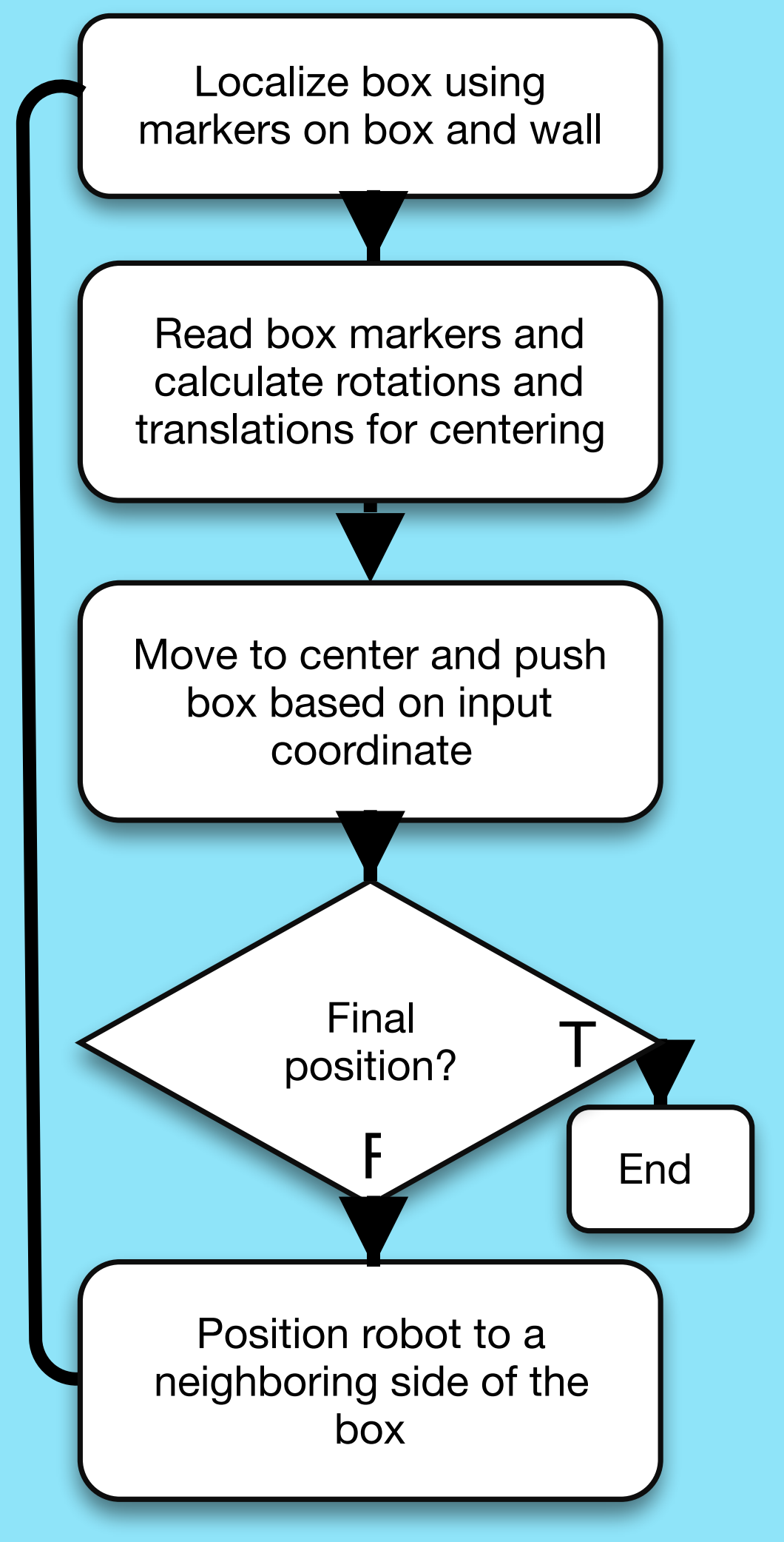


What is localization?

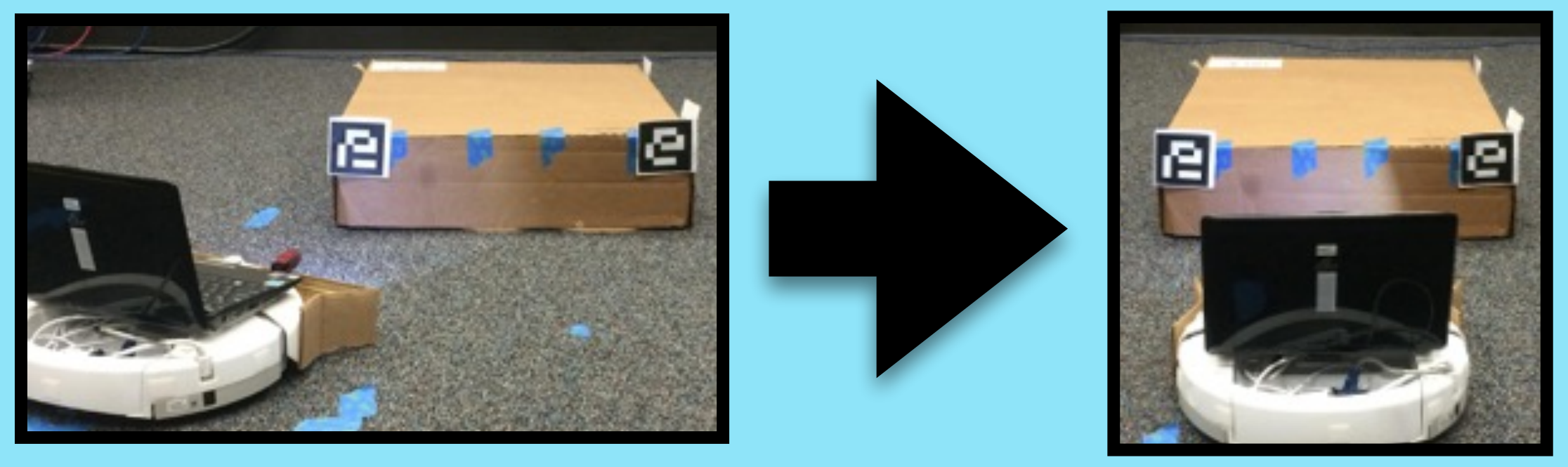
- Using the surrounding environment to determine an object's position
- The robot connects to Create's player server, netbook detects Aruco Markers, and sends a packet containing id, distance, and angle from the robot to the markers

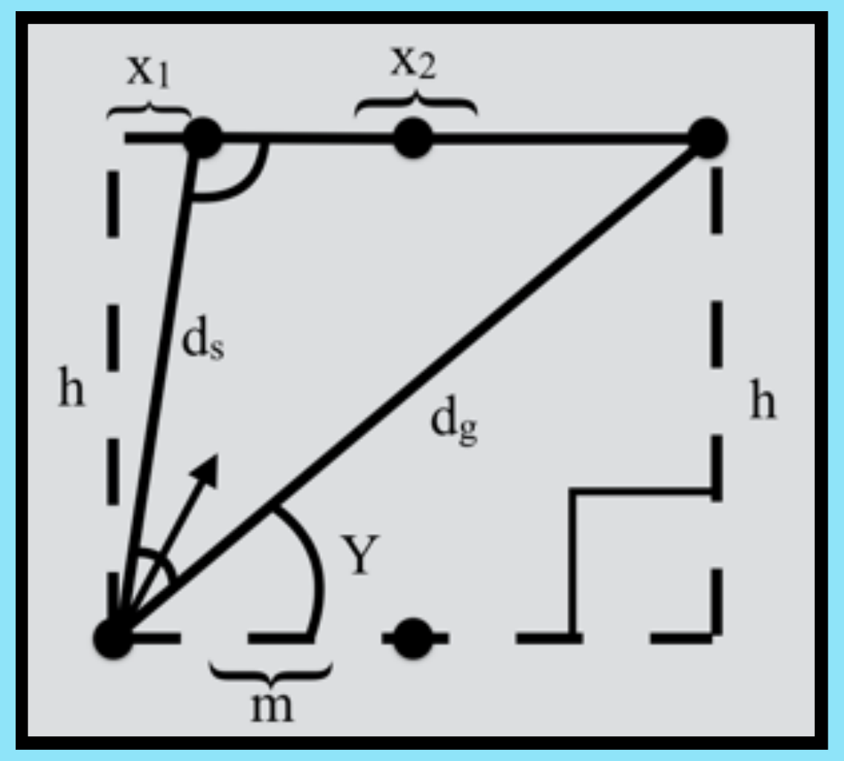
- Packet data is used for robot localization by using the distance from markers to get its location in the environment

Method


Localize box using markers on box and wall
Read box markers and calculate rotations and translations for centering
Move to center and push box based on input coordinate
Final position?
T
End
F
Position robot to a neighboring side of the box

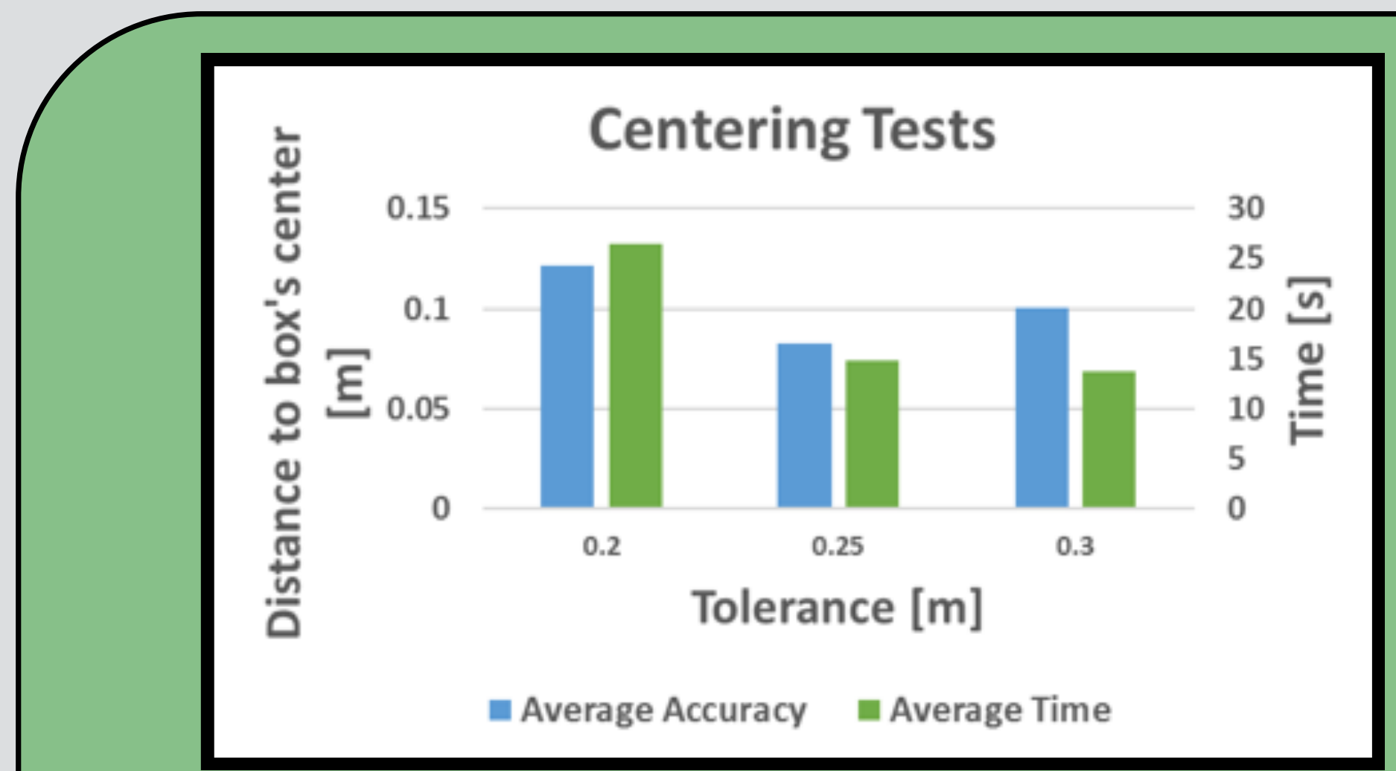
- Able to successfully acquire data from the markers e.g., position of marker, distance and angle to the robot
- Robot can successfully push a box forward a given distance with a margin of error under 5%
- Robot can accurately compute the distance between two markers and wall
- Robot uses trigonometric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



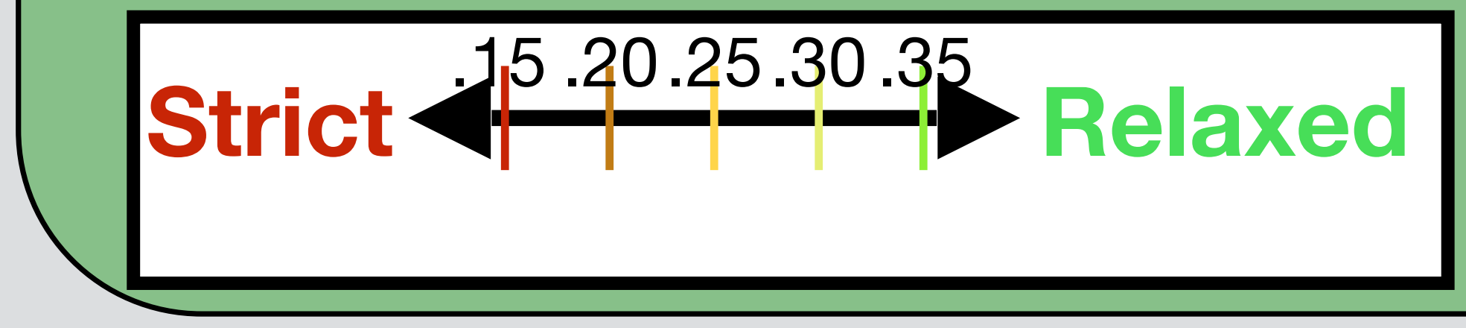


- We use the law of cosines and basic trigonometry to find h, Y, and m values
- This allows the robot to move to the center of the object precisely

Results



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

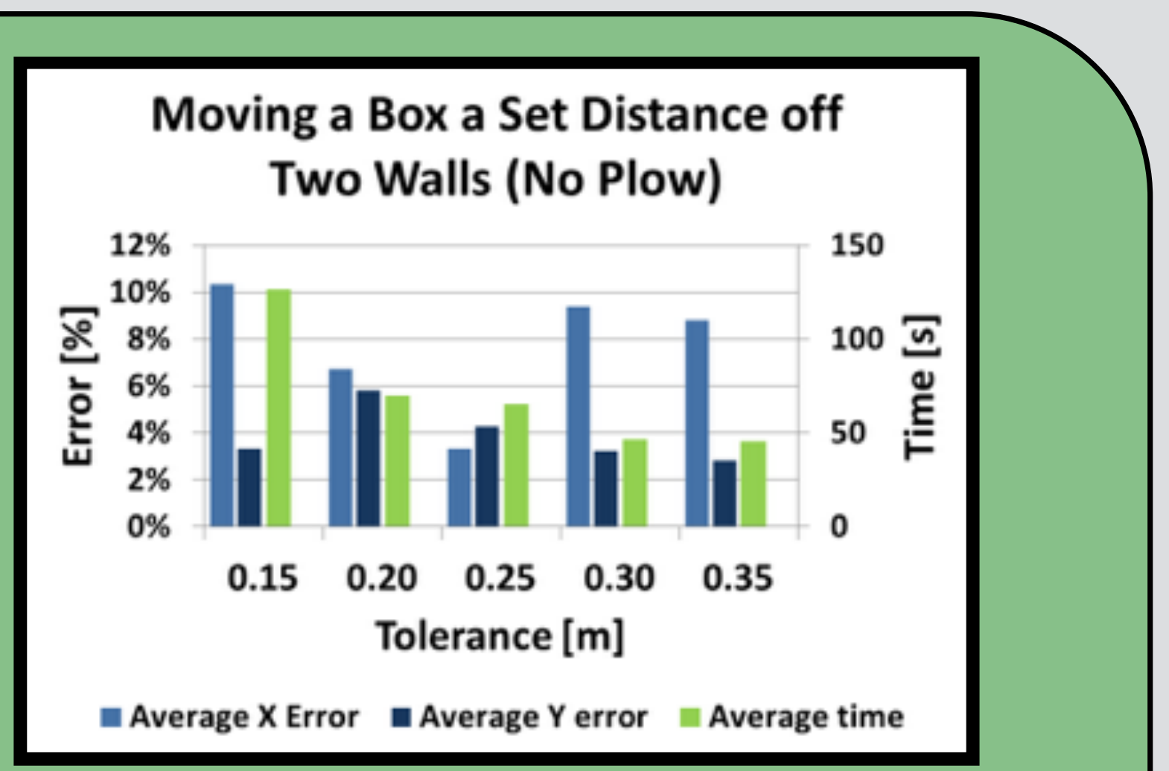


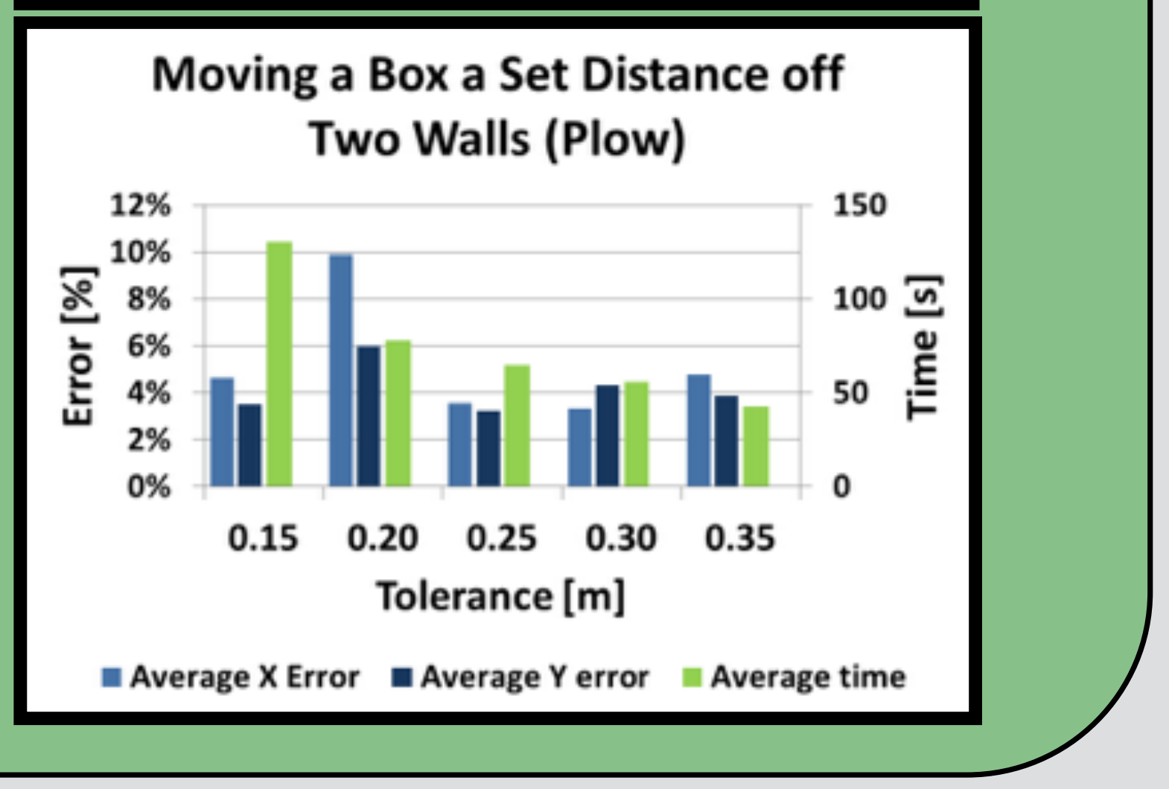
Centering:

- 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
- %Error & Time were reduced with plow





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.

Acknowledgements

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