

Introduction

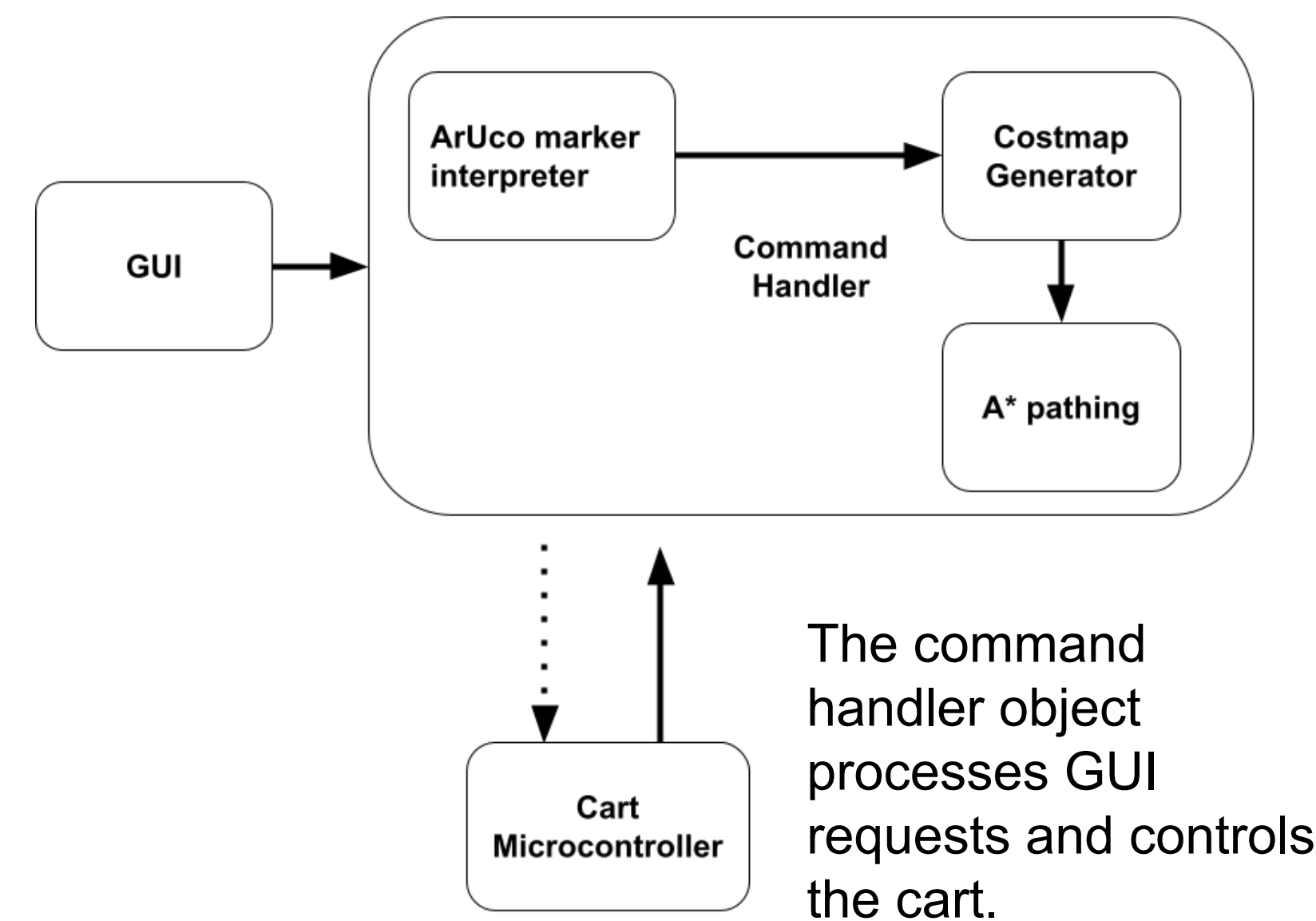
Team 40 was tasked with creating a cart for the navigation of 2D spaces utilizing control from an overhead camera and a base station.

They designed and tested:

- An autonomous vehicle
- A base station laptop
- A simulated warehouse environment
- A simulated overhead camera attached to the base station
- A graphical user interface (GUI) for requesting simple warehouse transport tasks



Block diagrams



Communication

After the string of coordinates for the path were generated, the base station laptop would transmit the number of units to move in each direction to the robot via the pyserial library. Many arduino libraries employed to utilize sensors like a gyrometer and serial communication back to the base station.

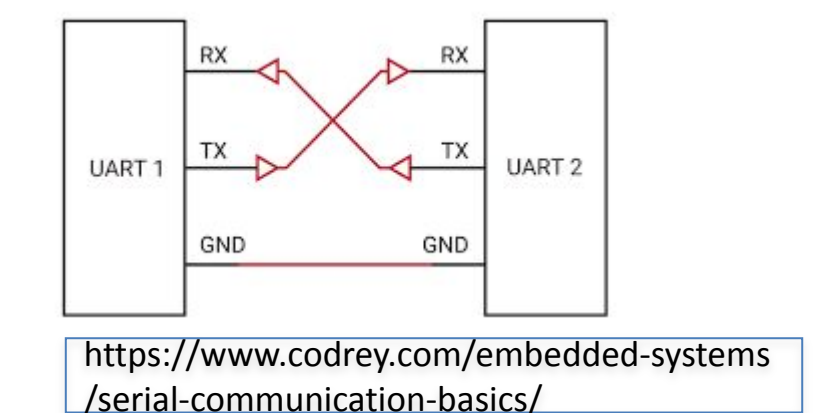
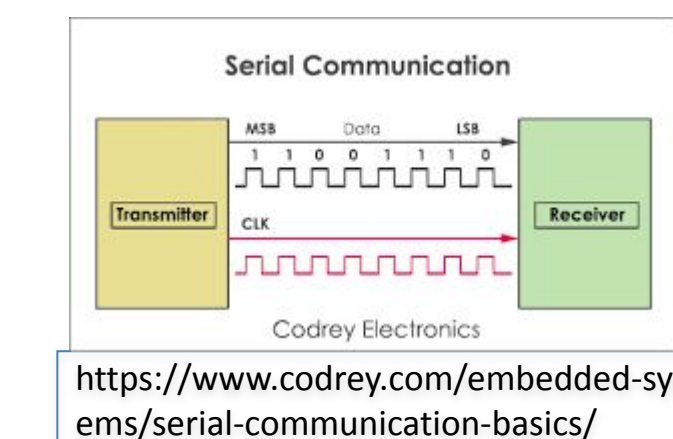
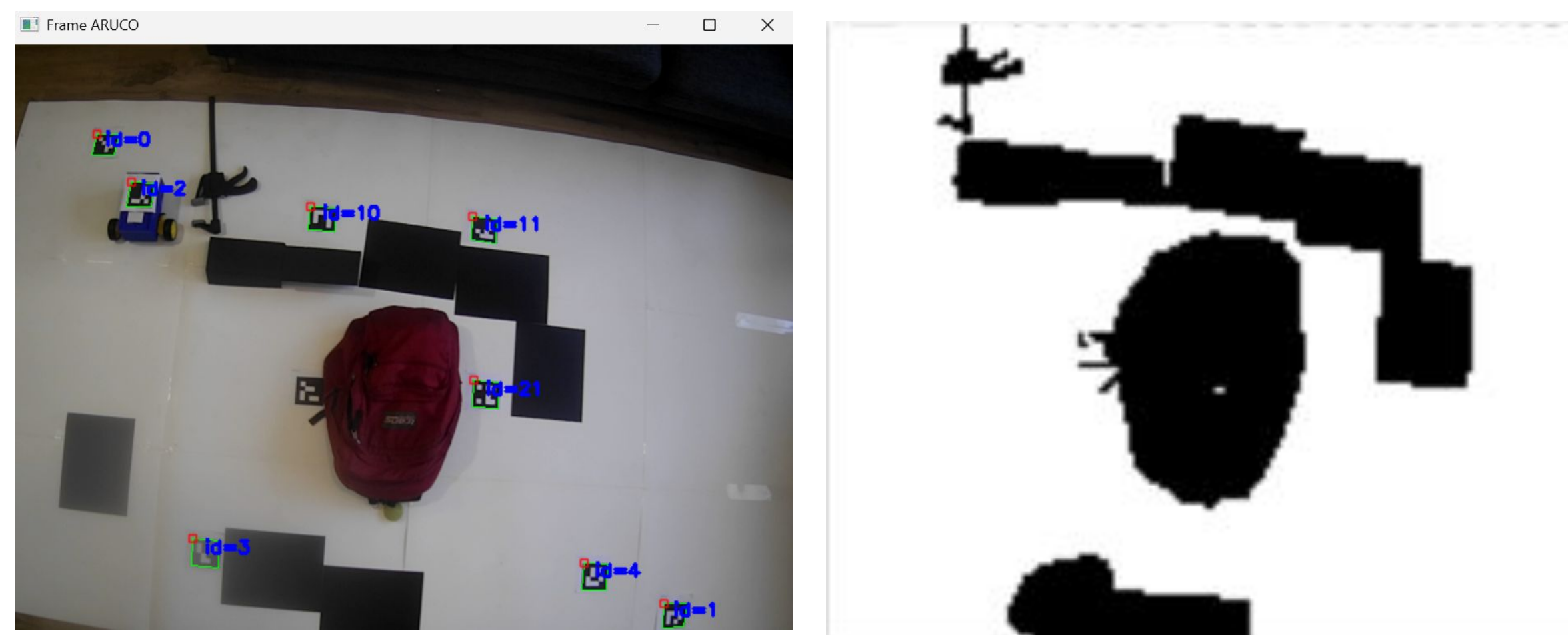


Image Processing

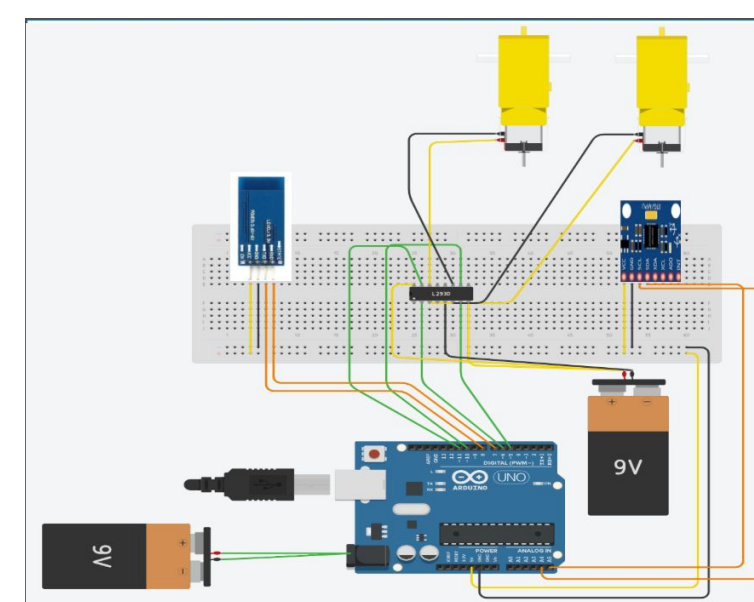
Points of interest (POIs) were captured using opencv image processing library. Locations of POIs were stored in ArUco markers and translated to lot and loading bay numbering schemes consistent with the GUI.

After the image capture and the processing of ArUco markers, image cropping from the kitty corner "origin" markers, further processing with opencv, combined with bit thresholds create a bit-based costmap.



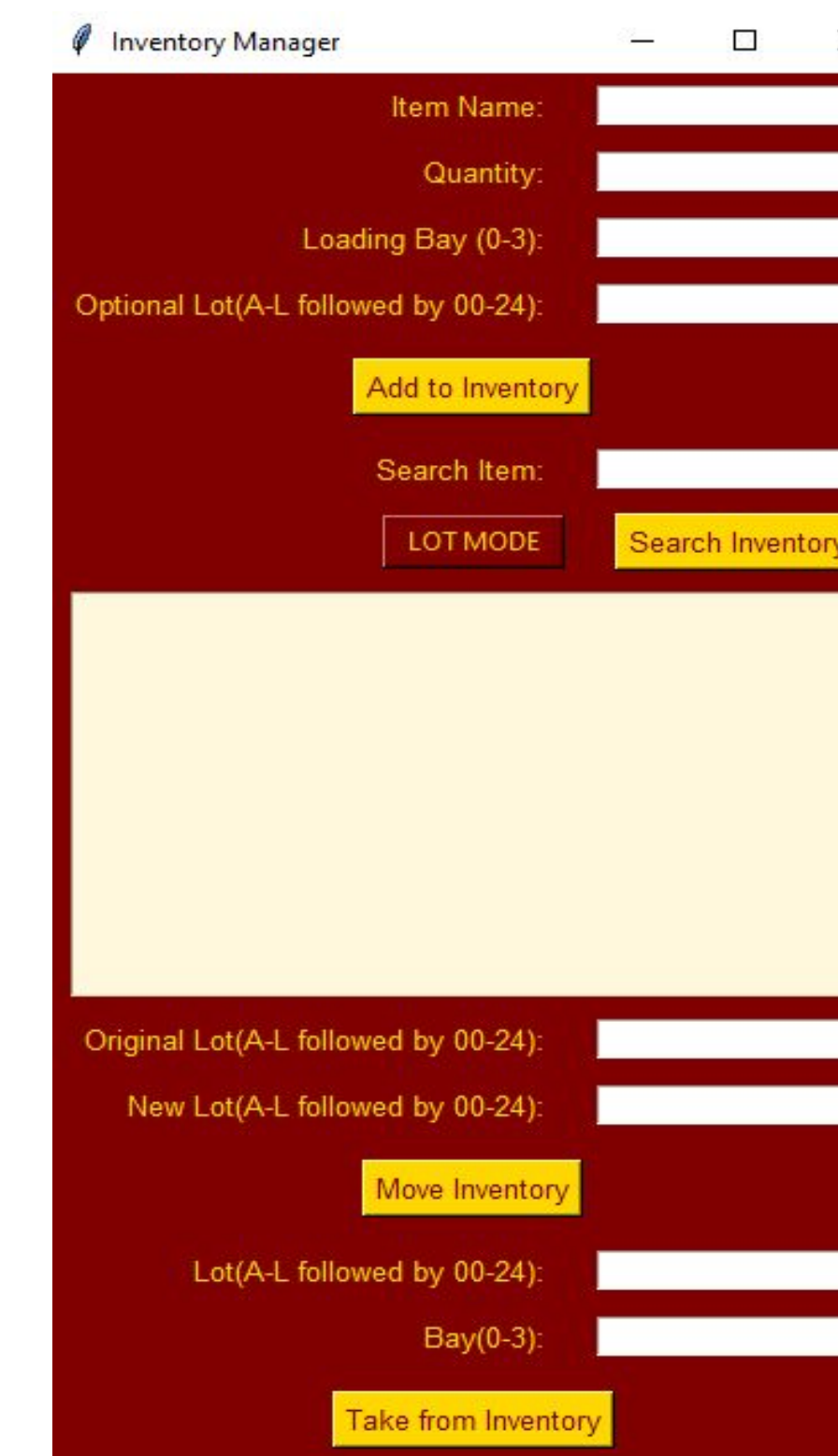
Interface

Simple test interface to simulate three different item movement operations



Wiring Diagram

Simple test interface to simulate three different item movement operations



Testing

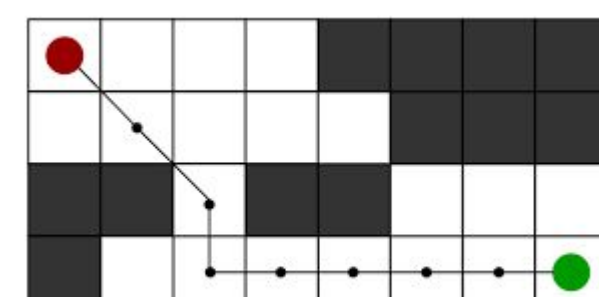
- Accelerometer movements smoothed out the cart's movements
- Front wheel drive (FWD) and rear wheel drive (RWD) yielded different movement patterns with FWD resulting in better cornering
- Different thresholds and masks for location markers and cart employed to adapt to different lighting conditions and prevent blocked destinations if cart moves over a location point.

Conclusion

- The team learned communication and work ethic skills for professionalism
- The team delivered a cart capable of communicating with a base station to execute maneuvers to traverse a warehouse environment
- The team demonstrated a use case of testing a bot using a simple warehouse management graphical user interface (GUI)
- Made the cart more adaptable to sensor packages or additional wheels/belts by adding exterior extrusions and additional drilled holes

Pathing

The team utilizes A*, a nodal pathing algorithm that uses a cost function generated from Dijkstra's Algorithm to evaluate the actual cost of traveling to a node along with a greedy best-first heuristic guess to estimate the cost to the goal to evaluate the shortest, lowest cost path.



<https://www.geeksforgeeks.org/dsa/a-search-algorithm/>

Cart Navigation of Obstacle Course

Electrical Engineering Capstone Design Project Spring 2026
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