RUTGERS
WINLAB | Wireless Information Network Laboratory

Multi-Robot Extension to ORBIT Lab

Joshua Olazo, Krishna Gotur, Einar Magnusson

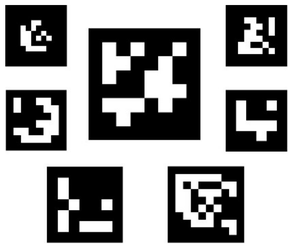
Introduction

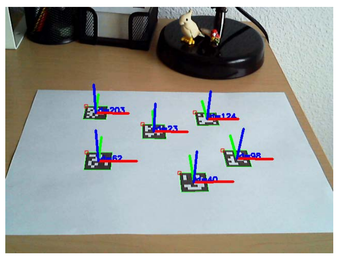
The purpose of this project was to develop a dynamic extension to the ORBIT lab. Such robots could be used to simulate mobile devices and how they influence other stationary and mobile transceivers. Ideally, these robots would serve as additional mobile nodes for the ORBIT lab.

Objectives:

- Construct system for robot indoor localization using Aruco markers (figure out where the robot is on the grid)
- Control robot via Robot Operating System (ROS), driving it in predetermined patterns throughout grid
- Attach onboard computing nodes and interface with ORBIT

Background



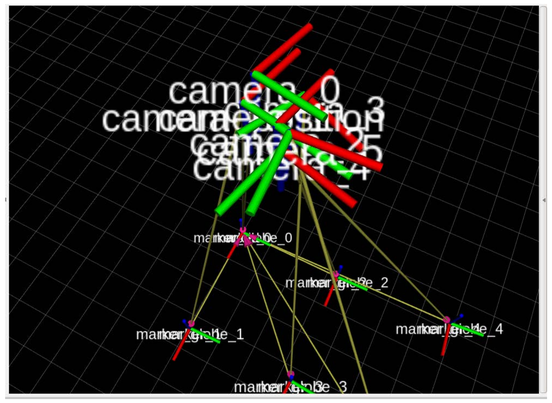


Each Aruco tag is composed of black and white squares that gives each tag a unique ID and a specific orientation. By analyzing the pixel length of each grid square and then referencing a known library of tag ID's and dimensions, a program can calculate the camera's distance and orientation relative to a specific tag [1,2].

Our mobile testbed was the iRobot Create 2. The webcam, Raspberry Pi, and 12V battery are all mounted on top of the robot.

Methodology

Aruco Tag Interpretation



A coordinate axis is superimposed onto each detected marker, and the camera's position is estimated relative to each marker.

ROS Pipeline

Camera input
- USB webcam connected to onboard Raspberry Pi published raw images to a ROS topic for processing

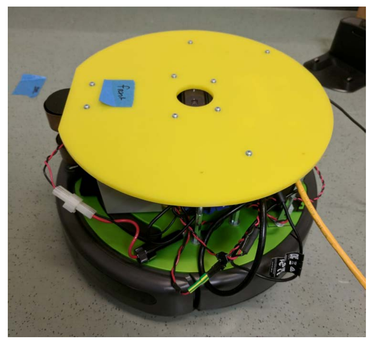
Filtration
- All published images are then passed through image filters to improve Aruco tag detection and extraction

Pose Estimation
- Aruco tags are parsed, tag ID is determined, looked up in ID library, and relative camera position is estimated

Drive Robot
- New pose information is used to update controllers, and new commands are passed to robot drivers

Results

- Robot can be directed to dock and undock from charging port
- Setup Aruco tags in ORBIT control room and created corresponding map file
- Angular estimation is accurate to ~0.01 radians, linear estimation is accurate to ~10 cm
- Achieved precise angular control, further work is needed for linear control



Future Directions

The immediate goal of the project is to improve the robot localization accuracy and expand the controller functionality. This could involve recalibrating cameras, revising image filtration, etc. To enhance controls, future plans could include developing a GUI to draw out paths for the robot to follow.

Long term goals include migrating the setup to the full ORBIT lab and adding/upgrading robots. Following additional testing, the computers onboard the robots would be interfaced with the ORBIT lab for remote users to port into and control.

References and Acknowledgements

The team would like to thank Ivan Seskar and Ayman Saleh for their continual guidance and support throughout this project. We would also like to express our gratitude to WINLAB for providing us with this opportunity.

[1] https://docs.opencv.org/3.1.0/d5/dae/tutorial_aruco_detection.html
[2] http://wiki.ros.org/aruco_mapping
[3] http://wiki.ros.org/create_autonomy
[4] http://wiki.ros.org/image_pipeline/CameraInfo

WINLAB