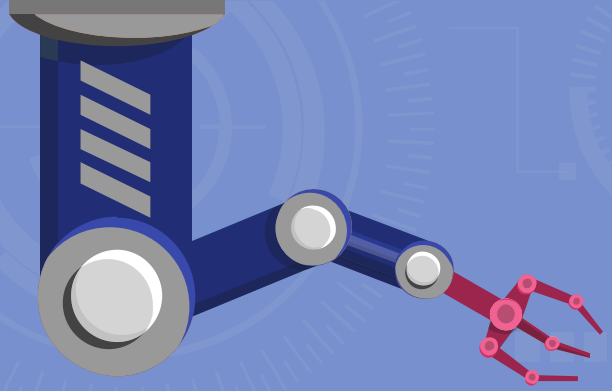


Intelligent Object Retrieval (UC-180)

CS-4850 Senior (Capstone) Project (WM-3)

Computing-Day Presentation

By Zhiwen Zheng (Section 04) and Ellie Ireland (Sections 03)

Introduction

- Developed a mobile manipulation system (TB3 mobile robot + OMx manipulator)
- ROS 2, Gazebo, and NVIDIA's Isaac Sim framework for M&S
- AI-based planning, navigation, perception, and control system in a semi-structured static environment.

TB3 [5]

Research Questions

1. How can we effectively **integrate** a mobile wheeled robot and a robotic manipulator?
2. What is the best way for autonomous **navigation**?
3. How can we incorporate object **recognition** capability to this mobile manipulator?
4. How can we best implement the **pose** estimation and **grasp** selection for autonomous object retrieval?

Materials and Methods

Hardware:

- Turtlebot3 [5] Waffle Pi
- Open ManipulatorX (OMX)

Software:

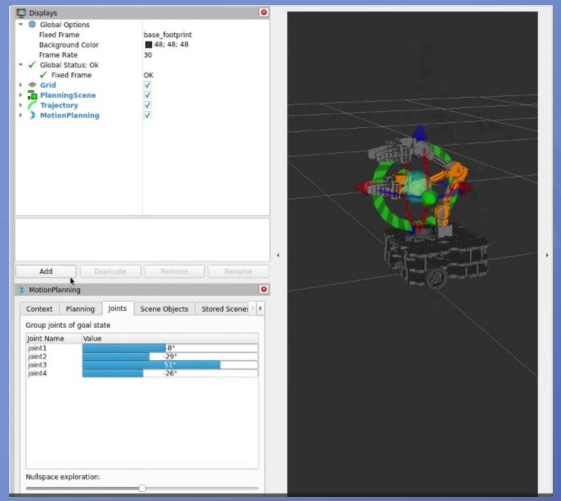
- ROS 2 Humble
- Gazebo Simulator
- NVIDIA Isaac Sim

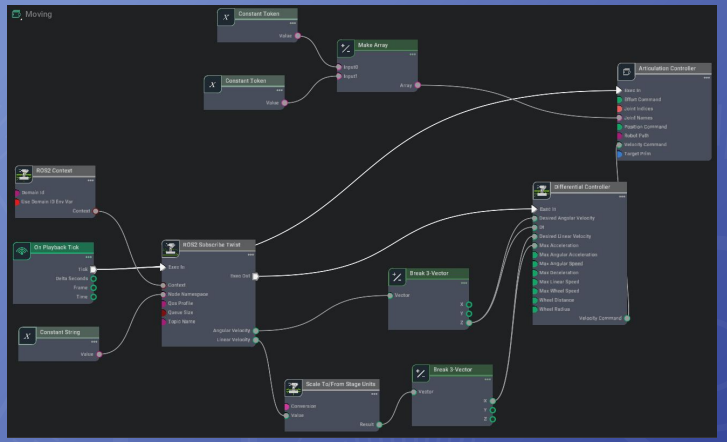
Methods:

- The Nav2 library is used for the autonomous navigation system,
- The YOLOv8 model is used for target identification and grasping,
- The MoveIt2 library will perform pose estimation and grasp selection

ROS, Gazebo, and Isaac Sim

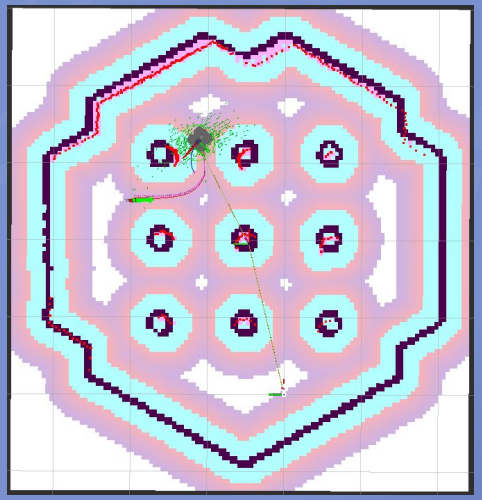
- Control of each individual joint was achieved using libraries provided by ROS 2.
- Path planning and joint trajectory was prototyped with user input.
- Programmed nodes were created with Python to have the robot execute a series of actions
- Isaac Sim accesses a computer's Nvidia GPU for better sensor tests and virtual environment.

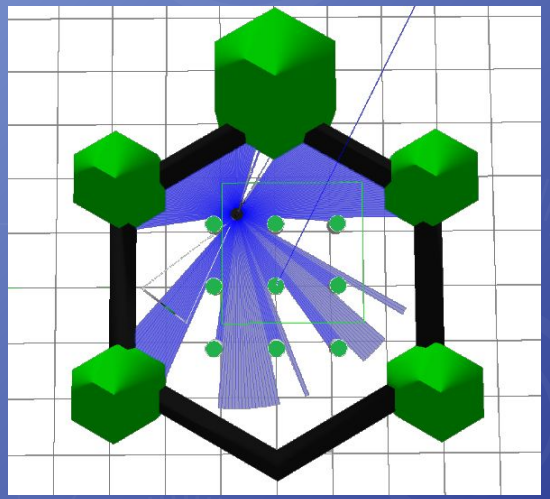




Navigation

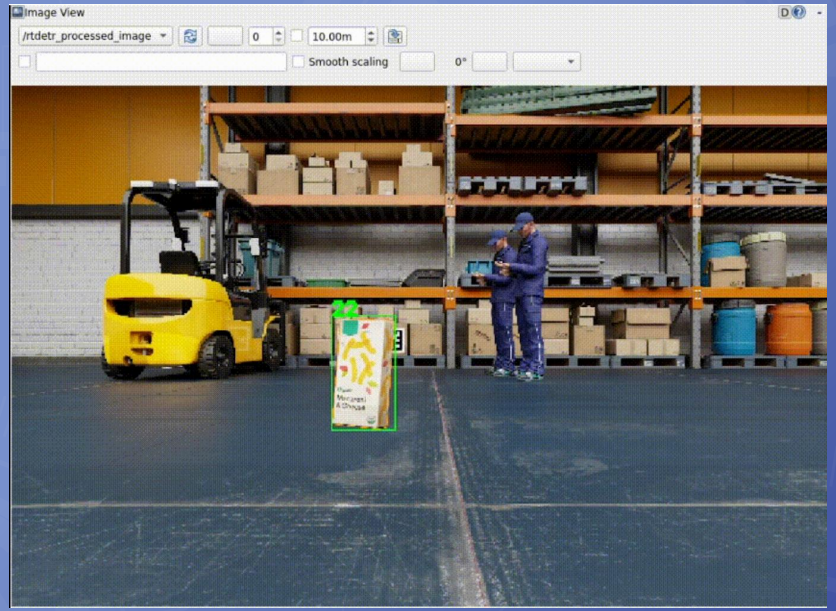
- The Nav2 algorithm is based on modular task servers that communicate with a behavioral based decision tree.
- Takes a user defined point and angle and plans a path to it from the start location.





Object Recognition

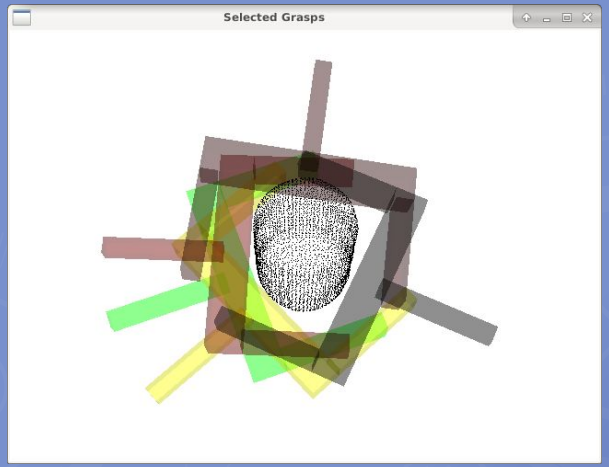
Implemented using the CNN YOLOv8 model.

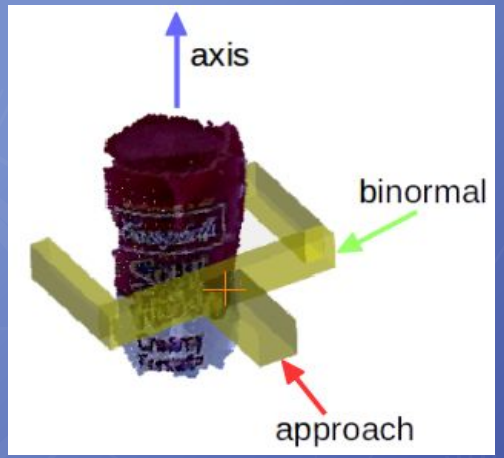


Pose Estimation and Grasp Selection

Implemented with the MoveIt2 library

- Produces potential positions and orientations that the end effector may assume in order to grasp the target item
- Selects optimal placement





Results and Conclusion

- Autonomous navigation functionality has a 100% accuracy with behavior tree based planning.
- The CNN model based object recognition has an accuracy of 86%.
- The mobile manipulator determines a correct grasp based on pose estimation 82% of the time.

- The mobile manipulator achieves autonomous navigation, object recognition, and pose estimation based grasp selection in a simulated environment.
- Our **future work** will include the object retrieval task in the non-structured and cluttered environments.

Contact Information and Acknowledgements

- Ellie Ireland: eirelan2@students.kennesaw.edu
- Zhiwen Zheng: zzheng@students.kennesaw.edu

- Project Website: https://sites.google.com/view/wm-3intelligentrobotarm?usp=sharing
- Project Github: https://github.com/WM-3-Inrelligent-Robot-Arm/wm3ira.github.io

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Thank you