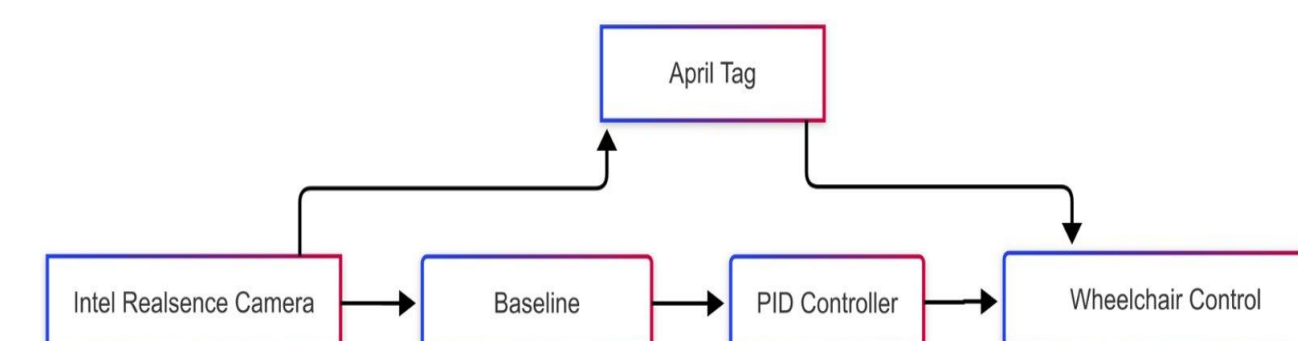




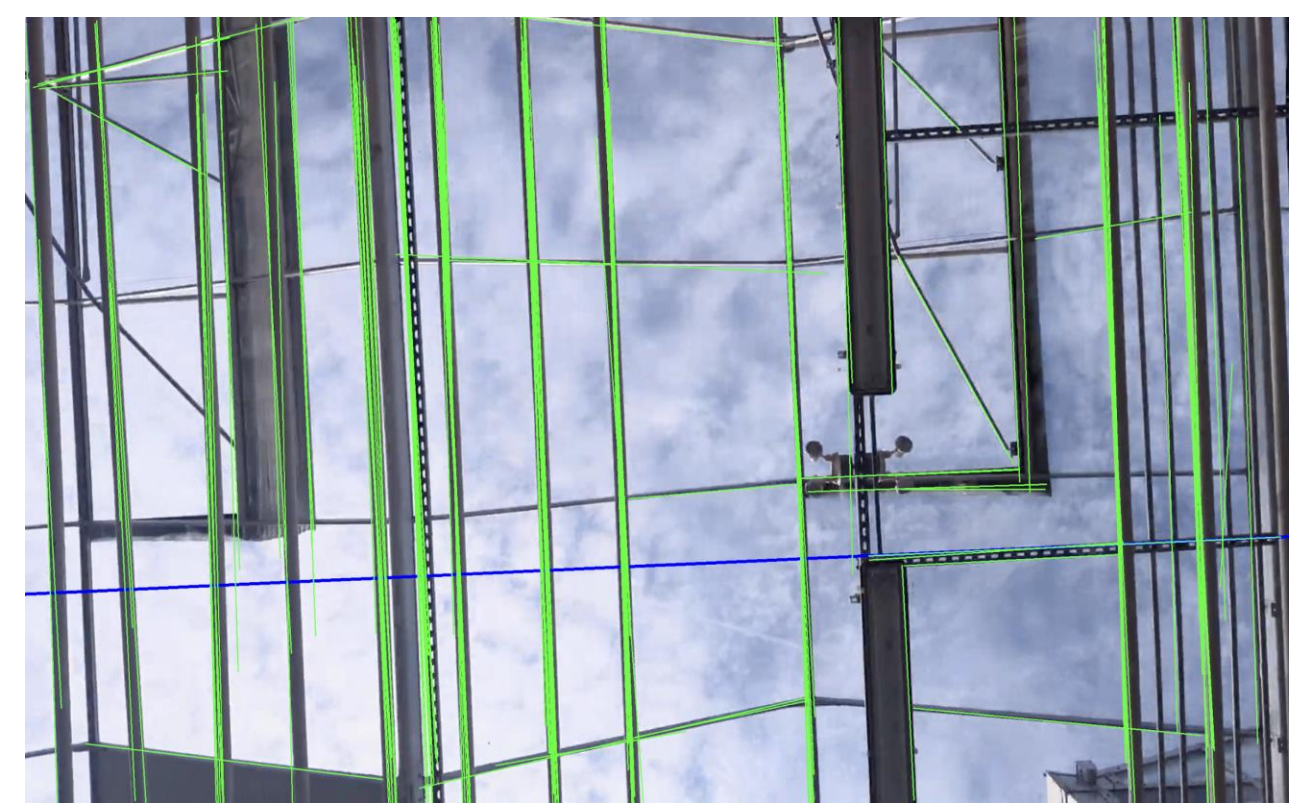
Skylane Team

- Ceiling Drift Detector system corrects drift of wheelchair.
- Calculates the 'best' line in real time via an ML model to identify all candidate lines and choosing the straightest line.
- AprilTags trigger the task manager to interrupt the PID and force manual controls depending on the tag id.



MLSD-based Best Line Detection

- Use MobileNetV2-based model as the backbone for real-time ceiling line segments detection.
- Customized algorithm considering the line segments traits for selecting the best line for lateral drift detection functions.
- Very robust model sticks to best lines for a long time to ensure PID functionality.



Hardware

- Intel NUC for ROS host system.
- The NUC hosts the task manager. and ROS serial nodes, controlling the PID, AprilTag detection, and communication with the wheelchair driver.
- Nvidia Jetson Orin Nano hosts the ceiling drift detector node, which is responsible for MLSD Line Detection model inference and camera operation.
- Arduino Mega 5600 and PCB uses ROS serial communication to listen for signals from the task manager and PID controller. Interfaces with the wheelchair's multi-proportional mode to send voltage signals to control the direction and speed of the wheelchair.

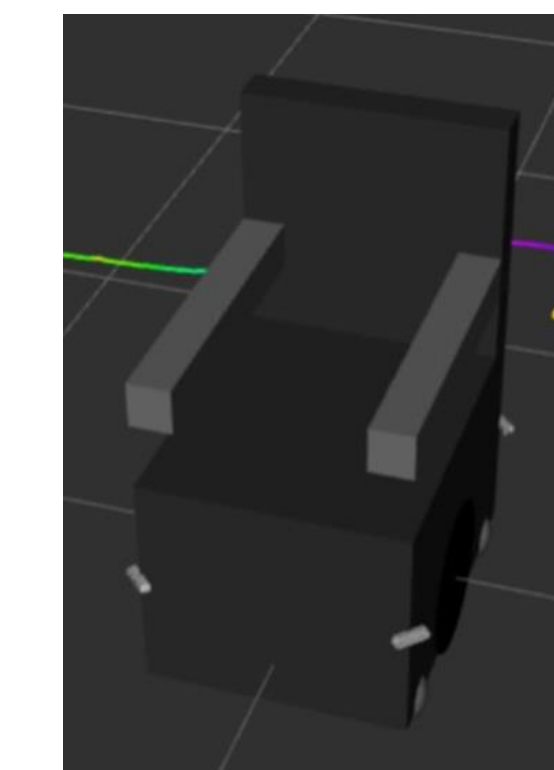
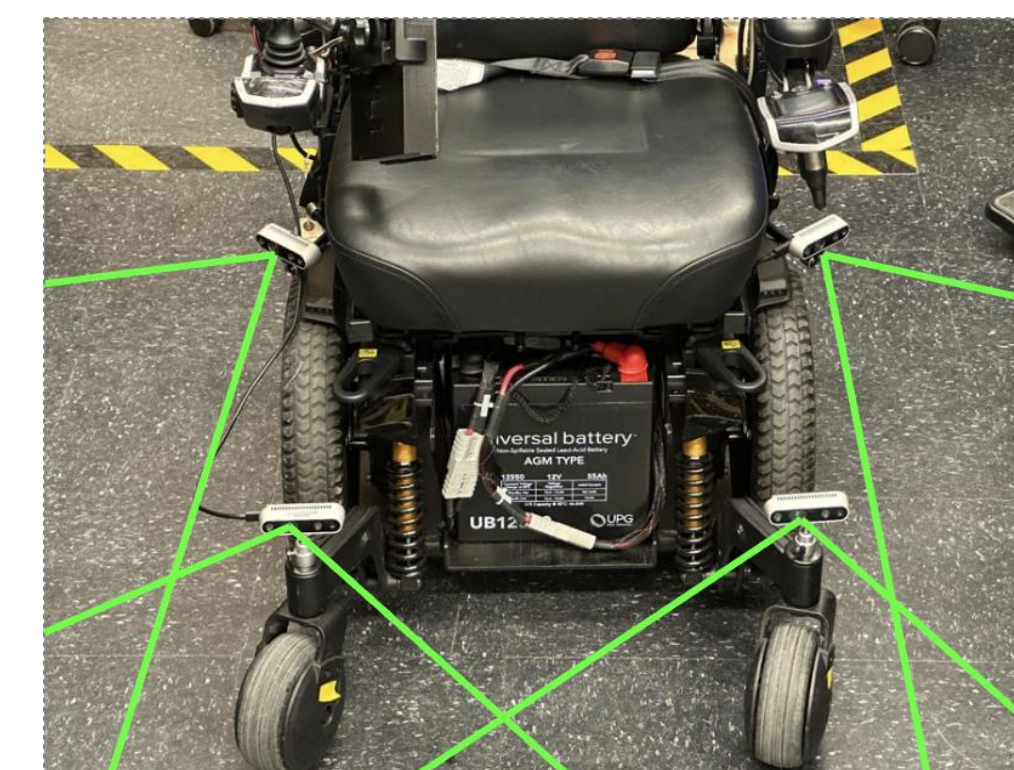


Task Manager

- ROS Noetic-based task manager using finite state machine that switches between following ceiling lines and preprogrammed turns triggered by AprilTags.
- When an AprilTag is detected the task manager interrupts and pauses the skylane system to rotate the wheelchair by 90° or 180° corresponding to the AprilTag id.

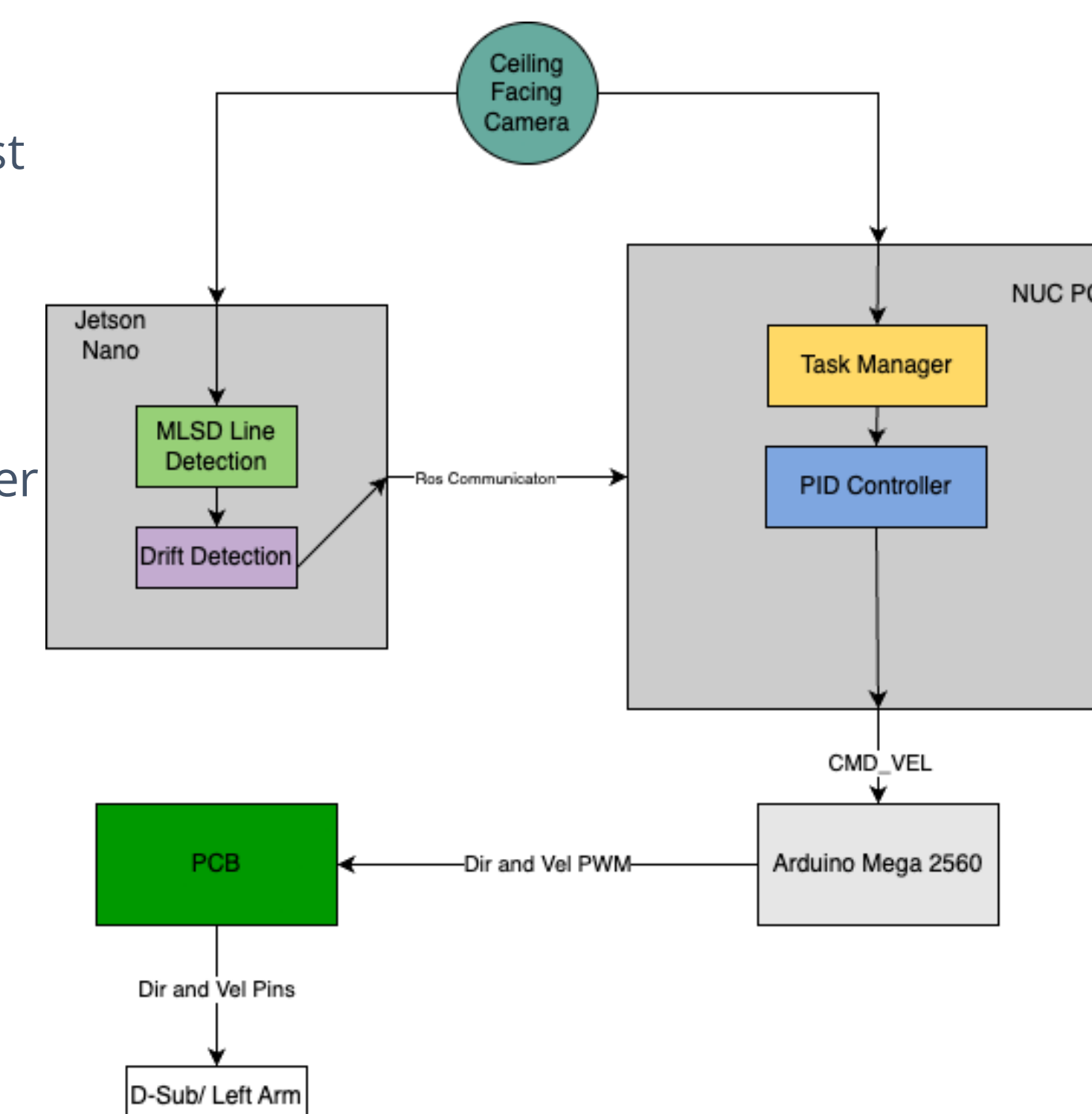
Wheelchair Integration

- Fully integrated wheelchair platform into ROS.
- LakiBeam 270° LiDAR mounted at 2m height for obstacle detection and odometry.
- 1 ceiling-facing camera for Skylane navigation.
- 4 side-mounted cameras, forward-angled, for future perception tasks.
- Designed a URDF model to define wheelchair structure and sensor placement.
- Added lightweight foam board enclosure to protect rear electronics.



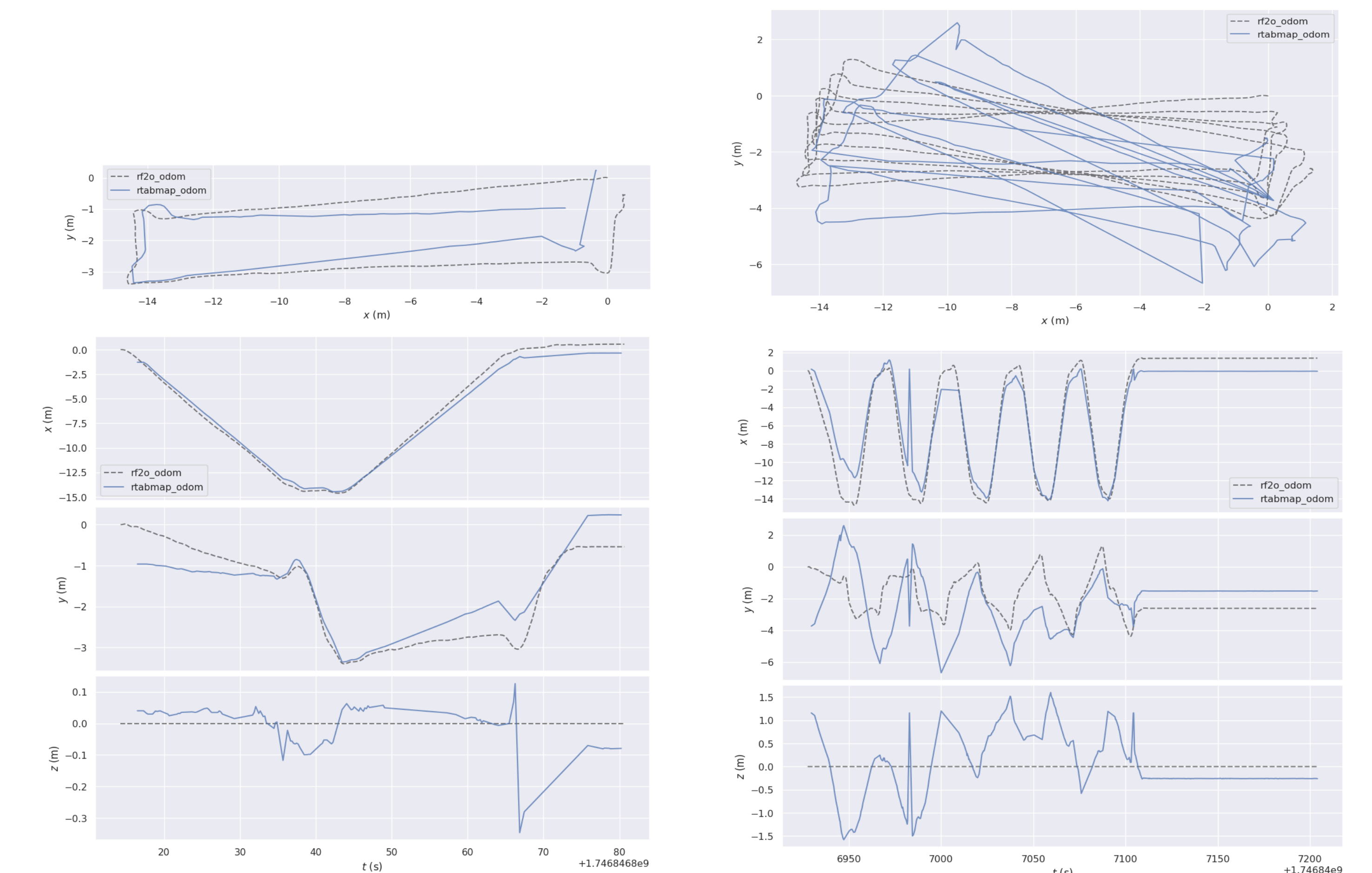
System Overview

- Full system includes the NUC PC for the ROS master, PID, task manager and all lidar packages .
- Jetson Nano edge device computes best lines and detects drift.
- System capable of travelling down corridors with best lines and turning to complete loops based on AprilTags.
- ROS communication protocol to transfer data on bestline and drift.



Lidar Odometry

- Evaluating LiDAR odometry methods: RF2O and RTAB-Map.
- Compared to vision odometry rtabmap single camera
- Tests involve driving the wheelchair along predefined paths (20–500m) in a long indoor hallway.
- Evo_Traj used for trajectory comparison.
- Both short-range (20–50m) and mid-range (200–500m) tests conducted to assess performance in constrained hallway environments.
- Goal is to identify which odometry method provides more reliable localization for indoor navigation.
- Preliminary results show RF2O performs well in short loops but accumulates drift in longer paths.



Trajectory Comparison – Short-Range (~35m loop)

- This plot shows the estimated trajectories of RF2O and RTAB-Map over a short square loop.

Trajectory Comparison – Midrange (~170m loop)

- The plot shows the estimated trajectories of RF2O and RTAB-Map odometry over a midrange square loop

Future Work, References, Acknowledgements

- Model Improvements, Taught Line Following between LIDAR and Skylane, robust task manager, LiDAR Mapping and Navigation, Obstacle Detection

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Graduate Students: Timber Gu, Andy Su, Moore Lin, Kyle Li, Jerrick An
Undergraduate Students: Luke Shields, Travis Hand

Sources/Resources:
Simple PID: <https://github.com/m-lundberg/simple-pid>
ROS: <https://wiki.ros.org/>