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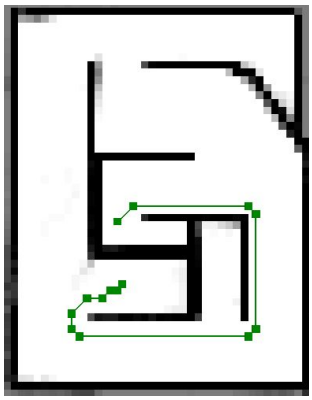
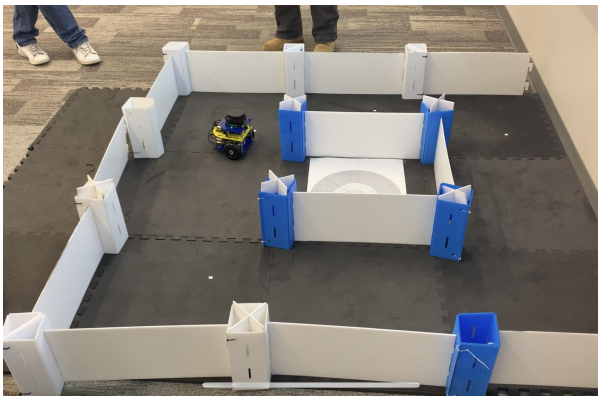
Maze Escape Robot - ROB 330 | ROBOTICS



Guidance with A* path generation



Robot exploring and mapping maze

What?

- Wrote probabilistic SLAM and navigation algorithms for an autonomous mobile robot to map and escape a maze
- Implemented an on-robot AI image classification model.

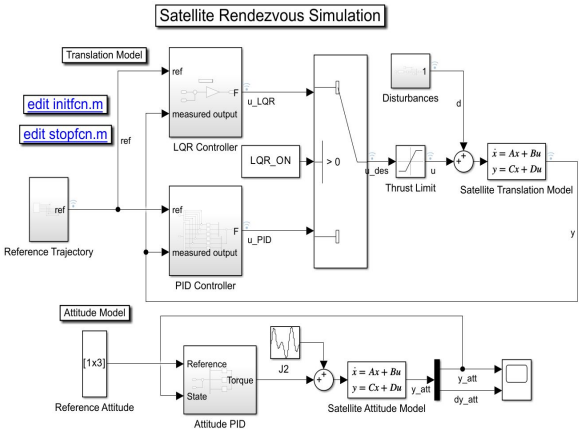
How?

- Two layered PID controls for wheel speed and robot speed.
- Monte Carlo and occupancy grid SLAM using LIDAR data.
- Navigate to frontiers with A* through obstacle distance grid.

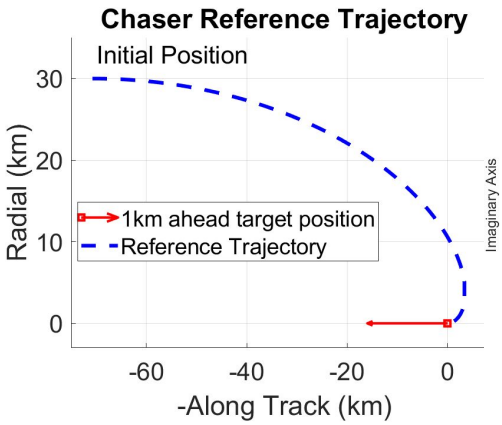
Results

- Successful exploration and mapping of a 3x3 maze.
- 65.8% accuracy on 10000 test images using a CNN model
- Successful real-time SLAM and navigation implementation.

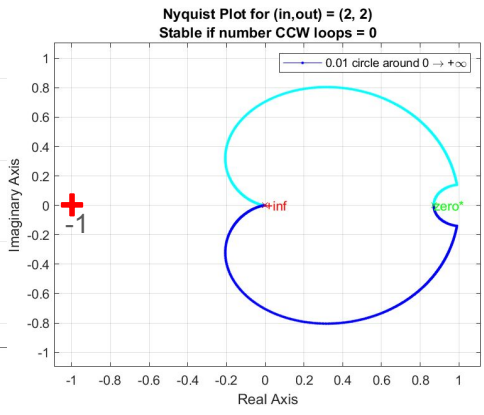
Satellite Rendezvous (RPOS) Simulation and Control System Design



Simulink Model Setup



Transfer Reference Trajectory



Stable Nyquist Plot

What?

- Design of a dual-approach control system for satellite rendezvous maneuvers in Low Earth Orbit (LEO).
- 6-DOF dynamics simulation in MATLAB and Simulink.
- Code on GitHub

How? *(My Contributions).*

- Designed 6-DOF satellite dynamics simulation, then implemented and tuned PID and LQR controllers.
- Integrated disturbances (drag, J2 effect) to analyze control robustness.
- First-order dynamics approximated with Clohessy-Wiltshire equations.

Results

- Smooth and stable tracking control with LQR controller.
- Achieved accurate tracking control with the PID controller, though with some oscillations.
- Bode and Nyquist analyses support simulation results.

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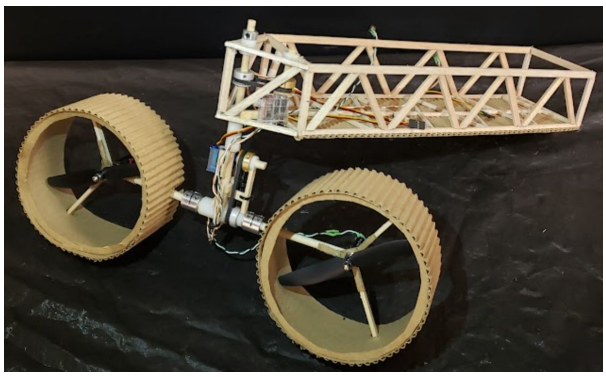
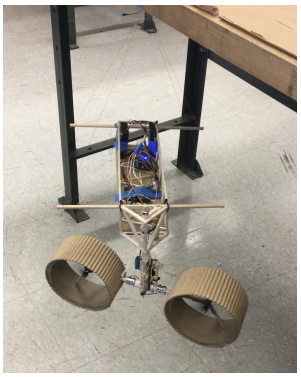
Blimp Thrust-Vectoring Propulsion Subsystem - ENGR 100



Assembled gondola and propulsion system



Maneuverability testing

Final blimp in competition

What?

- 2 DOF thrust vectoring propulsion system for a remotely operated blimp.
- Lightweight construction minimizing weight and maximizing maneuverability.

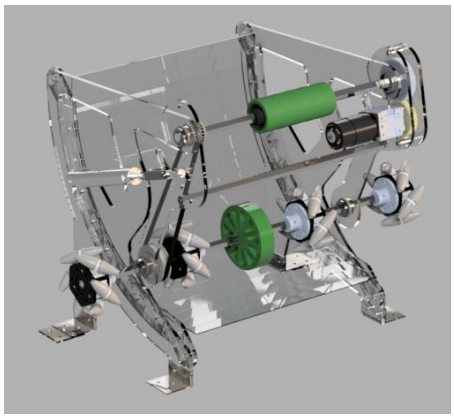
How?

- Dual servo motor actuation with lightweight timing belts/pulleys for precise positioning.
- Maneuverability verified through hanging test stand.
- Nylon bushings with low friction coefficient for smooth rotation.

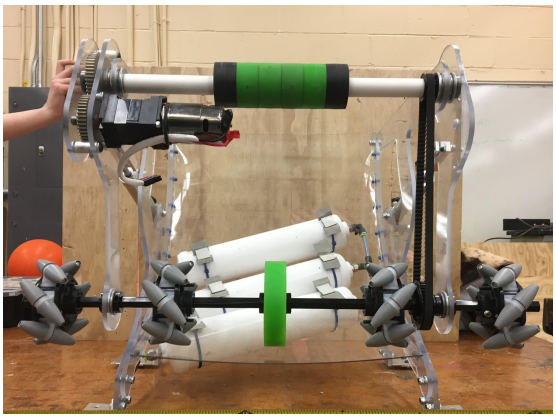
Results

- Won 1st place in all events in competition (speed and recon) against 11 other teams
- Superb maneuverability for quick and precise reconnaissance flight mission.

Robotic Kickball Intake - FIRST FRC Deep Space, Team 3322



CAD Rendering



Assembled intake mechanism

Fully Assembled Robot

What?

- Robotic mechanism to collect kickballs off the ground then feed them to an outtake
- Pneumatic actuation to extend outside the frame for collection and back inside to avoid damage

How?

- Prototyped with wood, dolly, spare parts, and power drills
- Designed in Autodesk Fusion 360 to be cut out on a CNC router
- Performed kinematic analysis to optimize ball collection

Results

- Reliable ball intake throughout the competition season and off-season
- Durable and lightweight polycarbonate design lasted the whole competition season