WS 2024-2025, SMT-ROB, DISAL-SP194 Project Summary

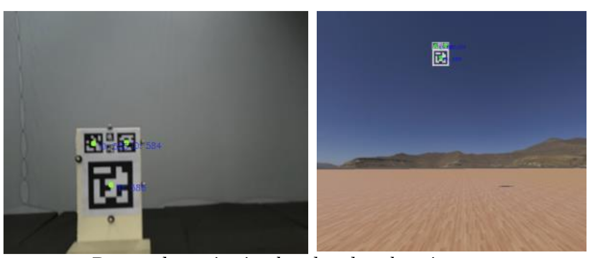
Odometry Frames Alignment with Fiducial Markers

Nina Lahellec

Professor : Alcherio Martinoli
Assistant(s) : Lucas Wälti

Accurate drone localization is critical for robotic applications, particularly in civil infrastructure inspection, where GNSS positioning alone can sometimes lack precision. This project investigates an AprilTag-based localization approach, leveraging fiducial markers to establish a static frame of reference for improved pose estimation.
A key limitation of the existing ROS AprilTag detection package is the absence of an on-demand toggle service, leading to unnecessary computational overhead when the detection is not required. To address this, a self-contained AprilTag detection ROS node was developed, featuring an adaptive toggle service that activates detection only when required, optimizing efficiency.

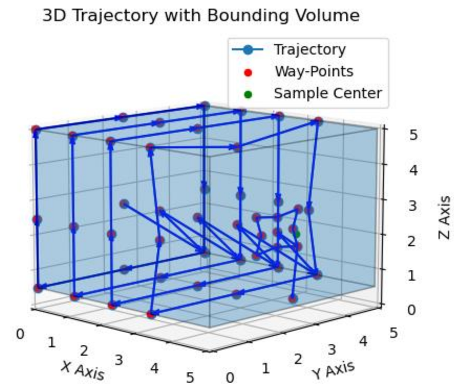
The detection node processes camera images by undistorting the feed, detecting AprilTags, and publishing their pose transformation in the drone's frame. It supports both pinhole (regular FoV) and fisheye (wide-angle FoV) camera models, integrating Brown-Conrady and Kannala-Brandt distortion corrections.



Detected tags in simulated and real environments.

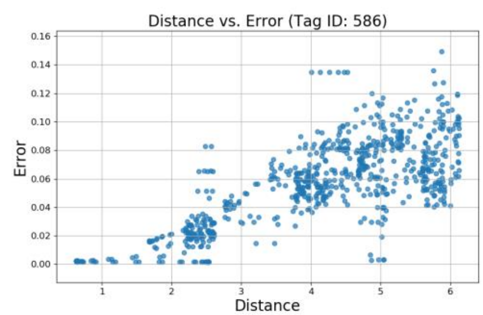
To systematically evaluate detection performance, a parametrized drone trajectory was designed, ensuring AprilTags were captured from extreme viewpoints and depths. The trajectory was defined based on drone navigable space, camera characteristics, and tag sample pose.

Experiments were conducted in both simulated (Webots) and real-world environments, using an AprilTag bundle, with regular and wide-angle cameras. Performance was measured using the L2 norm distance between the real and estimated tag poses, correlated with distance to the drone, time step, eccentricity (offset between the focal point and tag center), and drone velocity.



Parametrized trajectory for a wide angle FoV camera.

Simulation results showed small pose estimation errors, increasing proportionally with distance. However, real-world tests exhibited higher errors, likely due to imprecise intrinsic calibration, lower camera resolution, and manual drone operation instead of automated trajectories.



Detection error with respect to the distance to the camera, for a regular FoV camera in simulated environnment.

This project establishes a foundation for AprilTag-based odometry refinement, demonstrating its potential in marker-based localization while emphasizing the need for expanded real-world data collection. Future work could focus on quantifying detection error dependencies, enabling predictive error estimation for more robust and reliable localization.