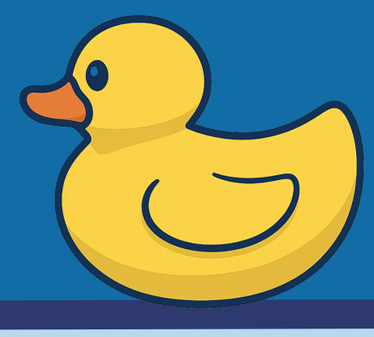
DRONE LOCALIZATION AND MAPPING USING ARTAGS

HACETTEPE UNIVERSITY
Computer Engineering



INTRODUCTION

- **Problem**: GPS is often unreliable indoors or in complex environments
- **Solution**: Develop a localization and mapping system using camera-based ARTag detection and SLAM (Simultaneous Localization and Mapping)

METHODOLOGY

Hardware

- **Raspberry Pi 3B+**
- **Raspberry Pi Camera**
- **Micro SD Card**
- **Flight Controller**

Software

- **OpenCV (cv2)**
- **ROS**

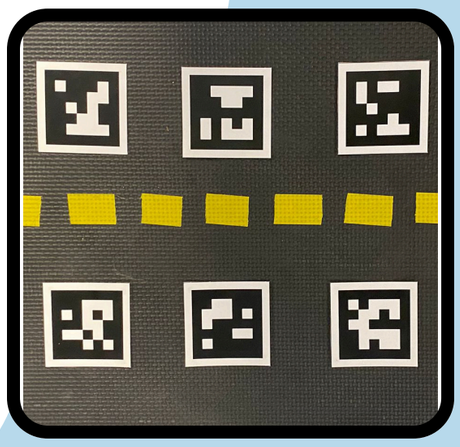
A camera-equipped Duckiedrone captures video. ARTags are detected using computer vision, and SLAM is used to build a map and track the drone's position.

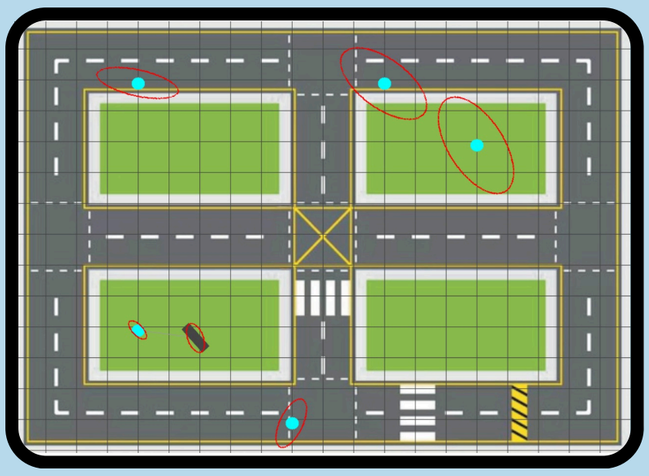
DuckieDrone21

ROS based drone system.

ArTags (Augmented Reality Tags)

Square fiducial markers used in computer vision to detect and estimate the position and orientation of objects.

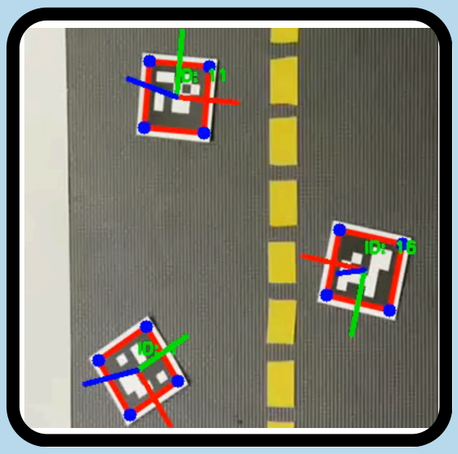


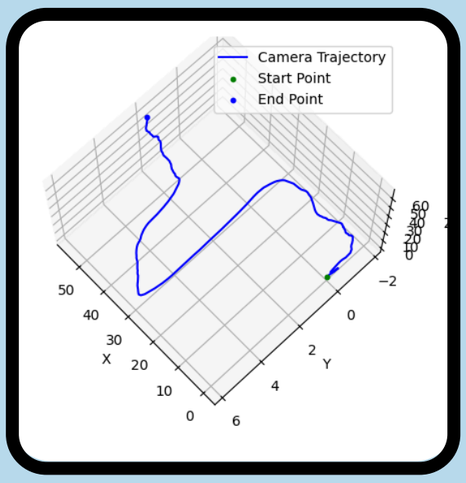


Mini Simulation in PyGame for testing EKF SLAM algorithm and parameters

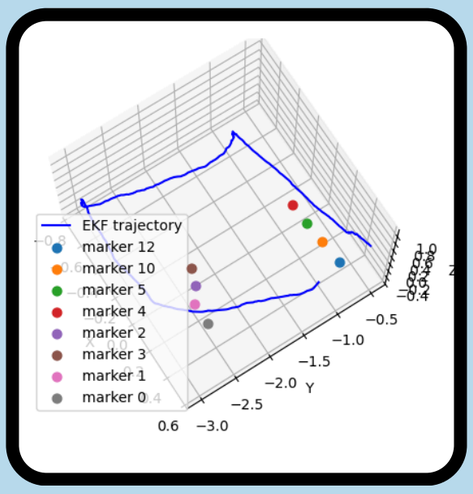
ARTag Detection and Pose Estimation

Pose estimation is done by calculating each marker's 3D rotation and translation vectors relative to the camera, based on the known marker size and the camera's intrinsic parameters.





Feature-Based Visual SLAM
Extracting and matching keypoints across video frames.



Extended Kalman Filter-Based SLAM with ArUco Markers
Feature-based motion estimates integrated with marker observations for corrections.

ANALYSIS

All processing was done offboard, the SLAM algorithm successfully generated a consistent map of the test environment. The system showed reliable performance in a controlled setting, demonstrating the potential of combining visual markers with SLAM for GPS-free navigation.

RESULTS

Our setup successfully detected ARTags and generated a map using offboard processing in a test environment, creating a map that closely resembles a real-world setup.

ACKNOWLEDGEMENT

The drones were provided by the project "Teaching SLAM with Autonomous Robots for Rescue Tasks" funded by Bridge to Turkey Fund, with sponsorship from NVIDIA.

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