Quadrotor landing on a moving platform
but not really... (yet)

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Project Overview and Goals

The goal of this work was to enable a quadrotor to autonomously land on a moving platform. In our approach we broke the problem down.

1. Develop a way to land on a stationary target
2. Expand these methods to work with a slow moving platform operating in a wind free environment
3. Further expand the methods to be able to account for wind

Hardware

The hardware used in this project was selected from an assortment of parts that we had laying around the WAVELAB.

- Quadrotor
  - Frame: DJI Flamewheel F450
  - Motors: Emax 912 KV motors
  - Flight Controller: Pixhawk running the PX4 flight stack
  - Computer: Odroid XU4 (Snapdragon 8 core processor)
- Additional Sensors
  - Camera: PointGrey Firefly 2.0 Camera (60 FPS at 640 x 480p)
  - Lens: 135 degree FOV

All in one flight controller that controls all them motors and maintains stability.

- Produced by 3DR robotics at a cost of 200 USD
- Runs the PX4 and APM flight stacks (both open source)
- Direct communication to the odroid via a package called mavros

Progress throughout the term

Needless to say out goal for a term project was... *ambitious*. Issues include:

- Difficulties getting the Odroid to talk to the Pixhawk
- Issues with finding and understanding the PX4 and mavros documentation
- Several parameters in QGroundcontrol that had to be set to make the quad work as expected

But enough with the whining...

Solving the Pose Estimation Problem

We used the MIT AprilTags Library for pose estimation:

- Uses a special type of 2D marker
- Processing entire images resulted in very slow pose estimates (3 - 5 Hz) on the Odroid. Down sampling increased frame rate but reduced the range to 1.5 meters.
- Varied down sampling size dynamically depending on the distance between the quad and the AprilTag
- AprilTag Inception (Tag within a tag to solve FOV problems)
- Black out image other than ROI

Proposed Method to solve the landing problem

Our proposed method breaks down the landing problem into three separate parts:

1. **Detect** April Tag and get initial pose
2. **Align** the font of the quad with the current location of the landing zone.
3. **Move** towards the landing zone by pitching towards the landing zone
4. **Descend** once the quad is located over the landing zone with PID controller

We call this the **DAMD** approach

The WAVELab has a motion capture system (MOCAP) that we used to test our code that we ran on the Odroid. Some of the results are shown in the following videos that show the quad moving tracing a square and then from last night, landing on the AprilTags

▸ Partial Success

and of course a few fails along the way

▸ Not quite there yet

And here are some of the not so great moments we have had

- Early attempts at getting the quad to just take off:
  - ▸ 2nd test flight
  - ▸ 4th test flight
  - ▸ 9th test flight
- MOCAP dropping out and causing the quad to crash:
- ▸ crash
- And here is how we tested to see if our commands made sense: ▸ checking Odroid command inputs

We have put a lot of hours into the project but greatly underestimated the time required to actually implement even the simple ideas that we came up for this project.
However we did get the quad to land (sort of). And so...

In summary..