Autonomous Quadrotor Landing on a Moving Platform

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Introduction

Our goal is to autonomously land a quadrotor onto a moving platform, the main significance of this work is to disgard GPS and perform autonomous precision landing using low cost sensors, such as sonar and vision.

In this interim-report we will discuss our progress, and any preliminary results we may have. So far we have spent a considerable amount of effort getting different components of the project working. In this report we will be discussing changes, progress in both hardware and software aspects of the project and remaining project schedule.

Changes in Direction or Project Scope

Due to time constraints, we will be forgoing our idea of using gimbal cameras for this project. We initially had hoped we would be using the gimbal camera to locate the landing target from afar and approach the target.

Since we are omitting gimbal cameras, we will be assuming that the quadrotor will be directly above the moving landing target as its intial conditions, and that is where our autonomous system will be to start its autonoums precision landing.

Project Progress

Hardware

Quadrotor Setup

For the hardware, we have chosen to reuse equipment that is readily available to us in the Wave Lab. For the quadrotor we have been using the DJI F450 quadrotor frame, Emax 2213-935KV motors with complimentary 1045R propellers, Thunder Power lipo 11.1V 4200mah battery, DJI E310 420S 20A electronic speed controller and Pixhawk v2.4 as our flight controller. At current our quadrotor flies reasonably well with some *minor* setbacks, mainly due to the instability of the firmware, and lack of good documentation for the firmware and software packages. Our problems thus far with the quadcopter are mostly software based.

Figure 1: DJI F450 with Pixhawk v1.5

Onboard Autonomous Control System

In terms of onboard autonoumos control, we have decided to use the Odriod XU4 due to its size and processing power available, and a Logitech C270 HD webcam as our vision sensor. One problem we may face very soon is the narrow field of view and relatively low frame rate (25Hz) the logitech webcam has. We will be keeping our options open, and plan on replacing the logitech webcam with a Ximia xiQ USB3 camera with a wide angle lens in the near future.

Software

Pixhawk Firmware

As mentioned in the hardware section, we have had numerous issues with regards to using the software suite for the Pixhawk Flight Controller, as well as the PX4 firmware itself. There are many instances where we could not explain the instability of the quadrotor during flight, many of which lead to costly crashes, but we believe through these experiences we have developed a procedure to lower the risk for such instances from happening often.

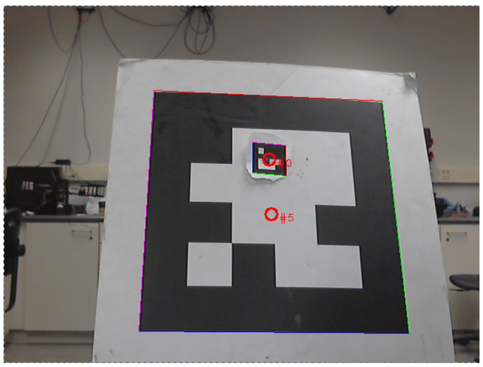
Odriod to Pixhawk Communication

For our autonomous system to control the quadrotor directly, the Odriod has to be able to communicate with the Pixhawk, this is where `mavros` (ROS package) comes into play. Mavlink is a popular UAV communication protocol between UAV and ground control softwares, `mavros` creates a mavlink ROS node to enable developers to monitor and issue mavlink commands with ease. We have successfully used mavros to arm and disarm Pixhawk (tested), in the near future we should be able to send velocity/attitude commands to control the quadrotor.

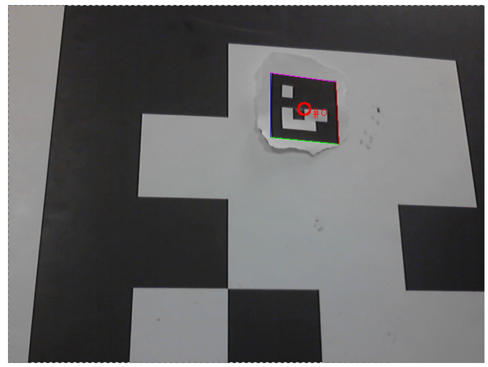
Simulator

Initially we have explored the possibility of using the combination of PX4's Software in the Loop Simulation (SITL) and Gazebo 6 as our simulation environment for our project, however we found the combination of install instructions changing at a fast pace, and the documentation not up to date to be a major concern for us. We have therefore decided to fallback on developing the estimation and control loop in Matlab.

AprilTag



(a) 2 Apriltags Detected



(b) 1 Apriltag Detected

Figure 2: Apriltag Inception - To mitigate the FOV problem

On the landing target from we have successfully calibrated the logitech webcam and used the Apriltag library to obtain a pose estimate, and have manually verified the estimates are accurate, for distance the error is ±1cm. We have also successfully implemented the ability to identify two different apriltags of different sizes (see Fig 2), pose estimates from both apriltags are equal.

Next is to workout how to transform the measurements from the pose estimates of the apriltags in relation to the quadrotor's body frame.

Schedule

- **6th March**: Implement and show in simulation that we can land a quadrotor successfully on to a moving platform
- **13th March**: Perform Autonomous Flying Outdoors and Implement Control code for the Huskey
- **21st March**: Perform Autonomous Flying Indoors
- **28th March**: Attempt to Autonomous Land the Quadrotor Indoors