Construction/Operation of Two Hexacopters for Autonomous Landing

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Overview

Two Tarot 680 Hexacopters enable real world testing of autonomous navigation techniques developed in simulation. This project tests an autonomous landing algorithm based on computer vision and fiducial markers.[1] A landing pad is marked with fiducial markers which are recognized by the drone's onboard camera. The gimbal automatically aims the camera at the landing pad to track it during descent. The landing software then directs the drone to descend towards the landing pad.

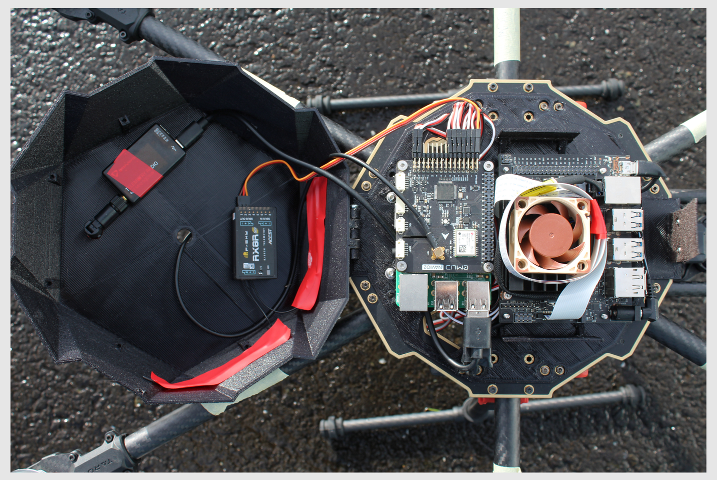
Components

Standard Drone Components

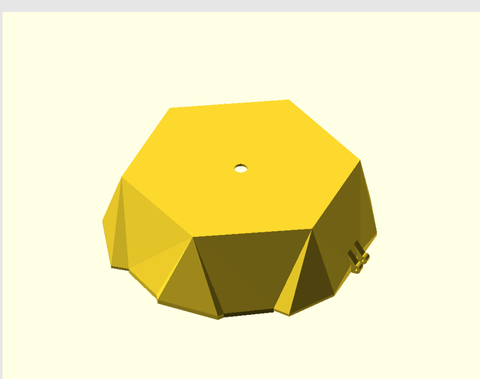
All drone electronics (e.g. motors, speed controllers, propellers, power electronics, RC Receiver, telemetry radio) are mounted on the Tarot 680 Pro hexacopter body.

Computational Components

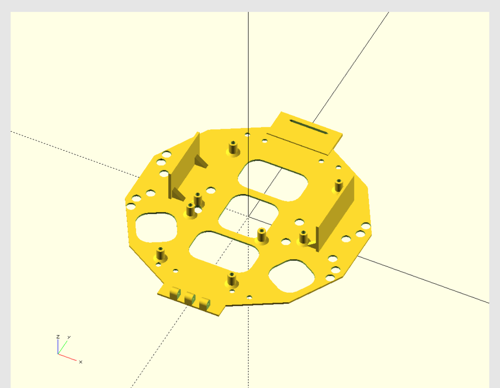
- **Raspberry Pi 3 B+:** runs the ArduPilot flight software and ROS.
- **Navio2 Hat:** provides IMU data and control signal interfaces.
- **Companion board:** handles image processing, fiducial marker systems and coordinate system transforms. One drone uses a Google Coral Dev board and the other uses an NVIDIA Jetson Nano.



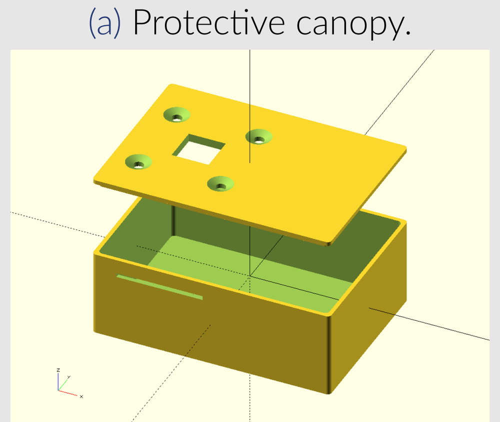
Custom 3D-Printed Components



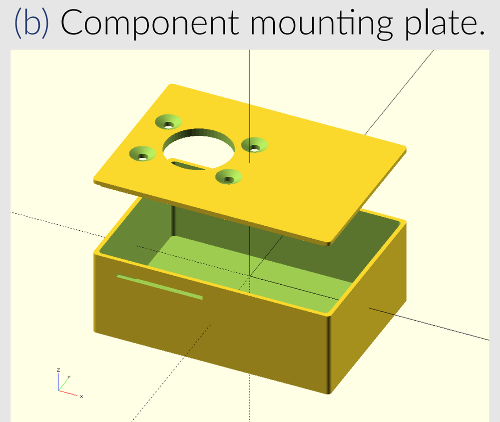
(a) Protective canopy.



(b) Component mounting plate.



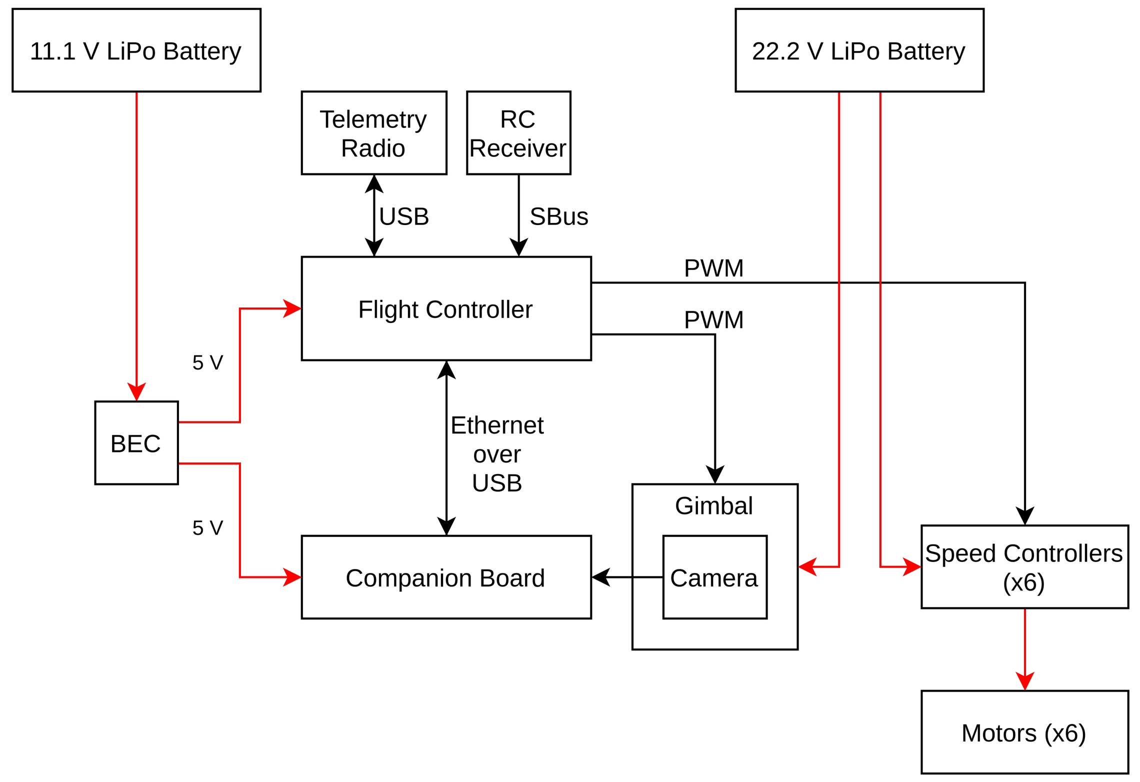
(c) Google Coral camera case.



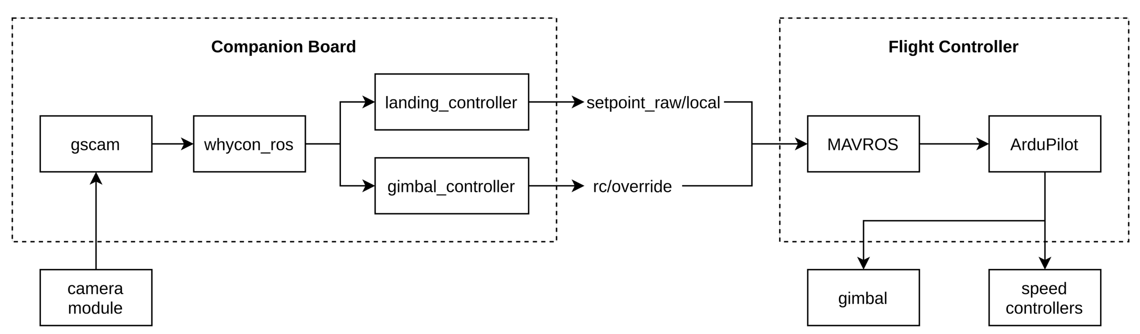
(d) Jetson Nano camera case.

Power and Data Flow

The drones have two isolated power systems - an 11.1V system (regulated to 5V by the BEC) for the electronics, and a 22.2V system for the motors and gimbal. This is because the electronics require a very stable power source to function reliably, and the motors can suddenly draw large currents, reducing the apparent voltage unpredictably.



Data flow for the autonomous landing task begins at the camera module, from which high-resolution video is fed into the companion board. A program `gscam` resizes the video to a lower resolution to reduce computational requirements, and pipes the resized video to the `whycon_ros` module for analysis. The `landing_controller` module performs coordinate system transforms to generate a target position for the drone based on the detected position of the landing pad. The `gimbal_controller` module sends control signals (through the flight controller via the `rc/override` ROS topic) to the gimbal in order to center the landing pad in the camera's field of view. When no landing pad is detected, the gimbal is controlled manually by the operator. The `MAVROS` module receives information from the landing and gimbal controllers, translates it into lower-level commands, and passes those commands to the ArduPilot software. ArduPilot sends control signals to the gimbal and speed controllers to make the drone approach and track the landing pad.



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Bar	2.17	1,392	β
Baz	3.14	83,742	δ
Qux	7.59	974	γ

Table: A table caption.

References

[1] Joshua Springer, ``Autonomous landing of a multicopter using computer vision,'' Master's thesis, Reykjavik University, Department of Computer Science, 2020.