 Robotics Final Proposal

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**Introduction:**

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Quadcopters are multirotor helicopters that are lifted and propelled by four rotors. Quadcopters are different from traditional fixed wings aircrafts and also helicopters. I believe that quadcopters are better for unmanned industrial uses. They are easy to maneuver in air and can also carry sensors and cargo. Quadcopters are also durable and versatile in that they can even fly properly with only two functioning propellers. They are used in many industries, from general aerial research to search and rescue. Building a good, durable quadcopter can have many purposes.

Despite of all the advantages and appealing features, one of the challenge of a quadcopter is to balance in air.

**Problem Statement:**

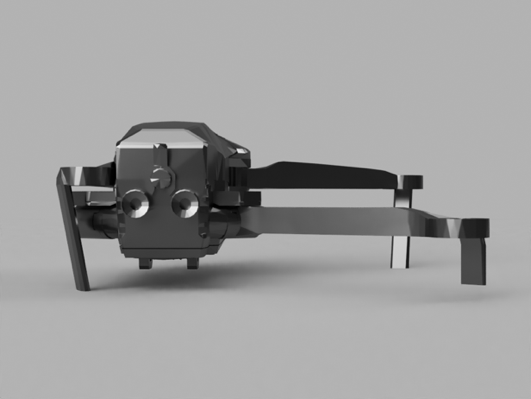
I will design and create a PID algorithm that allows the aircraft to balance in air and not be disturbed by small winds and turbulences. Controlling a quadcopter can also be finicky, therefore, I will create an iOS application as the controller of the quadcopter. The application should also provide information such as speed, altitude, and GPS locations. Last but not least, if times allows, the user will be able to plan out a route send it that information to the quadcopter via the controller software. Then, the quadcopter would fly autonomously following that path.

**Objectives:**

The goal of the project is to create a quadcopter that can balance in air. Minor wind and turbulence shouldn’t damage or impact the movement of the quadcopter. The quadcopter will also be remote controlled by an iPhone. Ideally, it will be able to avoid large obstacles. If time allows, I will create a program that allows the quadcopter to follow a given path and deliver some goods.

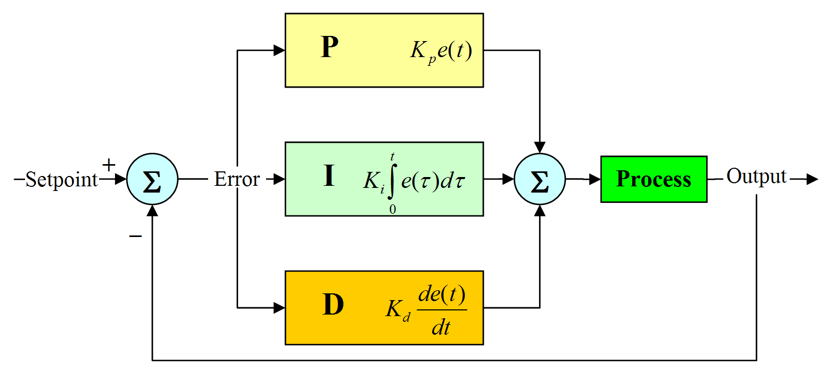
**Proposed Approach**

The frame of the quadcopter will be custom designed and 3d printed. The parts will also be printed with durable, biodegradable material. One extension for the project is to make a frame can fold in, just like the DJI drone Mavic Pro. I will not design the frame, instead, I will find open source stl files that I can use.

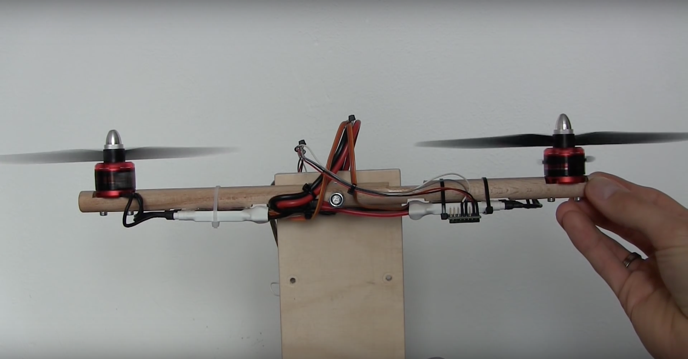


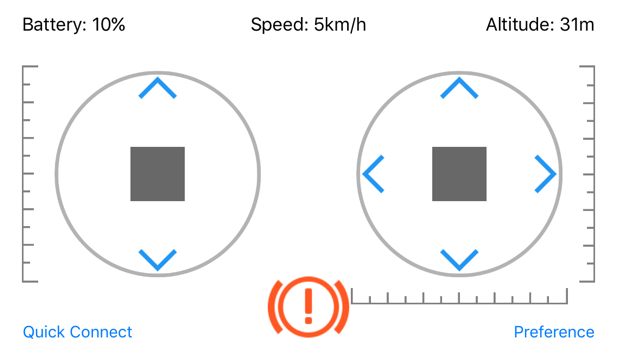
The quadcopter will be propelled by four 750kv brushless motors. These motors should provide enough thrust and are generally used in small quadcopter projects like this. To control the speed of these motors, I will use four electronic speed controller (ESC). The combination of those parts will make sure that the quadcopter can lift up, change speed, and also maneuver.

ESCs rely in pulses from 1000us to 2000us. After some research, the servo library and traditional PWM on the Arduino Uno is not ideal. Therefore, I create by own pulse and modify then with the software. With this technique, the processing time of the quadcopter will be much shorter.

I will implement a PID algorithm for balancing the quadcopter in air. According to Wikipedia: “A proportional–integral–derivative controller (PID controller) is a [control loop](https://en.wikipedia.org/wiki/Control_loop) [feedback mechanism](https://en.wikipedia.org/wiki/Feedback_mechanism) ([controller](https://en.wikipedia.org/wiki/Controller_(control_theory))) commonly used in [industrial control systems](https://en.wikipedia.org/wiki/Industrial_control_system). A PID controller continuously calculates an *error value* e(t) as the difference between a desired set point and a measured [process variable](https://en.wikipedia.org/wiki/Process_variable) and applies a correction based on [proportional](https://en.wikipedia.org/wiki/Proportional_control), [integral](https://en.wikipedia.org/wiki/Integral), and [derivative](https://en.wikipedia.org/wiki/Derivative) terms (sometimes denoted *P*, *I*, and *D* respectively) which give their name to the controller type.”

In order to safely test the hardware and software, platforms and harnesses need to be created. The safety mechanisms will be similar to the one shown in this video:



Arduino will function as the main processor of the plane. It will control all the motors and sensors. There are many types of Arduinos, my options are Arduino Uno, or Arduino Mega. Both platforms could support this project.

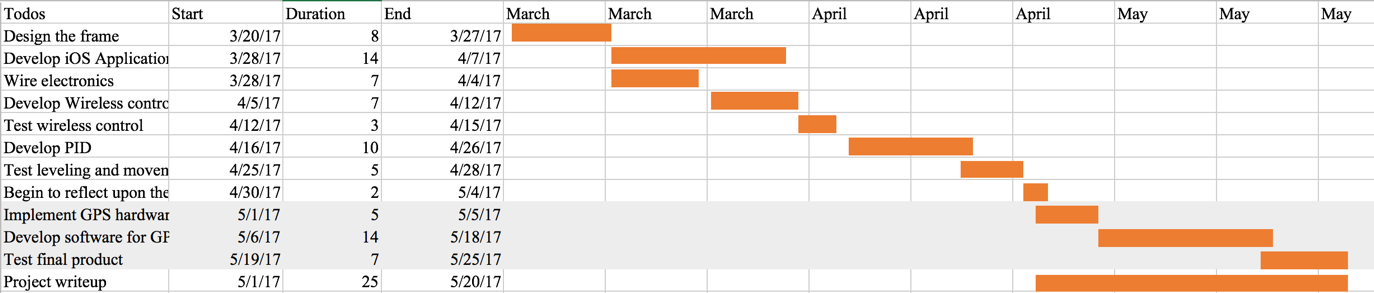
The quadcopter will be controlled by an iPhone, ideally via Bluetooth. I will write an iOS application for the project. The app will also provide the pilot information such as altitude, speed and battery life. The extension of the project is to create a program so the quadcopter can fly autonomously by follow a preset path.

**Project Management**

The project will span from Mid-March to the end of May. During this one and half month period, I have to complete numerous task. Following a schedule is critical, otherwise, there is the high risk of not completing this project on time.

The project can be divided into three major sections.

1. Hardware & electronics
2. Bluetooth control software
3. PID software
4. (Extension) GPS related software



There are some parallels in the schedule. It’s very difficult to estimate the construction time for the quadcopter. If there is any hardware failure, I will slow down the process tremendously. My goal is to have the frame and electronics finished by April 5th. If software and testing also goes according to schedule, I will have a finished quadcopter with Bluetooth control and PID by May 5th.

**Deliverables**

There are four main deliverables. One if a finished quadcopter that can balance in air. The quadcopter should be able to lift up, move in all direction and safely land. The second deliverable is an iPhone application that can control the quadcopter. The third, which is an extension, is a piece of software that allows the quadcopter to follow a planned GPS path. Finally, there will be some written work about the project.

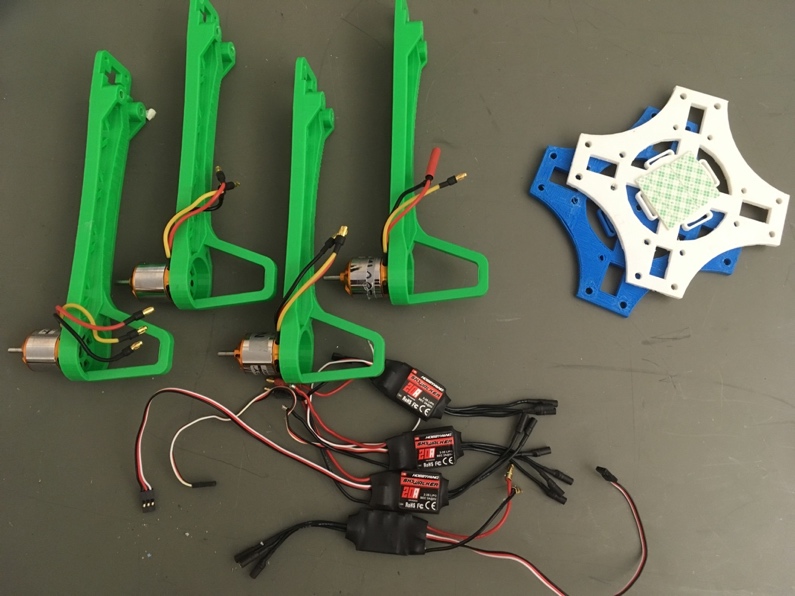
**Learning Goals**

Building a quadcopter from group up is a very challenging topic. First of all, the hardware and electronics are difficult to implement and requires great precision. Secondly, almost all quadcopter will need a PID algorithm. Seamlessly integrating PID and sensors is challenging.

My goal is to gain more knowledge on electronics and hardware. Specifically, control ESC with PWM. I will also learn the basics of PID and how to program one. I will also learn a lot about Bluetooth and wireless control.

More importantly, I will learn how to manage my schedule and also closely follow the rules. I will not test the quadcopter without permission. I will not rush through the steps. My biggest learning goal is to slow down, and be patient about this process. Especially, in the warehouse robot report Ms. Jiminiz pointed out to me that and I quote: “when things got hard and trying to do everything quickly really hurt you in the end. Sometimes you need to look up at the big picture to make sure that everything you are doing still makes sense.” I will certainly run into obstacles. The lessons I learned throughout this course, from my teacher, peers and myself will help me to accomplish this project.

**Budget**



This is the shopping list for the project. The total cost should be 51.6 dollars (not including taxes). The last two items are needed. However, I also own these sensors, therefore, the cost is zero.

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| --- | --- | --- | --- | --- |
| Item | Cost | Quantity | Total | Link |
| LiPo Battery | 13.99 | 1 | 13.99 | https://goo.gl/0CS44u |
| Bluefruit LE | 19.95 | 1 | 19.95 | https://www.adafruit.com/products/1697 |
| GPS | 17.66 | 1 | 17.66 | https://goo.gl/uzLDEF |
| Total |  |  | 45.29 |  |