Intuitive and Ergonomic Gesture-Based Drone Controller

ECE445 Project Proposal Spring 2019

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1 Introduction

1.1 Objective

The problem we have decided to solve is the lack of an intuitive method of controlling a quad-copter. Existing control methods often present a steep learning curve for new users and can lead to expensive crashes. While attempts to make a similar product already exist on the market, they are clunky and potentially more trouble than the original problem. To combat these issues, we aim to make a low-profile, ergonomic and intuitive quad-copter control device. The product will take the form of a glove-like wearable controller and a secondary base station to relay signals.

1.2 Background

Over the past several years small scale commercial drones for use in the public market have become available to the everyday consumer. However, these drones, costing anywhere from $40 to over $1000, can be difficult to control. On the low end of the price range, the controls are not sensitive enough or poorly implemented; likewise, on the expensive end the controls are far too complex for the novice user to successfully use without a high risk of crashing. Both of these scenarios result in potential loss of investment and time to repair the drone. Therefore, there is a need for a better controller that increases intuitiveness with marginal loss in the ability to control the drone. Our solution, a gesture-based controller mounted on a glove, would provide an intuitive way for novice users to fly without having to learn how to use a standard RC controller. By creating the glove many users who were not able to fly a drone should be able to with minimal instruction. This would allow the market for drones to expand to untapped demographics. While our design will be a prototype servicing a specific drone model, the project could be broadened to account for any number of different model's control signals.

1.3 High-level requirements list

- The glove must be able to read and process sensor data.
- The glove must be able to transmit control signals to the drone.
- The design must be as ergonomic and intuitive as possible while still allowing for accurate control of the drone.

2 Design

2.1 Block Diagram

The design for this controller consists of two parts the glove and a base station for proper operation. The glove has four sections: an array of sensors; a micro-controller; a power supply; and a transmitter. The array of sensors will collect data about the movement of hand when in the glove. The micro-controller will the data from the sensor array and convert it to a transmittable form. The transmitter will then take the output of the micro-controller and transmit the data stream to the drone. The power supply will provide 3-5V to power all components adequately for operation.

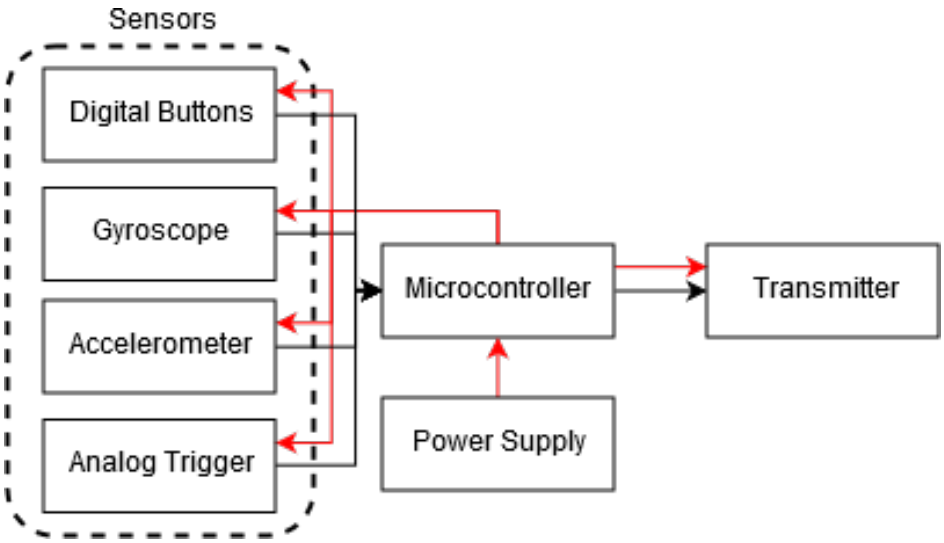

Figure 1: Block Diagram

2.2 Physical Design

Figure 2 below is a qualitative sketch of the glove with approximate designs where the senors, battery, and micro-controller will be place in the glove. The whole surface of the glove is used from the placement of the sensors on top of the glove for accuracy of capturing movement to the battery being placed on the underside of the forearm just below the wrist to reduce the strain from battery weight.(MKK, 2019)

Figure 2: Approximate placement of sensors and buttons

2.3 Functional Overview

The various sensors in the palm and on the back of the hand will relay information to teh microcontroller which will in turn translates those signals into control commands for the drone. The control commands will then be sent to the drone via a 2.4GHz transmitter. The combined electronics will be powered by a rechargeable Lithium-Ion battery.

2.3.1 Sensors

The sensor system of the glove is meant to collect all necessary control inputs from the user. Each sensor will be powered by the microprocessor and send their data to it.

2.3.1.1 Digital Buttons

The digital buttons will be used to signal different modes and features of the drone. They will be mapped almost directly to the existing controller buttons.

Requirement: The digital buttons must be the appropriate size ($2cm^2$) to fit on the back side of the glove.

2.3.1.2 Gyroscope

This gyroscope will create sensor data along 3-axis from movement of the hand. These movements will control the roll, pitch, and yaw of the drone.

Requirement 1: The gyroscope must consume under 3V.

Requirement 2: The gyroscope must be less than $1cm^2$ so it can fit on the glove.

2.3.1.3 Accelerometer

The accelerometer is used as a kill switch if the user moves their hand too fast to prevent erroneous flight of the drone.

Requirement 1: The accelerometer must consume under 3V.

Requirement 2: The accelerometer must be sensitive enough to generate the signal in 3-6 microseconds or less.

2.3.1.4 Analog Trigger

The analog trigger will control the thrust level of the drone.

Requirement: The trigger should be easy to press, but still provide a moderate level of resistance in order to more easily control the power.

2.3.2 Micro-controller

This micro-controller will be a ATmega328 boot-loaded with Arduino compatibility so it can be programmed with Arduino. It will collect sensor data, organize it, and transmit it to the drone through the transmitter.

Requirement: The micro-controller needs to process and transmit the data in less than 200ms in order to prevent latency.

2.3.3 Battery Pack

The battery pack will power the microprocessor which in turn powers the sensors and transmitter.

Requirement 1: The battery pack must supply voltage (3-5V) and current over the length of several flight periods about 60 minutes.

Requirement 2: The battery pack must be small and/or low profile.

2.3.4 Transmitter

The transmitter will be an XBee Pro S1. Its role is to communicate the sensor data from the glove to the base station.

Requirement 1: The transmitter must function with a latency of less than 200ms.

Requirement 2: The transmitter must function at least up to 300ft indoors.

2.4 Risk Analysis

The main risk for this project is hacking the controller and remapping the controls so the hacked controller sends the correct signals based on the data sent to the base station from the glove. This series of block is the most risky because of the number of devices and transmitters are creating, sending, or receiving data before the signals reach the drone. This poses significant risk for human error in the development of this interface.

3 Ethics and Safety

A possible ethical concern is someone using this product to control a drone that could be used in a non-personal use scenario. If this scenario were to happen it could violate the IEEE code of ethics in terms of potentially harming the public, environment, and/or hurting groups of people. Full statements of these ethics are IEEE Policies 7.8.1 and 7.8.9. (ieee.org, 2019) To alleviate this concern our controller will only control one hobbyist type drone. As part of the Federal Aviation Administration's (FAA) policies on drone flying for hobbyist users we must ensure the drones altitude remains under 400ft in uncontrolled airspace. There are also regulations at the campus level where before flying a drone on or inside campus property we must obtain approval from various campus safety groups including the Division of Public Safety and Code Compliance & Fire Safety.

We also must be aware of the voltages and currents across various areas of the glove to make sure no part becomes unstable where it would be dangerous for the user to wear on their hand.

4 Citations

MKK (2019). *Runing Glove*.[image] Available at: https://images-na.ssl-images-amazon.com/images/I/51TCOPNy%2BVL._SX425_.jpg [Accessed 7 Feb. 2019]

ieee.org (2019). *IEEE Code of Ethics* [Online] Available at: https://www.ieee.org/about/corporate/governance/p7-8.html [Accessed 7 Feb. 2019]