FPV Drone Shooting Game

ECE 445 Design Document

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1.Introduction

1.1 Objective

FPV drone racing is becoming more and more popular these days but is still considered as small group entertainment since most people who want to play with it are rejected by its operational difficulty. In order to improving flying skills, players usually need to find a large playground with extensive obstacles and stay away from people. However, such place is hard to find especially in city with large population density.That is one reason FPV drone is much more popular in Australia than Japan. Also, some player may get bored due to the limited number of flying routes and unchangeable obstacles. The interaction between drone players is only compete with each other to see who can use the least time finish the route.
In response to the above problems, we decided to develop a first-person real-life shooting game based on the DIY drone. Each drone equipped with game accessories can emit laser signals to attack each other, and HP will be lost when get hit. The game system will also be able to detect the enemy that is approaching. With the game system, players can also perform skill training without the professional training yard , thus reducing the difficulty of finding the proper place. At the same time, the game increases the interactivity between the players and enhances the entertainment function of the drone. Players can find more fun when the club initiates a party.

1.2 Background

The FPV aircraft was originally launched on a fixed-wing model aircraft carrying FPV equipment. Later, people tried to mount the FPV equipment on a multi-axis aircraft with better maneuverability and flight. With its increasing popularity, multi-axis aircraft that maneuver the aircraft through obstacles through the first angle of view gradually become self-contained, that is, the common passing machine. With the FPV equipment, the operation mode of the cross-machine changes from the “third perspective” of the traditional model to the “first perspective”. The manipulation feels more like an electronic game, which not only brings the immersive sensory experience to the user, but also let the rider have a different gameplay than the traditional model. At present, the number of people participating in the cross-machine competition is growing rapidly. The United States, Canada, the United Kingdom, Italy, Switzerland, Japan and other countries have set up a cross-machine alliance, set strict competition standards,and regularly organize large-scale professional events. The level of professionalism is getting higher and

higher, and the participants are developing towards a younger age, and children are increasingly participating in this competition. On March 11, 2016, Dubai spent more than 100 million US dollars to hold the WDP (World Drone Prix) through the machine competition. The event has a total prize pool of up to $1 million, the most relevant business event, and the winner is the 15-year-old British teenager Bannister and his "Tornado X-Blades Banni UK" team. The cross-machine competition, which set a high bonus, attracted the attention of fans all over the world. On March 30, 2016, Jin Huidong, Chairman of the Korean Drone Sports Association, and Lu Qing, the head of China's “D1 Sky Arena”, and Terra, President of the Japan Drone Sports Association, established the Asian Drone Racing Association (ADRO).

1.3 High-level requirements list

- Drone A can detect the attack signal sending by Drone B.
- Drone A can send the hit feedback signal to Drone B once get attacked.
- Game interface can be combined with the video taken by the camera and send to FPV goggle.

2. Design

The design consists of four sections : Video Processing Unit, Signal Processing Unit, Control unit , and Power Supply.

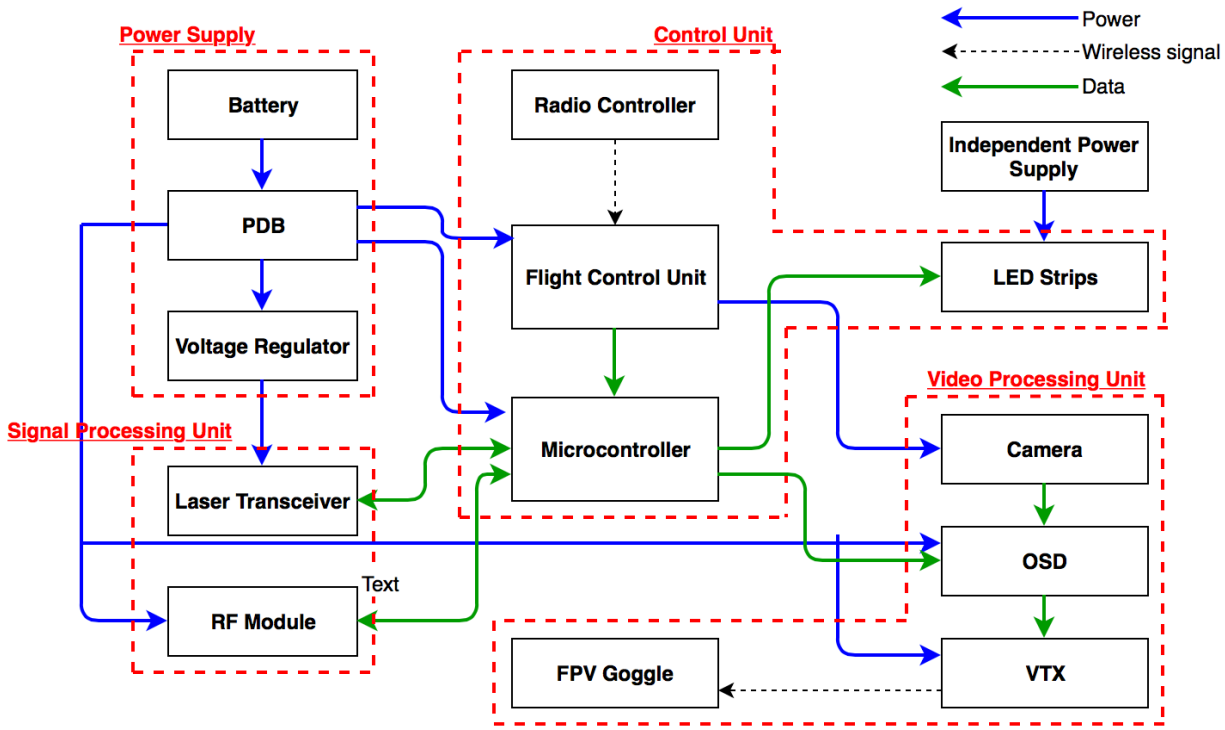


Figure 1. Block Diagram

2.1 Control unit

2.1.1 Radio controller

The Radio controller controls the basic movement of the drone and send the signals to the Flight Control Unit on the drone. We modify its additional switches using BetaFlight to achieve the control of game, including turn on/off the game mode and send the shooting command.

2.1.2 Microcontroller

The microcontroller communicates with two signal transceivers including sending attack signals to others and receiving location and hit feedback signals from others.It also controls the four LED strips to indicate the current HP. It sends the game information to the OSD.

Requirement	Verification
1. It should be able to encode and decode RF signal. 2. It should be able to encode and decode Laser signals.	1. Use RF24 Library to process RF signals.

2.1.3 Flight Control

The Flight Control Unit receives signals from RF controller and send the flight command to four speed controllers. For the game systems, we use its additional two PWM channels to send the game mode signals and shooting signals to the microcontroller.

Requirement	Verification
1. It should has at least 6 channels.	

2.1.4 LED strips

Attached to four arms of the drone and represents HP of the drone. Once the drone receives a hit signal, one LED will turn off.

Requirement: The length of LED strips should be compatible with the arm of the drone.

2.2 Power supply

We use the power supply system of the drone to power up the game components with additional designed PCBs.

2.2.1 Battery

The standard fpv drone battery.

Requirements: At least 1500mAh to support the flight duration,4s,25C.

2.2.2 Power distribution Board

The PDB provide 5V voltage to the Flight Control unit and 12V to video processing unit.

Requirements: PDB should be compatible with carbon skeleton.

2.3 Video Processing Unit

2.3.1 camera and FPV goggle

Camera is for catching video signals. FPV goggle displays our video game.

Requirements: Should catch the real-time signal.

2.3.2 OSD

It receives video signals from camera and receives “control signals” from microcontroller. Then it uses dynamic VDM to show the game information on the goggle.

Requirement	Verification

2.3.4 Video transmitter

It receives video signals from OSD and send the signals to the fpv goggle through antenna.

Requirement : Support fast transmission.

2.4 Signal Processing Unit

2.4.1 Attack signal transceiver

The attack signal transceiver can send the attack signal to the receiver on another drone and receives the attack signal from it.The attack signal receiver will be shut down for a moment once it receives the attack signal from others to avoid repeated receiving.We use Laser to simulate the attack signal.

Requirement	Verification
1. It range should be at least 50m and less disturbance in outside environment, 2. The receiving range should cover the drone body and relatively accuratly respond to the signal.	

Requirement: The laser signal should be detected within 30 meters.

2.4.2 hit feedback signal transceiver

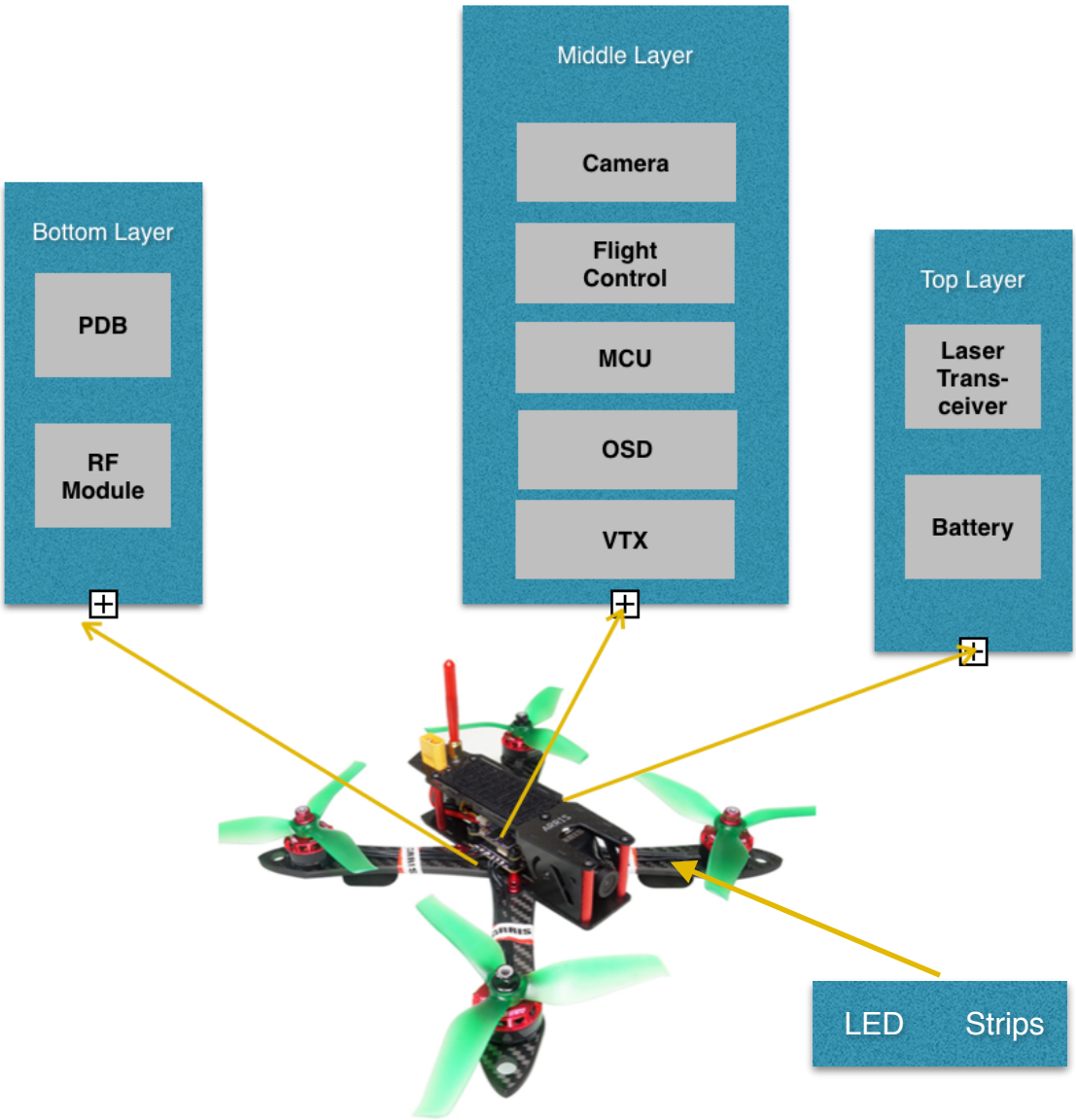
Once the drone receives a attack signal ,it will send the hit feedback signal back to the drone attacking it.Unlike the laser signal, the range of the feedback signal should be wider so we use RF module to achieve this processing.

Requirement	Verification
1. The receiving range should be around 50m 2. It should support multiplayer receiving the information at the same time.	

Requirement: The range of RF signals should cover at least 30m and using frequency at 433mHz.

2.5 Physical Design

Since it is a shooting game ,we will design two FPV drone carrying the game system and each controlled by RF controllers with FPV goggles. There will be three layers on the drone. The first layer is the power system of the drone, the second layer is the signal processing unit including two transceiver systems. The third layer is the video processing unit.



2.6 Tolerance

2.7 Risk Analysis

The main challenging part is two transceiver systems. Since drone moves really fast, it requires the signal transmission as fast as possible to achieve desired effect. The drone is also small, the size is only 210mm so it may be very hard to shoot the drone at 30m distance and high speed. We'd like to expand the laser beam so it can cover more area and easy to be detected.

Safety and Ethics

There are several potential safety hazards with our project. Firstly, the drone is powered by 4 propellers at the top with much high speed. Mistake in controlling the drones such as getting to close to people might result in injuries. To address the issue, we will demo the project in the space where there are few people around, and if possible we will DIY some proper propeller guards.

The second safety problem might show up when the battery runs out. When the drone is out of power, it might fall to the ground and crash people who are underneath. To address such issue, we will setup warning when the battery is almost out of power.

For the ethnic's part. There might be some open source codes we will utilize from the internet. We will formally and properly site the sources of the unitized data and info. And for our own development data, we will share most of the code and resources that we think might contribute to DIY drones industry.

And since we will use the goggles for FPV shooting, there might be personal privacy recorded in game players' sight. All the video in the goggles will only be used for project developing and private images if show up in the videos, will remain confidential.

References

1.https://howtomechatronics.com/tutorials/arduino/arduino-wireless-communication-nrf24l01-tutorial/

Tolerance analysis:

In the tolerance analysis, you will show that your project will still be able to function despite the limited accuracy of the sensors, actuators, component values, and so forth.