



Faculty of Engineering and Applied Science  
ENGR 4940U Capstone Systems Design for ECSE I

## **Low Cost Drone Light Show**

Final Team Retrospective Report

### **Group - 34**

#### **Team Members**

Michelle Cheng, 100696572  
Munazza Fahmeen, 100701595  
Nivetha Gnaneswaran, 100695935  
Rodaba Ebadi, 100708585  
Toluwanimi Elebute, 100724471

**Faculty Advisor:** Dr. Liixin Lu

**Capstone Coordinator (Fall 2022):** Dr. Vijay Sood

## Table of Contents

<b>1 Things That Went Well</b> .....	2-3
1.1 First Semester	2
1.2 Second Semester	3
<b>2 Things That Surprised Us</b> .....	3-4
2.1 First Semester	3
2.2 Second Semester	4
<b>3 Lessons Learned</b> .....	5
3.1 First Semester	5
3.2 Second Semester	5
<b>4 Final Thoughts</b> .....	5

## 1. Things That Went Well

### 1.1 First Semester

#### *Understanding General Drone and Drone Light Show Technology*

Going into this Capstone project development year, our group had limited knowledge on the exact mechanics of a drone and how a drone light show works. One of the main things that went well this semester was for us to build a strong knowledge base on drone mechanics and software. This included research about the critical components, types, use cases, electrical connections and the physics behind drone flight. Understanding drone light shows and existing technologies such as Intel Shooting Star and Spaxel also helped us brainstorm ideas on how we could incorporate the main theme of a light show in a low cost setting. Only by understanding these base principles, were we able to come up with our design plan.

#### *Auto-path set up for single Tello EDU drone*

Setting up an auto-path for the Tello EDU was one of the main goals of this semester. This is because one of the main requirements of a drone light show is to have a pilotless flight path. The drone must be able to move to a certain location or formation without the use of manual guidance from a pilot. After setting up the UDP connection through the Tello WI-FI access point, we were able to customize a script to set a default list of commands for Tello to follow. The driver script was used to read a command text file, which fed the read commands into the Tello Object stored in another script. This connection allowed us to set all of the commands we wanted Tello to follow without the need for a manual user control.

#### *Creation of manual commands to be read into Tello*

Having an expandable and scalable program was vital to ensure that we can further continue towards our project goal of setting a drone light show. Another component that went well this semester was being able to customize how and what types of commands we want to send to Tello. The default Tello SDK 2.0 offers a variety of commands that can be used to control Tello but we knew that to create a drone light show, we would need to initialize different commands in order to control the formations. We were able to create our own “poly” method which allowed a single Tello EDU drone to fly in a formation to create any regular polygon of choice by the user. This is important moving forward as we want to incorporate these custom commands for multiple drones to follow. Another critical component to this semester was having a way for the commands to be easily configured as we want to expand this project to be customizable by a user through a UI such as a mobile application.

## **1.2 Second Semester**

### *Swarm Programming*

A goal of this semester was to build off of the accomplishment we'd made of setting up an auto-path for a single Tello EDU drone into setting that up for multiple drones (in the case of our project, three drones). It first started with having to conduct thorough research on how to go about doing this which successfully led us into having to get a router and configure networking and such, something that none of us had experientially accomplished before. It took a lot of trial and error, a lot of continual required testing, a couple of accident crashes of drones, but we conclusively are now able to pass a command to the three drones through programming, to perform a particular shape sequence and it is able to do so.

### *Development of Mobile Application*

Finishing off the last semester, one of the future goals for the project was to develop a mobile application to allow users to interact with the system. This semester, we were able to initialize the plan and successfully developed and built a functioning, easy-to-use, app. We integrated the use of Figma to first design the UI using some skills and knowledge obtained from the User Interface course we had taken last semester as well as knowledge from the Mobile App Development course. Some of us had never used React-native (the chosen technology we used to develop the app) so some new skills have been gained along the way. We did have a couple of challenges along the way but had learned a lot during the process and the result of that is fruitful.

## **2. Things That Surprised Us**

### **2.1 First Semester**

#### *Cost of Drone and Drone Parts for custom build*

When starting this project earlier in the semester, we had anticipated that the cost of drones would be very high and thus, opted into researching more about making our own custom build. The ultimate thing that surprised us was the high cost of building the drone from scratch and through various research, the lower cost of a Tello EDU drone. This discovery made us change our initial approach to the project and led to the decision to pursue the Tello EDU path.

#### *Initialization of the drone upon receiving and setting up UDP connection*

When setting up the UDP client connection to Tello EDU drone, we had an issue due to hardware configuration that was needed. When we received the Tello EDU, we were not expecting this problem and had to do research through various sources in order to figure out the issue. After writing out the script, we were certain that this was not a

software issue. Turns out that recalibration of a Tello Drone was needed sometimes when using a new drone for the first time. This can be done through the default Tello app which upgraded the firmware.

#### *Battery consumption of Tello EDU drone*

When we were researching options for different drones, we came across Tello EDU due to its convenient connectivity through a WI-FI access point and UDP set up. Something that we did not consider was the battery life of a Tello EDU which is around 13 minutes flying time compared to 1.5 hour charging time. Although we had brought a spare battery, this made testing as we were configuring the scripts to be less efficient as we had to wait for the battery to charge before proceeding further.

## **2.2 Second Semester**

#### *Testing*

Something that surprised us this semester was how required testing was at each and every stage of development of the different aspects and components of our project. It does make sense the necessity of it but how tirelessly one can go through testing just to get things working was indeed an eye-opener. As a result, we exercised skills of resilience and determination to accomplish our goals which we were able to do to some measurable degree.

#### *Usefulness of Agile Methodology*

Agile Methodology is a method of project management by breaking it up into several phases. This method really proved useful to us over the journey of development of our project and aided in the cohesiveness of the two working teams we had under our project: one team for swarm programming and networking, the other for App development.

#### *Lack of means to Integrate App to network*

Another thing that had surprised us, from the conduction of research, was how limited resources were to know how to go about integrating the app with the swarm programming. We had hoped to use networking to which the app would connect to send messages to the router which in turn would send a message to the drones however, we couldn't find a library or straightforward way to connect to the router on React-native. We had tried some methods which hadn't worked successfully.

### **3. Lessons Learned**

#### **3.1 First Semester**

##### *Setting up proper physical testing environment*

One of the core components of a drone light show is to set up an auto-path for the drone to follow. This means that no manual control should be needed. When we were first creating and testing the commands, there were times when the drone was not acting as expected which caused it to crash into nearby objects or make abrupt movements. Although the drone is relatively durable throughout different incidents, we quickly learned that having a proper testing environment was critical to ensure that we do not break the functionalities. This included setting proper cushioning at takeoff and landing points, removing all nearby obstacles and ensuring enough room is allotted.

##### *Investing in backup battery and additional charging dock*

As mentioned, one of the lessons learned from this past semester is the limited battery life that Tello EDU drones have. This made testing our scripts to be inefficient at times as this could not be done simultaneously and ultimately used up more time. We will be investing in more back up batteries and charging docs to ensure that we can switch out the battery as needed.

#### **3.2 Second Semester**

##### *Router Issues & IP discovering*

One of the main lessons we learned was working with the router and configuring the IP addresses. We realized that the IPs of other devices were being found like computers and phones. To fix this we had to manually test the IPs through the packet sender.

### **4. Final Thoughts**

It is somewhat sentimental looking back at the start of the school year with our Capstone Project. In our initial beginnings, there were a few uncertainties about how to go about the project justifiably as well as in our ability to bring it to life but we look back now and are proud of the progress we made and the results that show for it. It's been a growing, learning process. Sometimes it was hectic, sometimes it was easy-going, sometimes it was stressful—many late nights and staying up to complete initiatives—but overall, it was a contributing learning experience and we can truly say we are satisfied with our beginnings as well as we are, our end.