INTRODUCTION TO TEAM

Good morning everyone. My name is Dylan, and these are my teammates, Abbie, Caleb, Harsha, Armando, Irshaad, Sanjeev, Benjamin, and Ritvik. We are Tellix from Nanyang Polytechnic and we're excited to share with you what we have done.

Explain the mission briefly

Our mission is to develop a search and rescue system using a swarm of about 10 to 25 drones that can identify and locate victims, and perform rescue operations autonomously. With obstacles in its way such as walls and windows, it must navigate around the arena and rescue the victims.

ABOUT TELLO

We chose Tello as our drone of choice due to its versatility. The drone has an inbuilt Vision Position System and 720p HD camera, and its compatibility with programming python makes it an excellent choice for our needs. Additionally, its lightweight design of only 80 grams makes it easy to handle.

1) The Connection between the laptops and the drones

The laptops are connected to the drones using a 3-way connection system, which includes a router, a laptop, and a drone. We began by resetting the router to avoid any conflicts with previous data. Then, we used a software called PacketSender to connect the Tello drones to the router and check the IP address via the router webpage.**(* hold up a D-link router to show the judges on the spot)**

Once the drone IPs were established, we binded the drone's mac address to an IP Address in the router to ensure that the drone IPs would be permanently assigned to the router and avoid the need for configuration steps in the future.

Finally, we connected the laptop's WiFi network directly to the router to establish a connection between the laptop and the drones using python and the djitellopy library. It was sufficient enough to meet our requirements to fly the swarm of drones using coding and simple enough for everyone of different levels of coding experience in our team to understand and learn it fast.

2) Localisation Markers

In our strategy, there are two different types of localization markers.

To best explain the strategy we are going to break it into two parts: Mission Pads and Coloured Lines.
The Tello drone receives instructions through numbered Mission Pads. When the drone scans a Mission Pad, it receives a command such as to move forward, backward, left, right, or land. For example, if the number 2 Mission Pad is programmed to instruct the Tello to move forward, the Tello will move forward when it scans that pad. Using mission pads we can assign up to 8 unique instructions, providing us the flexibility to program different commands.
(* hold up a modified mission pad to show the judges on the spot)

One of them would be mission pad id markers. It would scan the marker using the bottom black and white camera and identify using the patterns of circle shapes.

We evaluated different options such as using solely colored markers to guide the drone by tracking the color or solely mission pads that transmit commands to the drone when its Vision Positioning Sensor identifies the distinct pattern on the pad.

STRATEGY EXPLAINED IN DETAIL

Eventually, we opted to use both methods in various parts of our strategy for different objectives. We use mission pads in the rooms and colored markers in the bonus room.
(hold up both mission pad and localization marker)

2nd localisation marker is using Coloured Lines which is intended for bonus room. This idea allows us to send commands to the drone using colors instead of Mission Pads. The drone will execute the given command as long as the color is visible within its field of view. For instance, we can program the color red to move the drone forward, so when the drone detects the color red, it moves forward as long as the color is visible. This strategy is safe and reliable since the drone can accurately follow the color and is unlikely to go out of range easily **(* hold up a colored pad to show the judges on the spot)**

Current brief strategy

Our strategy involves running six different types of code, with individual functions such as detecting mission pads, obtaining directions for drone movements, and scanning color papers to follow a predetermined route. To minimize time loss, we divided our drones into five groups, with each group assigned a specific role in locating victims. This division of drones into groups provided us with greater flexibility and control over each group, enabling us to carry out the mission efficiently and effectively.

Our strategy for setting up mission pads in the arena involves dividing them into four sections and assigning a team of crew members to set up each section. To further streamline the setup process, we have also prepared all necessary attachments and modifications to mission pads in advance. These preparations will significantly reduce the overall setup time.

3) ***The Obstacle and collision avoidance system***

The drone will detect mission pad number 1. After detecting mission pad number 1, the drone will proceed to use its IR sensors and get its x,y,z axis coordinates. Using that information, it moves back to 0,0 of the mission pad to centralize and avoid the wall or obstacles.

FAILED STRATEGIES

However, before arriving at this successful strategy, we tried out several other approaches that were effective but eventually proved unsuccessful. For instance, our initial approach was to adopt a leader-follower system where one drone (leader drone) would lead the other drones (follower drone).

Unfortunately, this approach failed because it relied on the master drone scanning the room and transmitting coordinates to the other drones. The drones does not have an inbuilt GPS system and we needed to create a virtual GPS for this strategy to work. Through this setback, we learned about the differences between a physical and virtual GPS where the virtual GPS is not reliable compared to and physical GPS.

We also tried out color line-following system for the entire arena with no mission pad involved, which was an unsuccessful strategy too. The plan was for the Tello drone to follow a colored line into a room and pace themselves out and, will begin running the code to scan the room for a mission pads aka victims

While the approach showed great promise during testing, we encountered signal interference issues that degraded the video transmission quality and significantly lowered the strategy's overall success rate due to data being loss between transmission. Anticipating potentially worse signal interference on the day of the competition, we decided to abandon this approach altogether to avoid taking any unnecessary risks.

4) Modifications to the Tello drone

As the requirements of our strategy went up, we realized that the default setup of the drone was not enough to meet our specific targets in terms of flight time or
even speed of the drone, so we made a few changes that improved the overall performance of the drone

Over time as our strategy changes, we need to change and improve our drones.

Application of a thermal paste

Applying a layer of thermal paste helped with even and faster heat distribution away from the drone's heat sink, as a result, the drone cooled down much faster than it normally would. This increased the average battery life of a fully charged drone by about a minute which increases flight time ***(Show the thermal paste packet to judges)***

- ***Fast and even heat distribution away from drone's heat sink - cools down faster***
- ***Increases battery life from 12 to 13 mins - increases flight time***

Bottom mounted cameras

In our colored lines strategy, we needed to use the bottom camera to scan the colored papers. However, during testing, we found the existing bottom camera is only providing black and white video. Moreover, it couldn't give us a live feed of the bottom camera. As a result, we decided to repurpose the front-facing

camera as the bottom camera by moving it downwards to scan the papers. To hold it in place without moving, we designed a 3D printed custom camera holder to mount the camera. This ensured our modification stayed in place.. ***(Show the drone w bracket to judges)***

- ***Bottom camera unable to provide live camera feed, unable to view different colors other than black and white***
- ***Front camera repurpose to face downwards to scan colored papers instead - colored paper strategy***
- ***Use 3D printed mounts to hold the camera in place***

Removal of propeller guards

After realizing that the propeller guards did not enhance performance, we made the decision to remove them. Although we were aware of the risk of motor damage in case of collisions with other drones, we conducted further testing to determine if the change was worth making. Our testing revealed that by removing the guards, we were able to reduce the drone's weight by a few grams. As a result, the drone's full battery life increased by about 30 seconds.

- **Removing propeller guards risk motor damages**
- **Removing propeller guards reduced drone weight by a few grams, increasing the drone's battery life by 30 secs.**
- **Reduce air resistance**
- **Con, Exposes motor, can be easily damaged**

Failures in modifications

We made multiple modifications to enhance the performance of our drone fleet, and most of them were successful. However, one modification we tried nearly destroyed a quarter of our drones.

We wanted an LED on top of the drone that could be seen from any angle, so we tried soldering LEDs onto the motherboard. Although it didn't affect the drone's performance initially, after a few days, motors started failing among those with soldered LEDs, and we had to replace them. We found that the problem was common among the drones with LEDs soldered onto them, so we removed them.

To avoid further damage, we opted for battery-operated LEDs that could be glued onto the drone's top without altering the circuit. This proved to be a safe and effective solution, and we learned to test modifications thoroughly before implementing them.
(show a Tello drone that has LED soldered onto it to judges)

ROLES OF PEOPLE

As a team of nine people, we used a "divide and conquer" strategy to the project by leveraging each member's expertise. For instance, Sanjeev and Armando specialized in coding, and thus, took charge of the coding side of the project. Meanwhile, Harsha, Benjamin, Ritvik and myself focused on logistics and planning, ensuring that all required resources were available and prepared for testing schedules on top of overseeing the set-up of the arena. Abbie and Caleb were responsible for the project's media aspects, such as planning videos and posters. Finally, Irshaad played a vital role in overseeing all the departments, ensuring that the project progressed according to plan and bringing the team together. Overall this was an enriching and interesting experience as we bonded a lot and made a lot of memories.

Colour legend 👍

Red - Dylan
Blue - Sanjeev
Green - Irshaad
Yellow - Caleb