University College London (UCL)
(UCL Air)

# 1. Imaging and ODLC:

Camera used: CE zr10 gimbal camera

## 1.1 Object localization:

- The location of the airdrop targets was calculated by using a single camera and GPS module
- The longitude and latitude of the targets were determined by calculating the target's location in pixels from the center of the image and then by using the focal length of the camera the distance was converted into meters and then into GPS coordinates

## 1.2 Object Classification:

### 1.2.1 Colors Classification:

- Colors were detected using the K-means clustering algorithm. The largest contour was extracted and pasted into a pink background. Pink was chosen because it is not a color listed in the regulations
- The algorithm maps each RGB code of the cluster center to a color dictionary and output two colors for the shape and for the alphanumeric

### 1.2.2 Shape Detection:

- The shapes were classified using YOLOv8 trained on synthetic dataset of 10 K images over 50 epochs and by using a batch size of 5
- The size of the shapes was approximated using the focal length of the camera. The symbols recognized was rotated 15 degrees before being into OCR test for alphanumeric classification

# 2.Air Drop:

## 2.1 System Design

- The system was controlled by Arduino Uno and an encoder is installed to monitor the drop progress and control the time taken for each drop
- Capacitive Proximity sensor was used for redundancy to ensure that the carrier is in the correct position location before the next bottle is released

### 2.2 Alternatives Considered:

- A parachute, a winch with electromagnetic release, and even a bungee jump concept

## 3.Communincations:

### 3.1 System Design:

- For air ground communications, two telemetry and radio units were utilized. The first of this equipment are the RFD 900 radio
- Data transfer is achieved using Mavlink
- The second communication unit uses the here-link ecosystem consisting of air unit and controller. It has a RC receiver to allow manual flight using the controller at the same time the air unit communicates with the controller using mapping

### 3.2 Safety, Risks, and Mitigation:

Risk: Loss of communication with the drone

Mitigation: A backup redundancy communication channel

## 4.Autopilot:

- The navigation system is handled by the pixel cube orange which runs the Ardupilot autopilot firmware
- The navigation system can be controlled by the on-board computer entirely using mavos which is a Mavlink extendable communication note for ROSS
- Mission planner is used as the ground control station
- Before the start of the mission the predefined waypoints in the paper format is detected and uploaded to the waypoints database using alphanumeric algorithms
- Once the process is completed the UAV waits for an arming and mode change command after which it will initiate the entire Mission automatically which include navigating the competition waypoints, initiating the obstacle avoidance algorithms, and executes the coverage and airdrop sequence in the airdrop zone

## 5.Obstacle Avoidance:

- A 2D lidar with 360 degrees horizontal of FOV is used, point cloud data of any object within 100 meters range are collected and then segmented to identify the number of obstacles and its distance to the UAV
- Kalman filter is used to detect the future trajectories of the dynamic obstacles
- The artificial potential field algorithm was used as a path planning algorithm were the present and future predicted location of the obstacles are fed into it.

- The system updates the flight plan by generating local waypoints that the UAV can follow so that it can fly to the next global waypoint without encountering the current and future positions of the obstacles