Istanbul Technical University

(ITUNOM UAV team)

1. Object Detection and Classification:

1.1 Object Detection:

- YOLO model was used
- The model was trained using photos from ground in real life scenario. They set the classification and localization part in parallel to optimize the code

1.2 Object Localization:

- The field view equation was used to determine the co-ordinates of an object

1.3 Object Classification:

1.3.1 Color Classification:

- To determine the color, the detected object was passed through blur then thresholding methods and using a machine learning model trained with 40 K RGB values the corresponding color of the RGB value was obtained

1.3.2 Shape Classification:

- For detecting shapes in ROI, feature extraction performed better than the geometrical methods because of the distortion and noises in the image taken

1.3.3 Letter Classification:

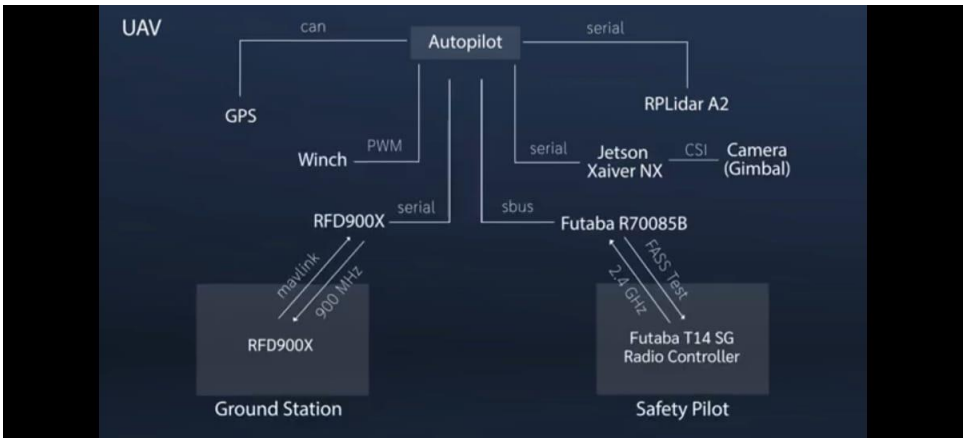
- OpenCV metashapes methods was used

After all these stages, the results are accumulated as Metadata with result confidence

2.Air Drop:

- A custom PCB is designed to control the airdrop mechanism
- Dronekit API was used for autopilot to perform drops at the detected locations
- Using the classification data saved in Metadata, they calculated the similarity of the classification materials found in payloads given to them, and determined the delivery location of the payloads
- By reading the PWM signals from the autopilot the drop system will be able to know when to make a drop
- When the vehicle arrives at the drop location for a specific object, the system will be notified, and the related winch will be triggered to execute a safe drop

3.Communication System:



4.Autopilot:

The team chose the Pixel Orange Cube autopilot due to its proven reliability in previous years and the various functionalities it provides to the UAV. These functionalities include:

1. Vibration Damped IMU: This sensor provides critical information for estimating the UAV's position, orientation, and velocity, contributing to stable flight.

2. Integrated Magnetometer: The magnetometer is used to determine the UAV's heading relative to the Earth's magnetic field, aiding in navigation and orientation.

3. Temperature-Controlled Barometer: This sensor helps estimate the UAV's altitude by measuring changes in air pressure with respect to altitude.

The autopilot software utilized is ArduCopter, which was used to tune the vehicle's parameters for stable mission flight. The hardware includes a Jetson Xavier NX, and communication is facilitated through a Drop PCB communication protocol, all of which are open-source components, allowing for easy integration of custom elements.

During the mission, when the drop area is reached, the autopilot takes on several responsibilities:

- It initiates the software on the Jetson NX by transmitting the vehicle's state.

- It ensures the vehicle is delivered to the correct position by following commands from the Jetson Xavier.

- The autopilot handles payload delivery, providing instructions to the Drop PCB via PWM signals.

At the ground station, Mission Planner is used for interacting with the UAV.

The system benefits from real-time kinematics positioning support, enhancing positioning accuracy for both airdrop and flying waypoints.

5.Obstacle Avoidance:

- RP lidar A2M8 was used to avoid aircraft during the mission as it is compatible with Arducopter firmware. It provides detection for 360 degrees and 8 meters range.
- The Bendy Ruler algorithm is used for path planning. The algorithm works by dividing the area around the drone into small cubes and mapping out the distance to the nearest obstacle in each one. It generates a virtual ruler that bands around the obstacle in the drone's path and continues to update it as the drone moves forward enabling real-time obstacle avoidance without human interaction