UWA ELEC5552

Indoor Line Following Drone

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Manual and Operating Guide
Volume 1

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1 Introduction

1.1 Purpose of the Manual

This manual provides comprehensive instructions for the operation, maintenance, and troubleshooting of the Indoor Line Following Drone. It is designed to guide users in safely operating the drone and maintaining optimal performance.

1.2 Target Audience

This manual is intended for drone operators and technicians with basic technical knowledge, providing step-by-step guidance for safe usage, routine maintenance, and troubleshooting.

2 System Overview

2.1 Drone Components

The **Indoor Line Following Drone** consists of the following key components:

1) Flight Controller (BetaFlight): Manages the drone's flight stability and controls motor commands for pitch, yaw, and roll.
2) Ultrasonic Sensors: Used for obstacle detection and altitude control.
3) Motors and ESCs (Electronic Speed Controllers): Provide thrust and control the drone’s movements.
4) Battery and BMS (Battery Management System): Powers the drone and manages energy efficiency.
5) Camera: Used for line detection and navigation along predefined paths.

2.2 Functionality

The drone is designed for autonomous navigation in indoor environments using line detection and obstacle avoidance systems. The flight controller processes input from sensors and cameras, while the motors and ESCs adjust the drone’s movement in real-time, maintaining stability and accurate path-following.

3 Operational instructions

3.1 Pre-flight Setup

1) Battery Check: Ensure the battery is fully charged and securely connected.
2) Component Inspection: Check propellers, sensors, and motors for damage or obstructions.
3) Flight Controller Calibration: Calibrate the flight controller via BetaFlight before each flight.

3.2 Powering On

1) Power on the drone by connecting the battery.

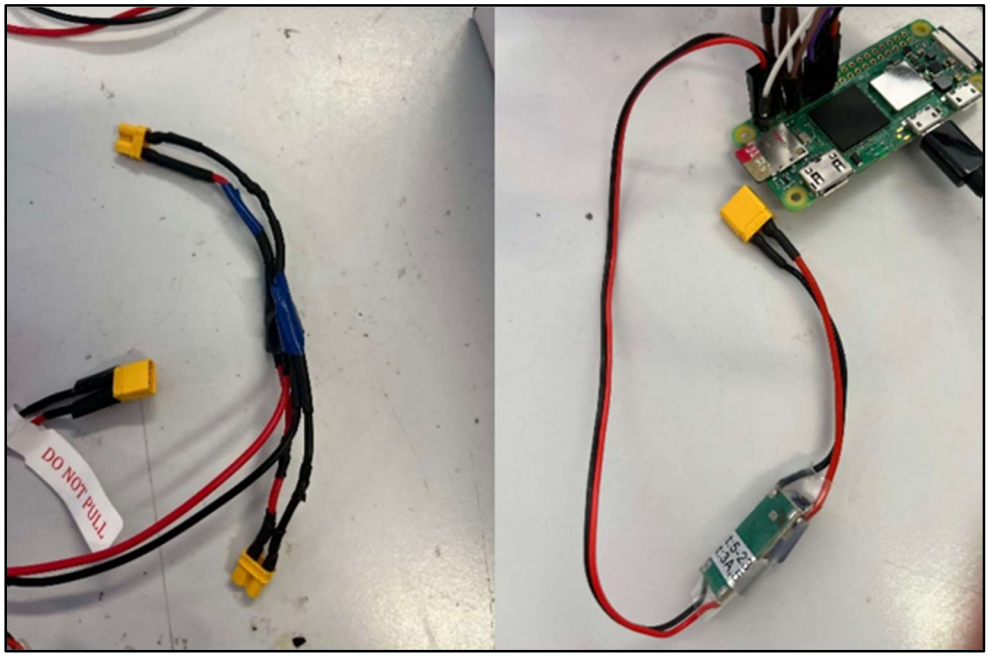

Figure 1. Connecting the Battery cable

2) Connect the drone to the ground station via Wi-Fi or Bluetooth for telemetry data and manual override access.
3) Ensure both the laptop and Raspberry Pi are connected to the same Wi-Fi hotspot.

4) On the Raspberry Pi, enable **SSH** by running and open a terminal on the Raspberry Pi and run the following command:

```
sudo raspi-config
```

5) Navigate to Interfacing Options > SSH > Enable.
6) In the terminal, find the IP address by running:

```
hostname -I
```

7) On your laptop, open a terminal and SSH into the Raspberry Pi using the following command:

```
ssh group3@<RPI_IP>
```

- Replace <RPI_IP> with the actual IP address you retrieved in the previous step.
- When prompted, enter the password: group03.

3.3 Flight Mode Selection

1) Manual Mode: Use the controller for manual flight if necessary.
2) Autonomous Mode: Activate autonomous line-following mode via BetaFlight. The drone will detect and follow pre-marked lines while avoiding obstacles.

3.4 Flight Controls

1) Takeoff: Use the ground station commands to initiate takeoff.
2) Navigation: In manual mode, use the WASD controls to control pitch, yaw, and roll. In autonomous mode, monitor the drone's progress as it follows the line and avoids obstacles.
3) Emergency Stop (E-stop): Activate the E-stop button via the laptop ESC key for immediate shutdown if necessary.
4) Running WASD Commands:
    - Download laptop_sender.py and ensure the directory points to where the code is located on the Raspberry Pi.
    - Run laptop_sender.py on the laptop to send WASD commands (for up, down, left, right control) directly through the terminal.

3.5 Post-flight Procedures

1) Power down the drone by disconnecting the battery.
2) Inspect the components for any wear or damage after the flight.
3) Recharge the battery and store the drone in a cool, dry place.

4 Maintenance Procedures

4.1 Battery Maintenance

Ensure the battery is fully charged before each flight and store it at 50% charge in a cool, dry place to prevent degradation. Replace the battery if you notice a significant drop-in flight time or swelling. Avoid exposing the battery to extreme temperatures.

4.2 Component Inspections

Regularly inspect the motors for wear or debris and ensure the propellers are free of obstructions. Check the ESCs for overheating or damage after each flight and verify that sensor connections are secure. Clean the camera and ultrasonic sensors regularly to ensure optimal performance.

4.3 Firmware and Script Updates

Update the flight controller firmware via BetaFlight as needed to ensure compatibility with new features. To modify scripts, SSH into the Raspberry Pi, navigate to the correct directory, and use nano to make changes. After editing, test the scripts by running them to confirm the changes do not impact flight performance.

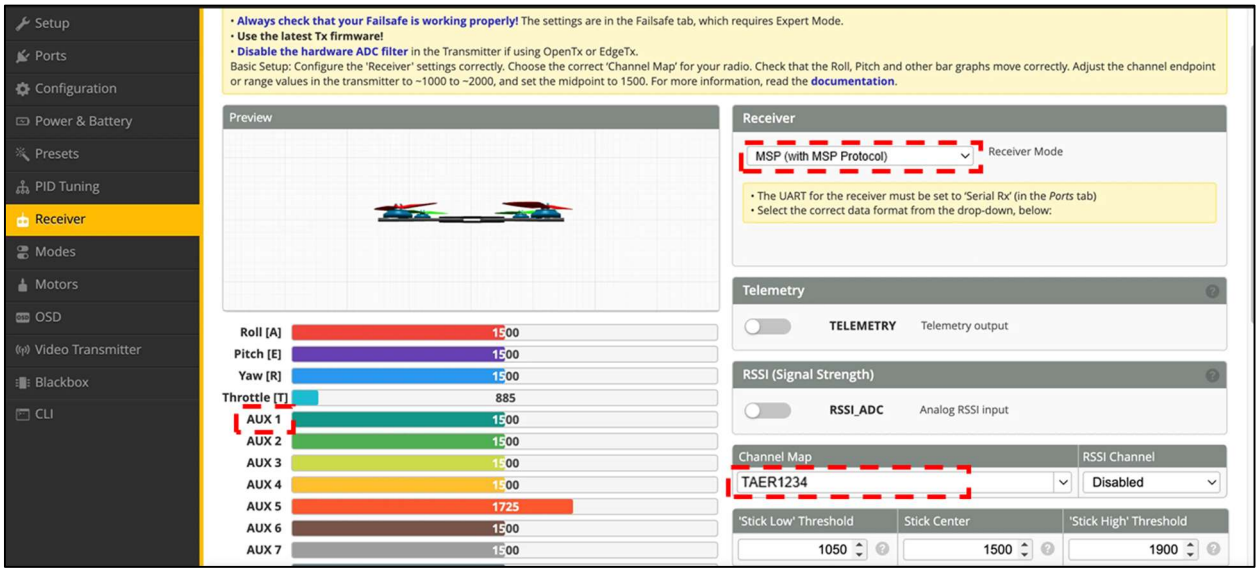

Figure 2. Betaflight GUI

4.4 Cleaning and Care

Clean the camera lens and sensors with a microfiber cloth and use compressed air to remove dirt from the frame and propellers. Replace any damaged propellers to avoid flight issues.

4.5 System Calibration

Before each flight, recalibrate the flight controller using BetaFlight to ensure stable operation. Regularly test motors and ESCs, recalibrating as needed to maintain responsiveness and optimal performance.

4.6 Testing and Diagnostics

Periodically test the ultrasonic sensors and PiCam to maintain accuracy. Test the communication link between the Raspberry Pi and the flight controller using tools like minicom to ensure reliable data transmission.

5 Safety Considerations

5.1 Lithium-Ion Battery Safety

Handle the battery carefully to avoid punctures, overheating, or damage. Always use the recommended charger and never leave the battery unattended while charging. Store the battery in a cool, dry place, and avoid exposing it to extreme temperatures. If the battery becomes damaged or swollen, replace it immediately to prevent fire hazards.

5.2 Propeller Safety

Ensure the propeller guards are securely attached before every flight. Keep hands, loose clothing, and objects away from the propellers when the drone is powered on to prevent injury. Always power off the drone before handling the propellers.

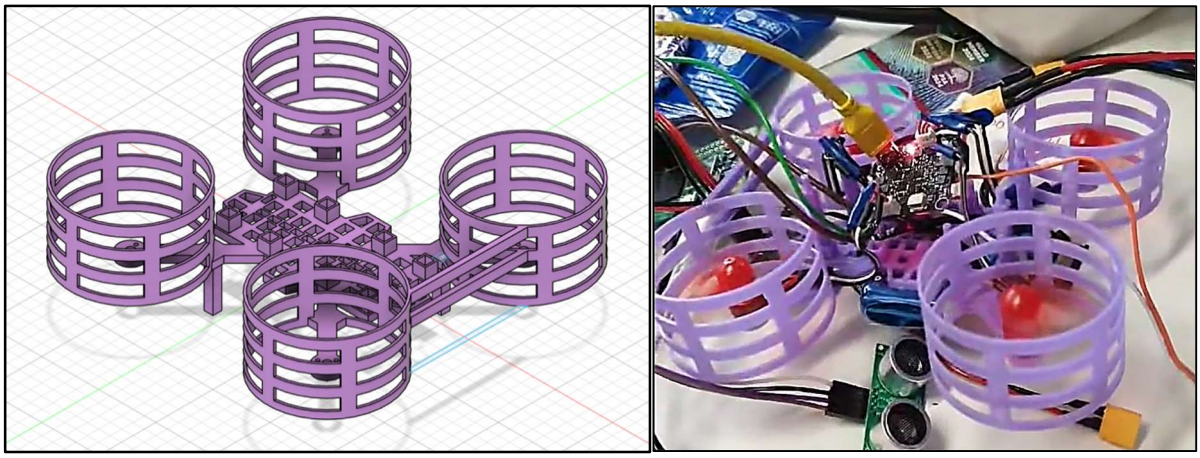

Figure 3. Drone Frame with spinning propellors

5.3 Emergency Stop (E-stop) Procedures

In case of a malfunction or loss of control, activate the E-stop immediately using the designated button on the controller or ground station. This will cut power to the motors, preventing further movement and minimising potential damage or injury.

5.4 Operating Environment

Only operate the drone in open, obstacle-free indoor environments. Avoid flying near people, fragile objects, or valuable equipment. Always maintain a clear line of sight with the drone to ensure safe operation.

5.5 Sensor and Component Safety

Regularly inspect and maintain sensors and electronic components to prevent malfunction during flight. Any damaged components should be replaced immediately to ensure the drone remains safe and operational.

Figure 4. Ultrasonic sensor to be cleaned via compressed air

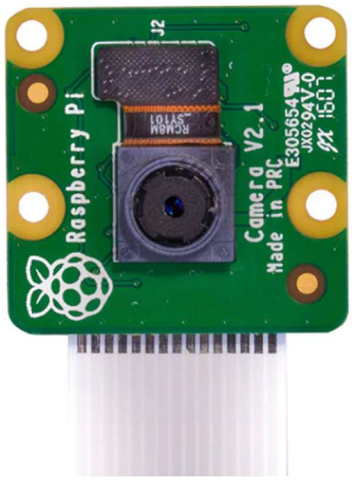

Figure 5. Picam 2.0 to be cleaned by microfibre cloth