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Faculty of Engineering, Computing and Mathematics Assignment, Report & Laboratory Coversheet for Individual & Group Assignment

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Piracy, copying, forgery, lifting, expropriation, appropriation

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Revision History

Date	Version	Description	Author
18/10/2025	A	.Made start on setting up document and writing RPI operation guide	Martino, D.
20/10/2025	A	Expanded Battery Maintenance, Drone Components, Component Inspection, Lithium Ion Battery	Prasetya, R.
20/10/2025	A	Edited and added more to safety and maintenance	Martino.D

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1. Introduction

This document highlights the intended user operations of the Autonomous 3D Mapping drone. It is recommended that the user uses this document as a guide to operate the drone.

1.1 Purpose of Manual

This manual is designed to give the reader a comprehensive overview how to operate, maintain, and resolve issues related our drone, in a safe manner.

1.2 Target Audience

For operation of this drone and ergo use of this manual, basic technical knowledge of computers and electrical equipment is required.

2. System Overview

2.1 Drone Components

The drone must include:

- 1x Frame
- 4x Propeller guards
- 4x Motors
- 4x Motor ESCs, 1 for each motor
- 1x Battery
- 1x Flight Controller PCB
- 1x Ranger Deck sensor PCB
- 1x Flow Sensor
- 1x Z-Ranger sensor
- 1x Raspberry Pi Zero
- 1x Raspberry Pi camera

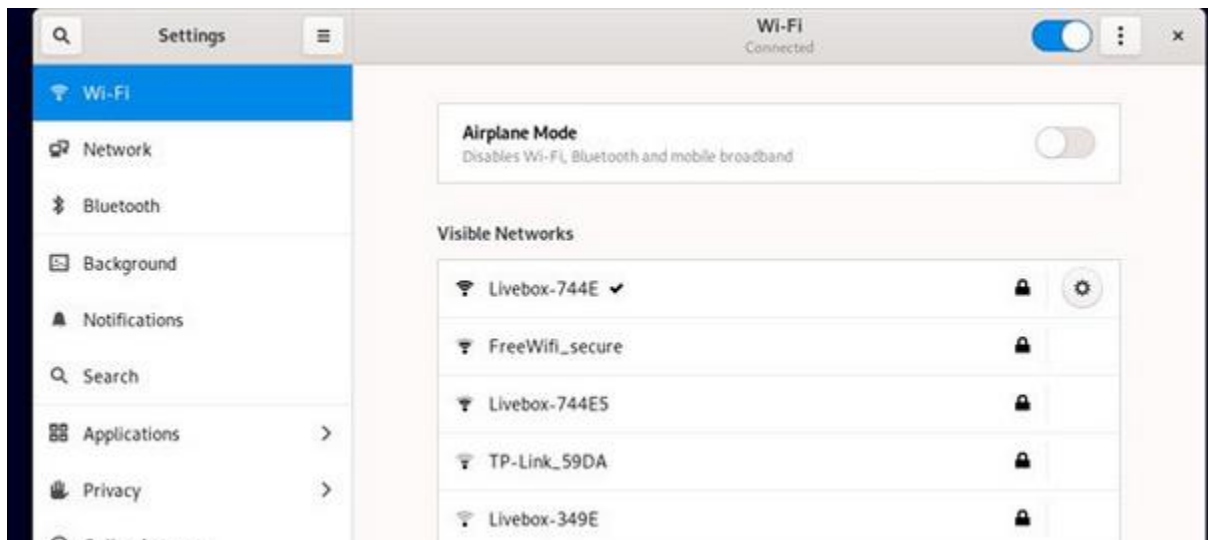


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3. Operating Instructions

3.1 Raspberry Pi Network Setup

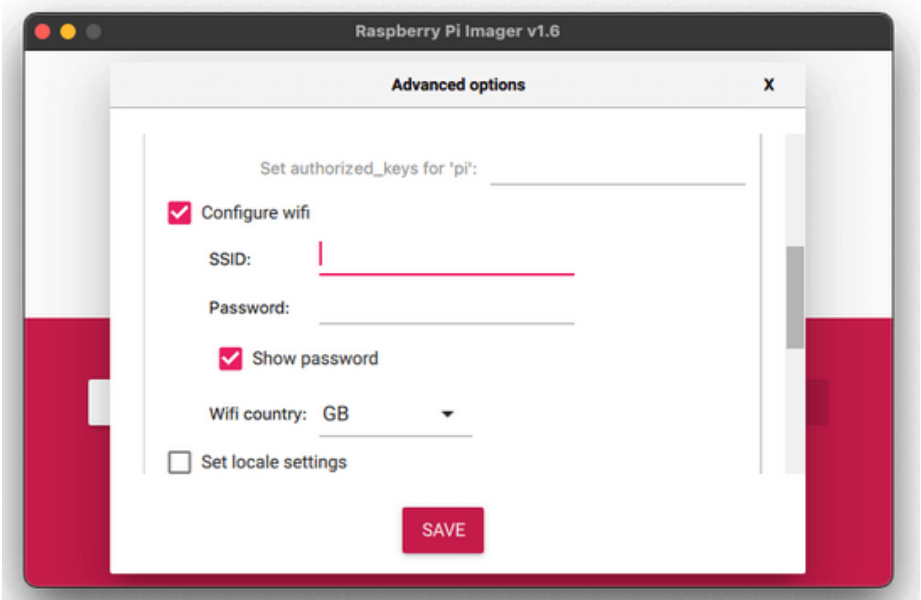
For the drone to function it is critical that the Ground station, Raspberry Pi, and ESP are connected to the same access point. For ease of setup and use, it is recommended that the nominated AP is a mobile hotspot.



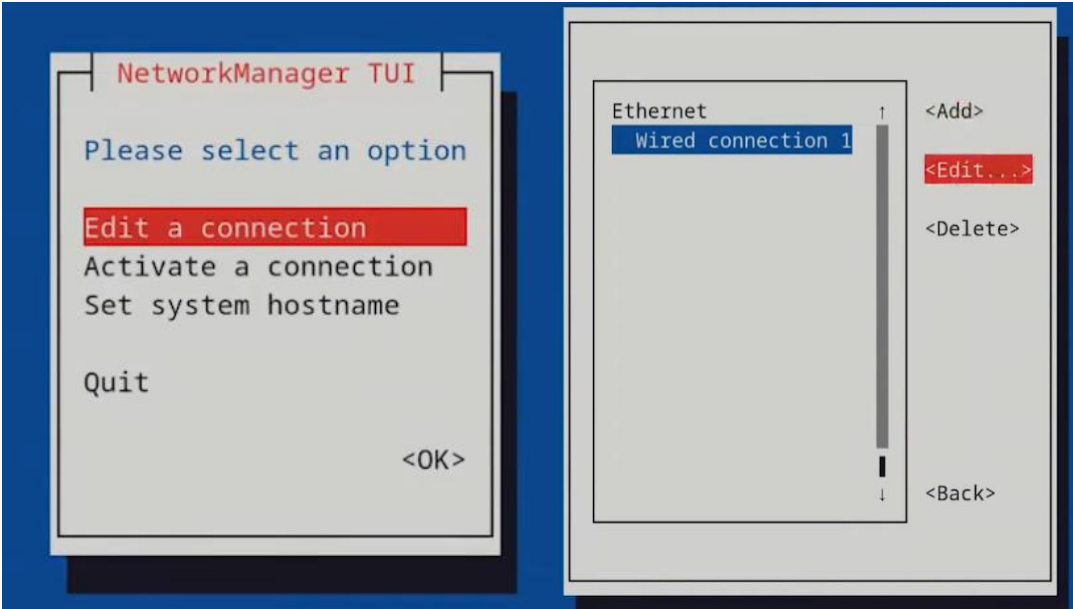
On the ground station connect to the nominated AP and verify internet access is established as seen in the figure above.

For the RPI network setup, caution needs to be taken when flashing the OS the RPI. In the advanced option section of the RPI flashing tool, configure input the details for the nominated AP, which included the SSID and password for the network. When the RPI is powered on for the first time this is the network it will automatically connect to.

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The network can be reconfigured by running “nmtui” in terminal.



In the GUI interface, the user can navigate to the current connections on the network, where they can be edited or new ones added.

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Edit Connection

Profile name: moto g(6) 4221
Device: A4:4E:31:98:94:C4 (wlp3s0)

WI-FI <Hide>

SSID: moto g(6) 4221
Mode: <Client>

Security: <WPA & WPA2 Personal>
Password: *****
☐ Show password

BSSID:
Cloned MAC address:
MTU: (default)

IPv4 CONFIGURATION <Automatic> <Show>
IPv6 CONFIGURATION <Automatic> <Show>

☒ Automatically connect
☒ Available to all users

If a new network is added, the required details are shown in the figure above, and show match the nominated AP. The network can also be configured to connect automatically.

3.2 Pre-flight checks

IMPORTANT!

The exploration area must be carefully controlled. Ensure no personnel are in the exploration area and that all entrances are sealed.

The drone will only be capable of 3 minutes of flight time, so do not attempt to map a large area

Ensure the following checks have been complete before flying:

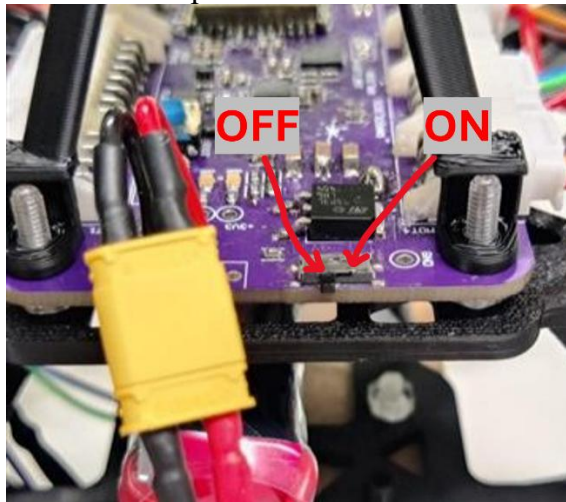
Item	Checked?
Battery is fully charged	
Propellers can spin freely with a light push	
Propeller guards are secured tightly	
FC, MRD, OFD are secured tightly	
All connectors are in correct position	
Battery is securely held	

Do **NOT** attempt to fly the drone without the MRD and OFD attached, as this will cause uncontrolled behavior.

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3.3 Connecting to the drone

1. Plug in the battery and switch on the power



2. The following indicator LED and sound sequence should play
 - Red and 3 beeps in ascending tone
 - Green solid
 - Red solid
 - Blue solid
 - Fast flashing Green and 2 beeps from each motor (low tone then high tone)
 - This sounds indicates the ESCs have successfully armed.
 - Slow blinking blue (will stay on)

Troubleshooting

If the Red LED turns on but the blue light still blinks, then the battery is low:

→ Action: Measure battery with a multimeter or charge.

If the Red LED turns on and there is no blinking blue light, then the IMU failed to initialize:

→ Action: Power cycle drone

If the ESCs do not arm successfully, it is likely to be a firmware or hardware issue:

→ Action: Try to reflash firmware (see section 4.4). If this still does not work, submit an issue to the GitHub page.

3. Run the *SystemInit.bash* file. The green LED should blink and a terminal window should open.
4. Press *t* on the keyboard to take off.

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3.4 Flight

Once flying, the drone will begin autonomously exploring its environment. No user intervention should be necessary, however operators can also manually control the drone if desired.

The controls are described in Table 1.

Table 1: Manual drone controls

Key	Motion	Type
Take off / Landing		
t	Take-off	Single
b	Land	Single
Horizontal Motion		
i	Forwards	Continuous
j	Yaw Left	Continuous
l	Yaw Right	Continuous
,	Backwards	Continuous
k	Stop x-y motion	Stop
Height		
r	Rise	Continuous
v	Descend	Continuous
f	Stop rise/descend	Stop

The types are as follows:

- Single: The key is pressed once, and a procedure is carried out and then finished.
- Continuous: The key is pressed once, and motion will begin and be sustained without the need to hold the key down.
- Stop: The key is pressed once, and any continuous motion will stop.

Once the environment has been mapped entirely, the drone will automatically land.

3.5 Exporting data

After the drone lands, two OctoMap maps will automatically begin exporting into the same directory from where *SystemInit.bash* was run from.

4. Maintenance Procedures

4.1 Charging

If the red LED near the ESP32 is on while flying, this means the battery is low. The drone has safety features that prevent the battery from being discharged below 6.3V during flight. The battery can be charged while mounted to the drone, however the yellow XT30 connector should be unplugged. When charging the battery, use the included battery charger by plugging in the white connector into its respective port. Ensure the keys of the connector align with the sockets on the charging port. The charger has two charging ports so that two batteries can be safely charged simultaneously. The charger light states are described below

Red	Green	Port State
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Solid	Off	No battery detected
Solid	Flashing	Charging
Off	Solid	Charge complete

Examples are shown in Figure 1. Any batteries not in use should be stored safely in a strong flame-retardant bag.

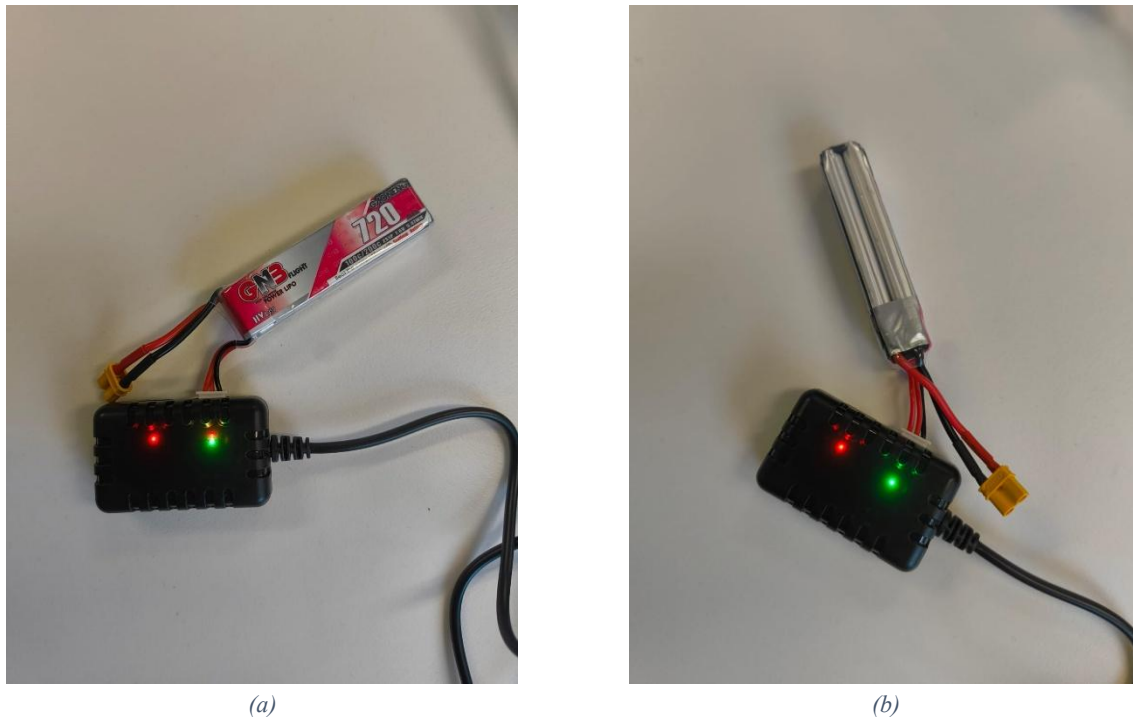


Figure 1: (a) A solid red light and a flashing green light indicate a battery is charging (b) A solid green light indicates the battery is fully charged to 8.35V. A solid red light indicates no battery was detected,

4.2 Component Inspection

Inspection of every component should take place before and after flight. Key areas to inspect include the ESCs and motors for overheating damage, the camera lens to make sure it is not dirty, and the propeller guards to ensure they have not sustained any mechanical damage.

4.3 Software

The GitHub should be frequently pulled, and the README read thoroughly to make sure no compatibility issues arise.

4.4 Flashing new firmware

Firmware updates may be available from the GitHub page. The following is required to flash new firmware:

1. Install VS Code and install the ESP-IDF extension.
2. Clone the GitHub repository

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3. Open the firmware folder in ESP-IDF
4. Set the target as ESP32-S3 and the flash method to UART
5. Press the *build* button. This will take some time.
6. Connect to the drone via the micro-USB port using a USB data cable.
7. Select the ESP32's COM port in ESP-IDF. If it does not show up, download and install the CP210x USB-to-UART driver from <https://www.silabs.com/software-and-tools/usb-to-uart-bridge-vcv-drivers>
8. Press the *flash* button. The flashing process should begin. Once finished, a message will be printed to the terminal notifying that the flash is complete.

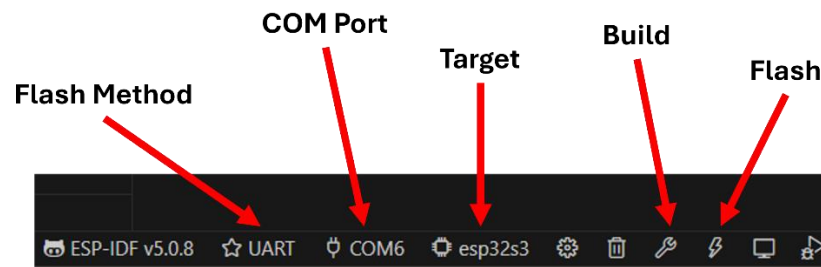


Figure 2: ESP-IDF Controls.

5. Safety Considerations

5.1 Emergency procedures

The drone will automatically land in the event of a communication loss of 5 seconds, or low battery. To perform an emergency landing, press *ctrl+c* in the terminal, and this will engage the communication loss event and initiate the landing. If the drone has landed, but is still spinning erratically, keep a safe distance – a tumble detector will trigger and should turn off the power to the motors.

5.2 Lithium Ion Battery

The lithium-ion batteries should be carried in a safety bag during charging and as a storage bag. Always use the designated charger with them and never leave them unattended while charging. Perform routine inspections of the battery, checking for cuts or breaks, and replace the battery immediately if any are noticed.

5.3 Propeller Safety

Ensure that the propeller guards are attached correctly before flight and do not attempt to move the drone while the propellers are spinning.

5.4 Operating Environment

The drone should only be operated indoors in the absence of other people. The operator should be behind a transparent window when operating, and do not operate the drone without line of sight. The drone is designed to only operate indoors, and thus it is not recommended to operate it in outdoor conditions.