Task 3C: Drone kit assembly

blogpost-style , task-3

Smit 1 January 16, 2023, 7:45am

@sd_22_s2

Task 3C : Drone kit assembly and testing

To make it simple, this task is further divided into 3 sections

- **Flight controller preparation**
- **Onboard computer (Banana Pi) preparation**
- **Full drone assembly and testing**

Proceed in the given order only

Flight controller preparation

fc_prep.mp4

Google Drive file.

- A flight controller is a small embedded computer used to fly and control the drone.The flight controller used in this kit is GepRC GEP 12A F4. Identify the flight controller in the kit by following the figure given below.

Figure : Flight controller packet

- First step is to test the flight controller. Use the micro USB-B to USB-A cable given in the kit to connect flight controller to the laptop/pc. The software running on this flight controller is a widely used open source firmware named **Betaflight**. The flight controller comes pre-loaded with a version of Betaflight. But we will use the latest version of Betaflight. For this we need Betaflight Configurator on our laptop/pc to configure it. Download betaflight configurator **from here**. Click on assets at the bottom of the release notes. You can find the installation file for your OS. For linux, you can use amd64.deb package. You can download release 10.8.0 for linux from **here** and for windows from **here**. For installing on linux, go to the downloads directory and run command

```
sudo dpkg -i betaflight-configurator_10.8.0_amd64.deb
```

For windows, just open the installation file and follow usual installation steps.

- Connect the flight controller to PC and open Betaflight configurator from the start menu. After connecting the flight controller, you can see some lights blinking on the flight controller. This means the flight controller is working. The betaflight configurator window should look something like this and the device should be detected by betaflight configurator as `/dev/tty/ACM0`. Click on connect and the configurator should be able to connect to the flight controller.

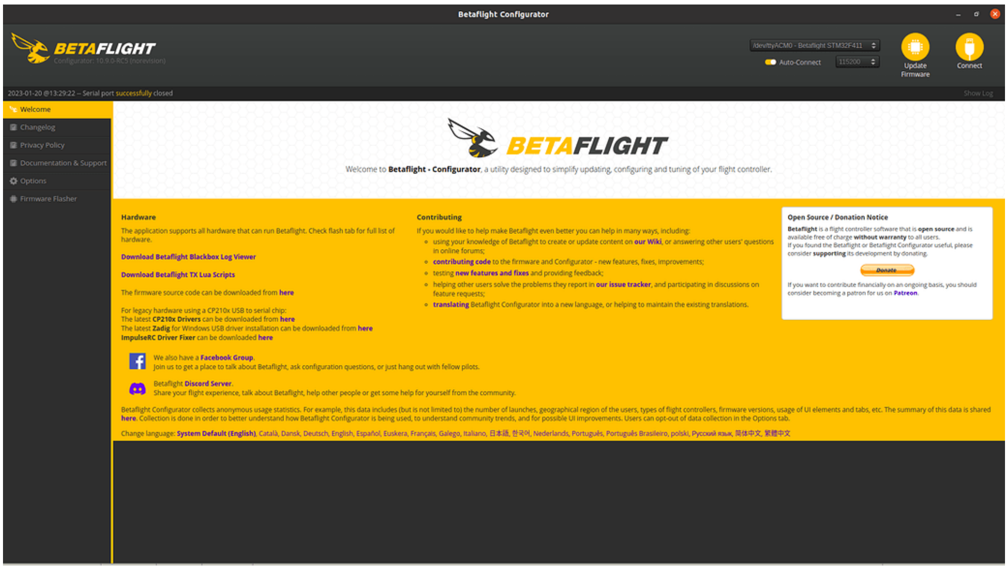


Figure : Betaflight Configurator

> WARNING: Read the following steps very carefully and while updating the firmware, make sure you follow instructions strictly. Small mistakes in these steps may corrupt the flight controller firmware.

- Now click on disconnect and click on Update Firmware.
- Click on Auto Detect to detect the model of flight controller automatically. It should detect GEPRCF411.
- Select the firmware version 4.3.2 29-Nov-2022-08:00. Then click on Load Firmware [ONLINE], once this is loaded, you will see a new button unlocked - Flash Firmware. DO NOT change any other settings or any other buttons while flashing the firmware.
- Click on Flash Firmware. Once the flashing starts, you will see a progress bar. DO NOT touch the flight controller while the flashing is in progress and completes. After the flashing is successful, the flight controller will restart and connect

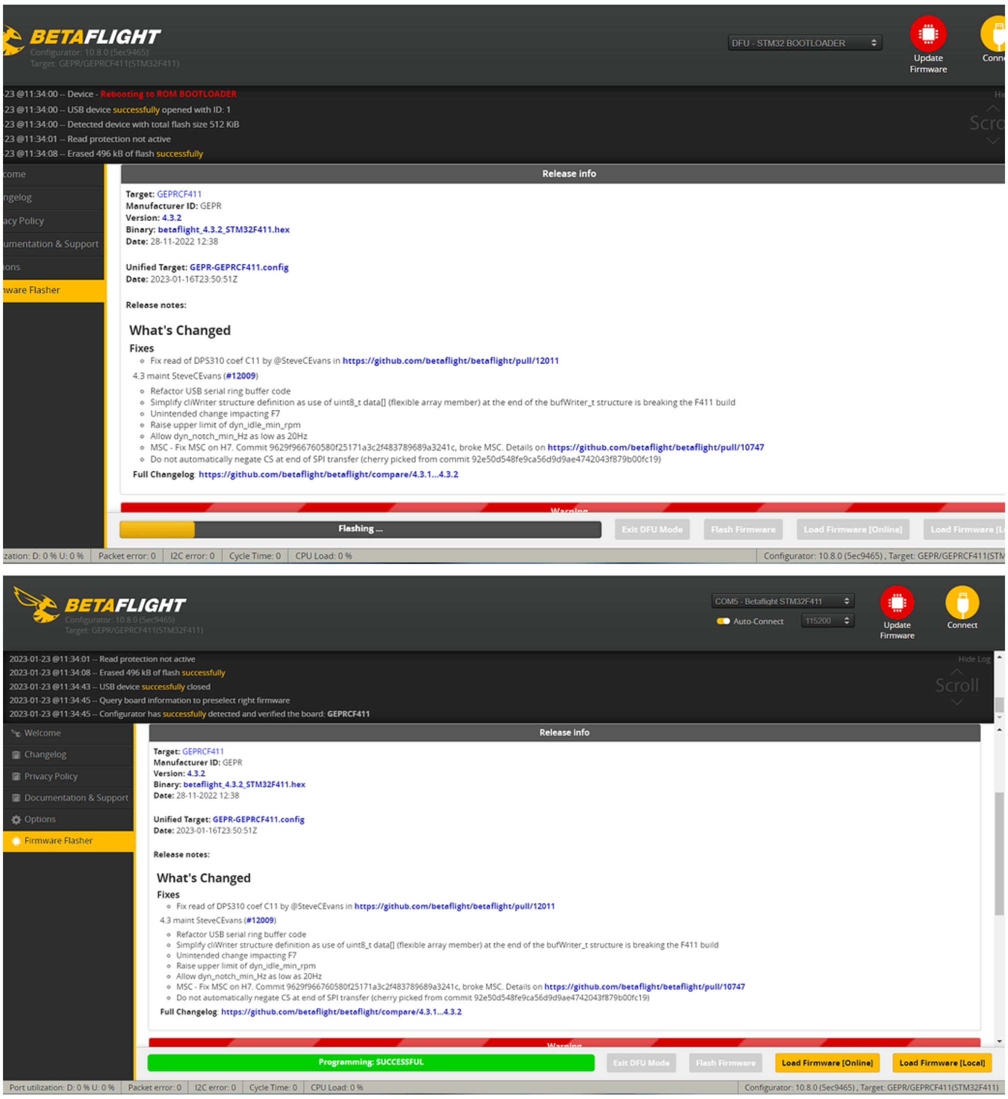


Figure : Flashing Firmware

> Note : If you are facing problems flashing new firmware, then switch to windows and try the same procedure.

- After flashing of firmware is successful, click on connect. You should see the following screen of setup. A pop up might appear saying

```
Notice
There are custom defaults for this board available. Normally, a boa
```

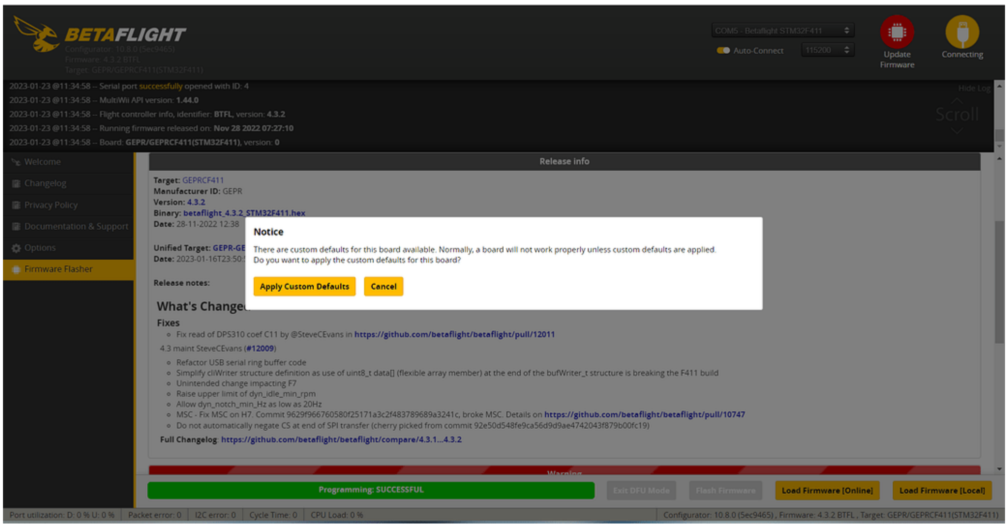


Figure : Pop Up window

Click on `Apply Custom Defaults`. DO NOT click on cancel.
After this step, a warning might appear saying the Accelerometer is not calibrated. Click on close and proceed further.

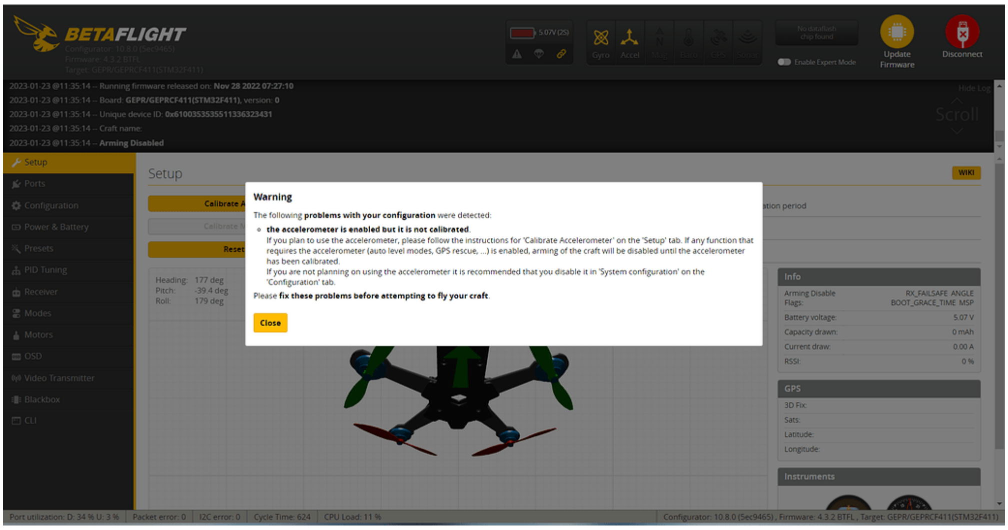


Figure : Warning

- Next step is to calibrate the accelerometer, for this, you need a perfectly flat and leveled surface.

> Note: Making errors in this step will lead to improper behavior of drone while flying. The better you level the accelerometer in this step the easier for you to tune the PID controller in the next task.

- Arrange a perfectly leveled surface which is parallel to the earth's surface. You can use a spirit level tool **like this** if it is available in your college lab. Else, you can try judging a perfectly leveled surface and keep the flight controller stable and leveled on the surface and then click on calibrate accelerometer. Make sure you orient the flight controller as shown in the image and **NOT UPSIDE DOWN.**

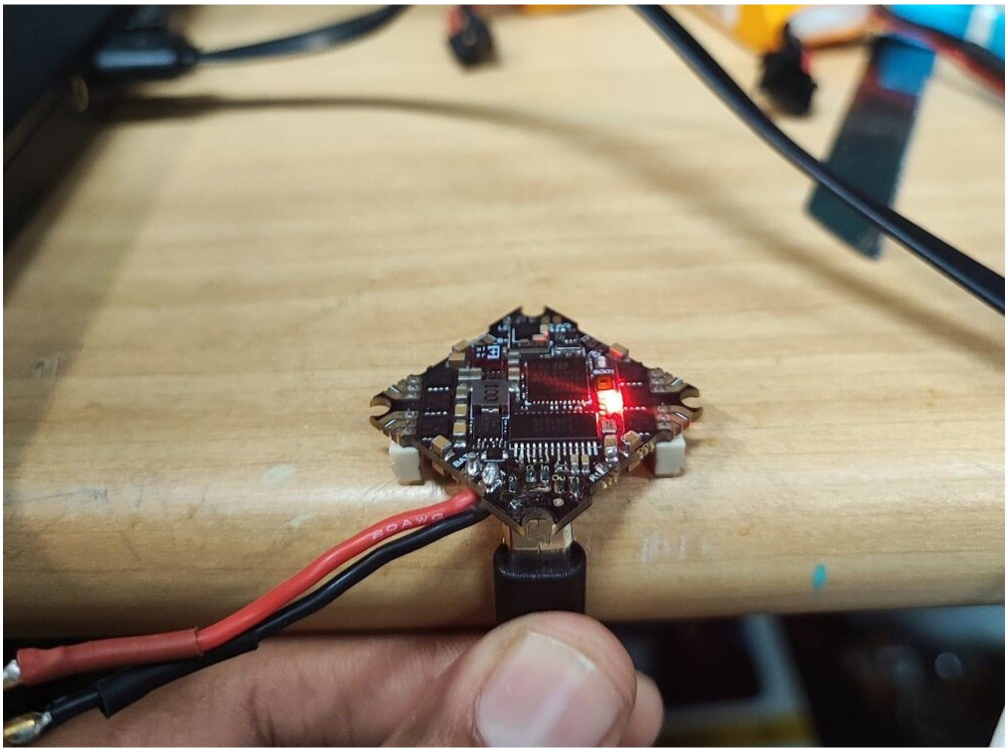


Figure : Levelling flight controller exactly flat and parallel to earth

If you are satisfied with the factory calibration and can see that the drone in the betaflight configurator is leveled when you keep the drone on a flat surface then you can skip the calibration

- Now go to the Ports tab on the left side, it will open a screen shown like this

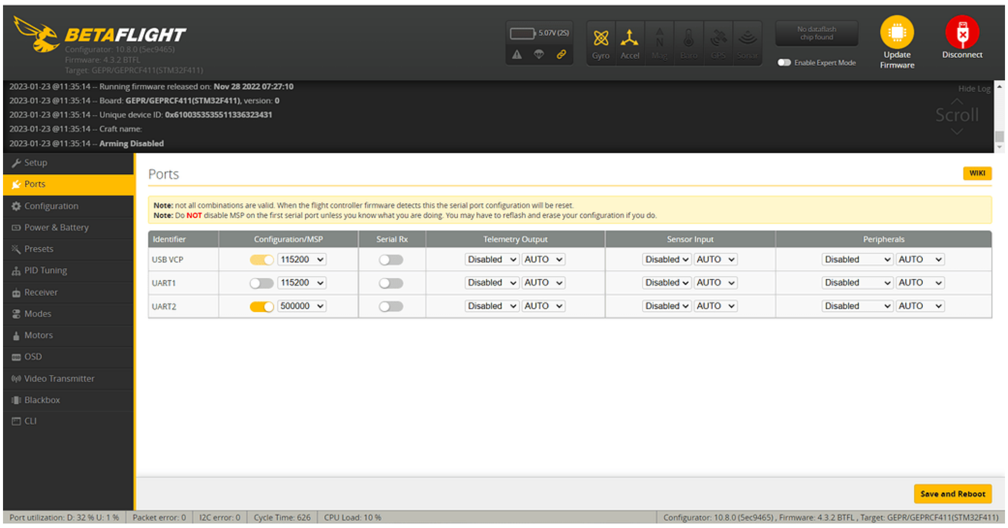
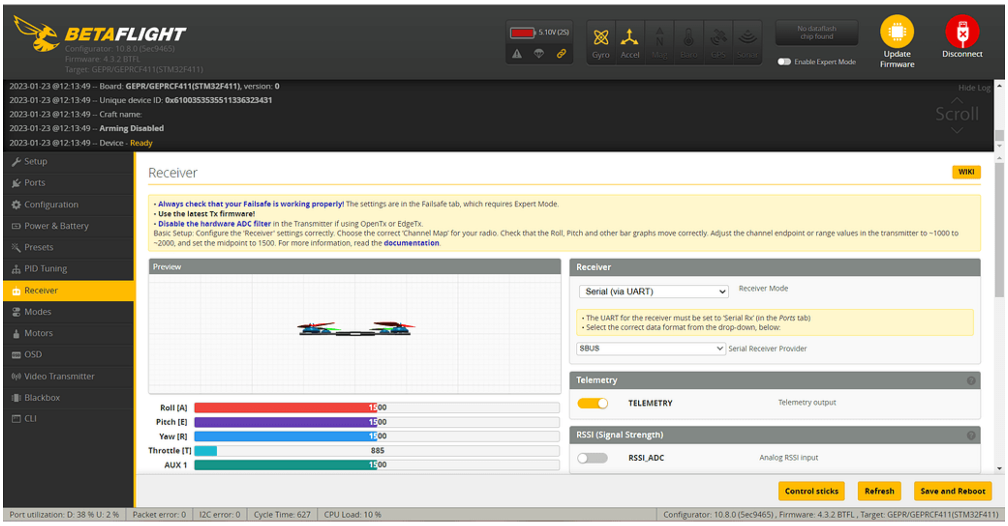


Figure : MSP setting

Turn on the **MSP** switch in **UART 2** and select the baud rate to **500000** . Click on save and reboot, if you do not click on save then this setting will not take effect.

- Go to receiver's section on the left side. On the window, under the Receiver section, there is a dropdown. Change to MSP. Under the same option, turn on the TELEMETRY option. Make sure it looks like the image. Click on Save and Reboot. After reboot, verify the settings are configured and saved.



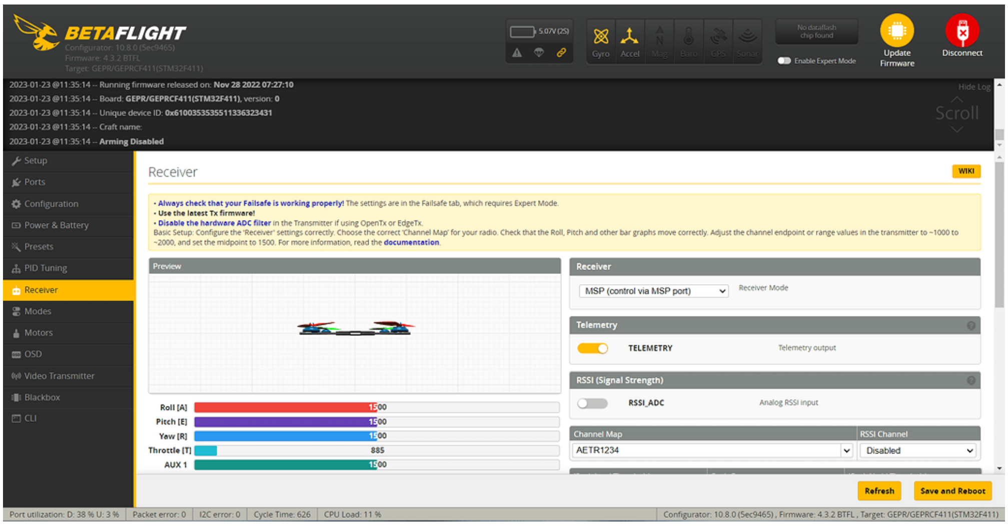


Figure : Receiver settings

- Now go to Modes on the left side, you will see a window like the following image

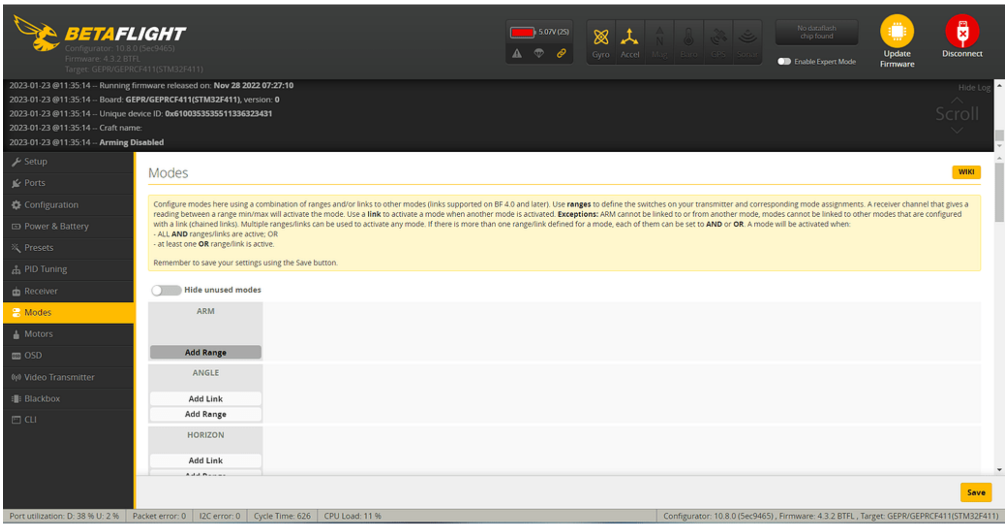


Figure : Modes

Add a range for ARM mode, select the channel as AUX1. Drag the yellow line from 1700 - 2000

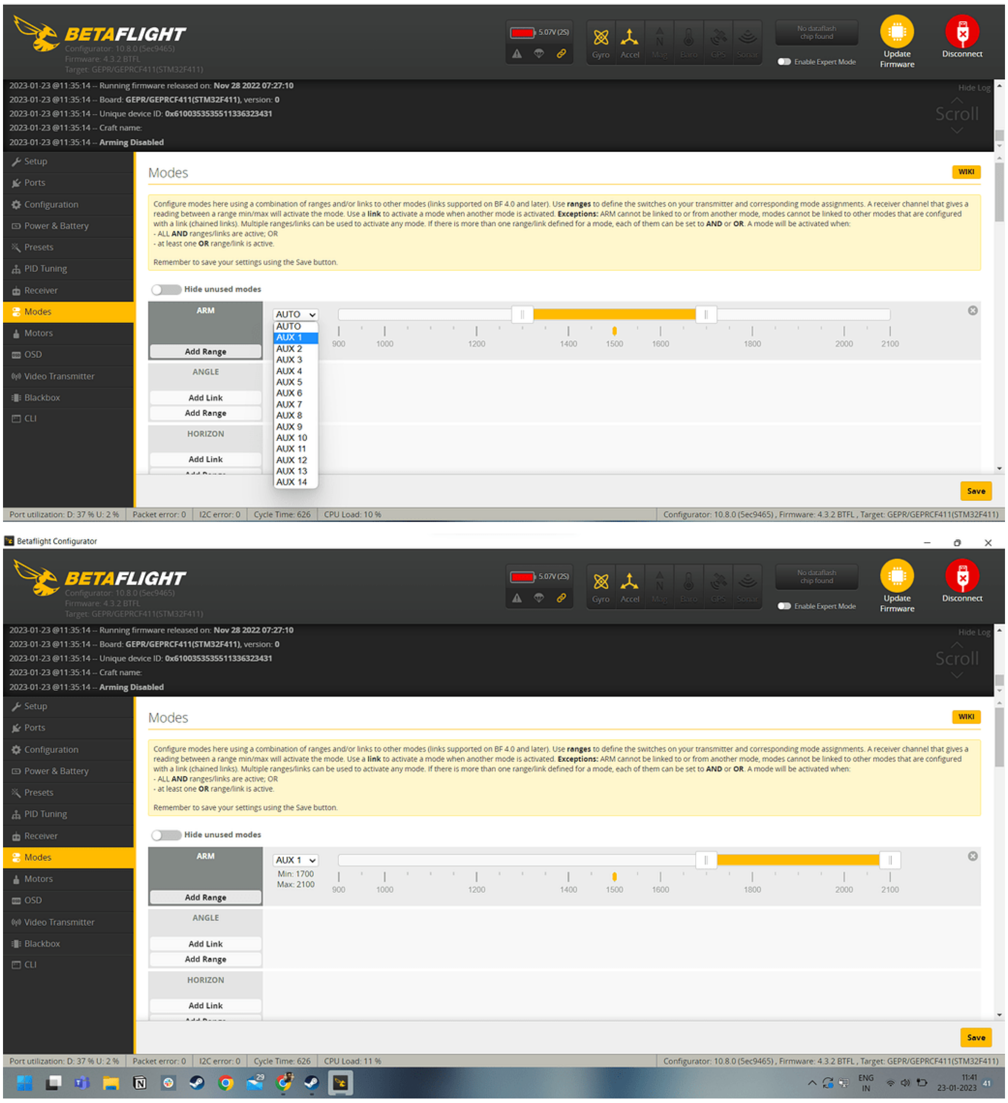


Figure : Arm mode settings

Add a range for ANGLE mode, select the channel as AUX2. Drag the yellow line to cover the entire range.

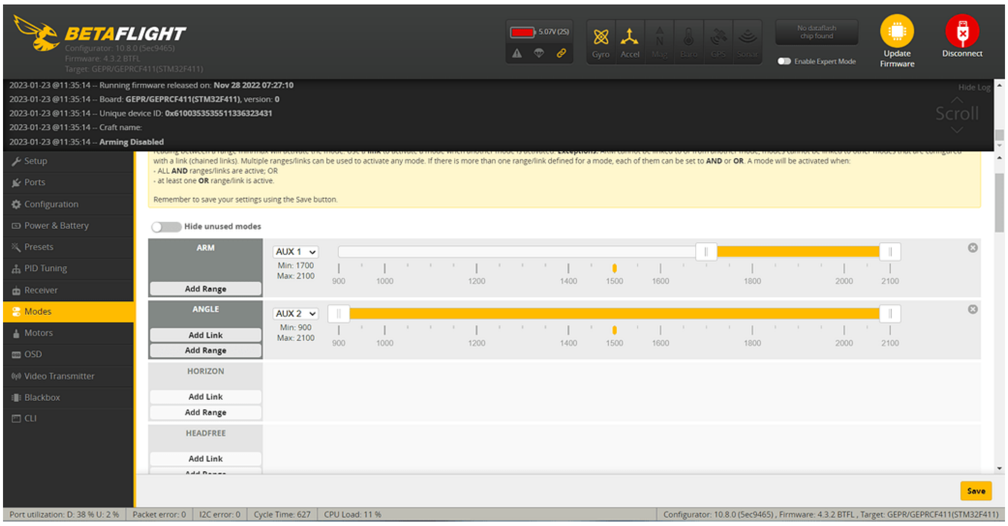
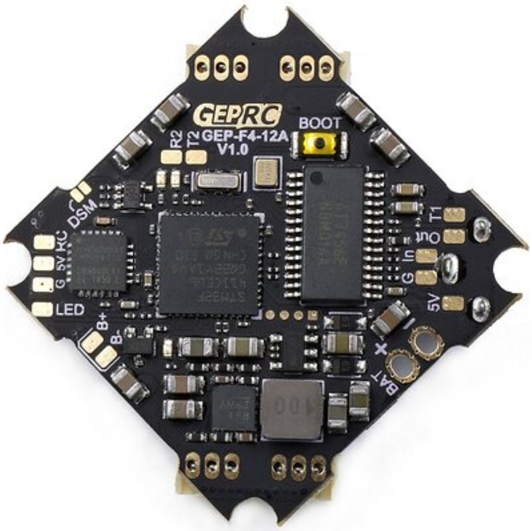


Figure : Angle mode settings

Click on SAVE button. Restart the flight controller (by unplugging and plugging in) and verify the modes section and check if the settings are saved.

> Note: The above step is crucial and is mandatory for the drone to fly as required. If this step has errors then drone can crash immediately. Check this setting multiple times before proceeding further.

- Next step is to connect the battery connector to the flight controller. This step has to be executed with full attention and with a lot of care. Find a red & black wire with a yellow connector. Connect the red wire to + pad and black wire to - pad as shown in the picture.



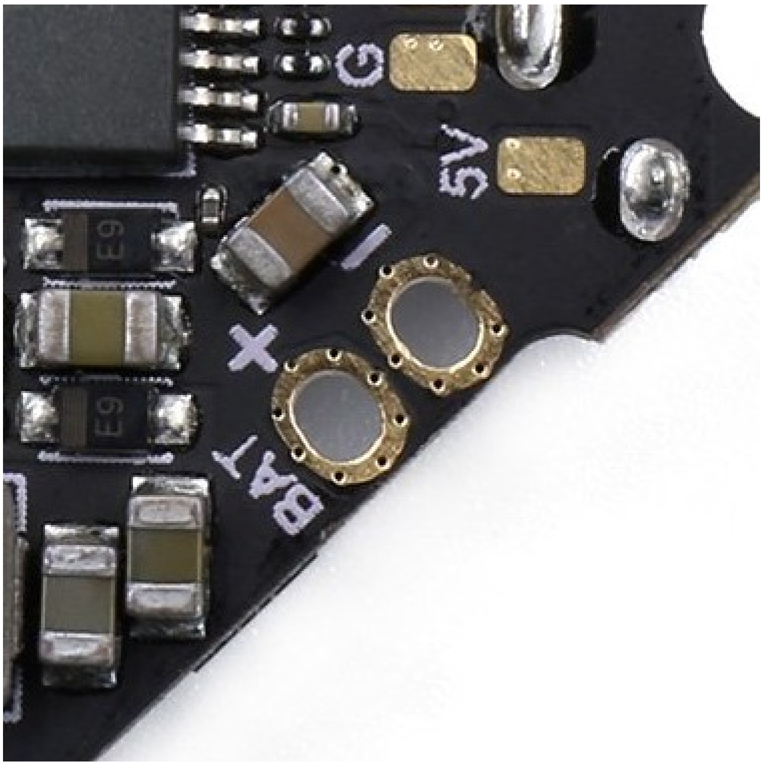


Figure : Flight controller battery terminals

Before connecting the wire to battery, check the connection using a multi-meter and verify that there is no connection between the + and - terminal and once you are confirmed then you can check by plugging in the battery. Follow this image for a good connection.

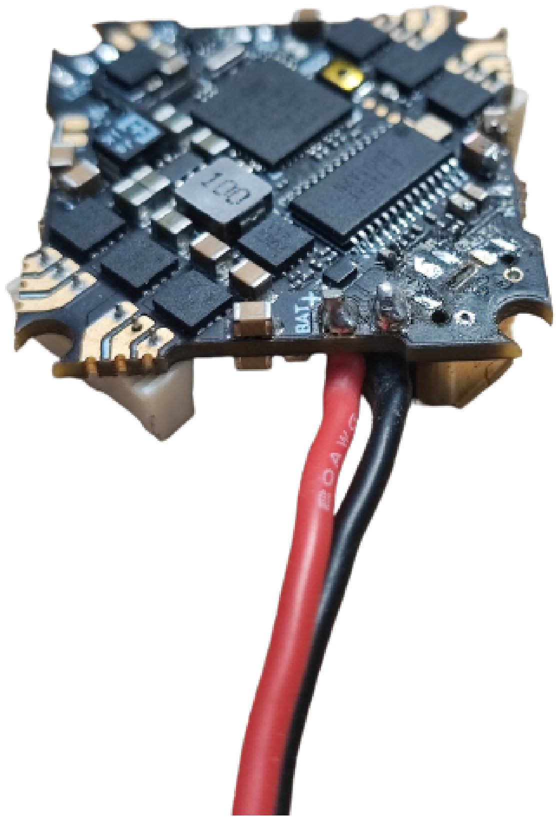


Figure : Power wires solder joint

- Go to configuration tab on the left plane. Scroll down and find Airmode setting. Disable the Airmode setting and click on Save and Reboot

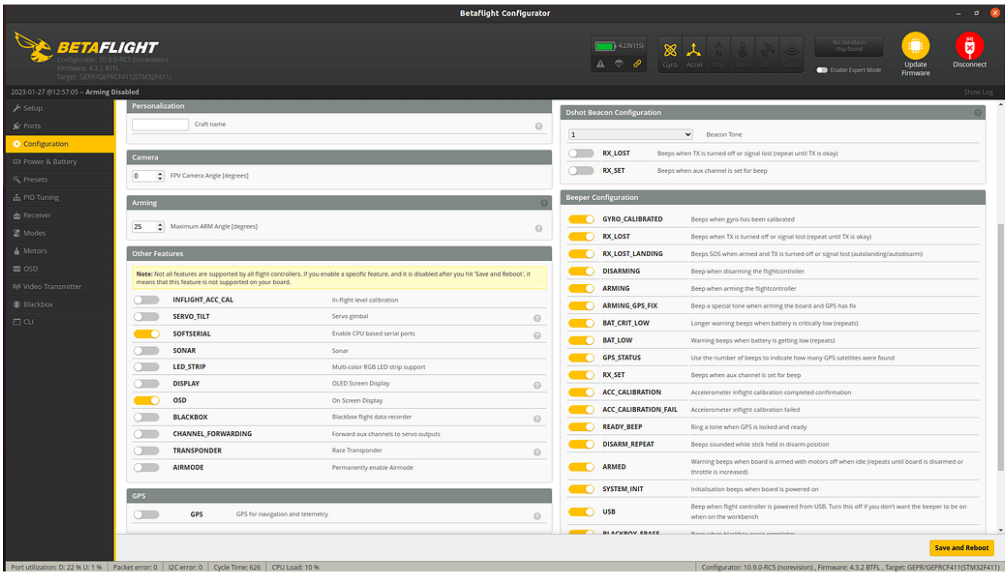


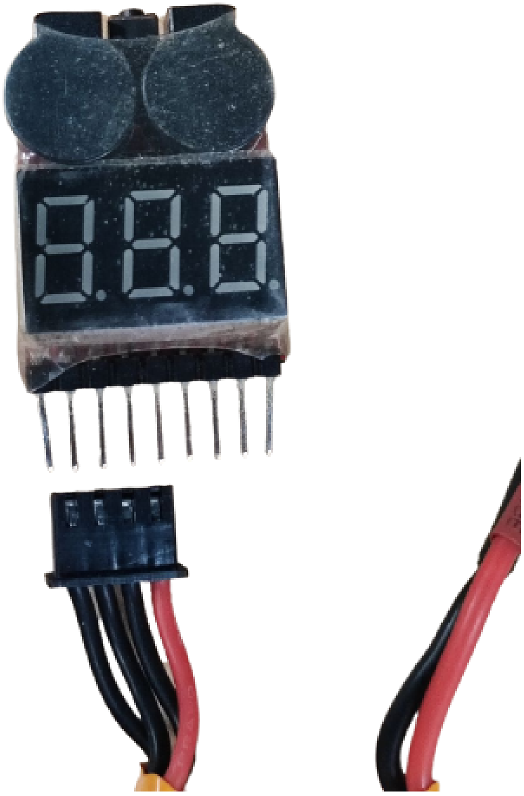
Figure : Airmode disable setting

Battery checking and charging

> WARNING : Lithium batteries are inherently dangerous and can cause instant fire or explosion if mishandled or used violating the standard operating procedures. Read all the instructions carefully and always handle the batteries with extra care. It takes one small mistake / negligence to cause an accident.

- There are 3 lithium polymer 3 cell (3S) 350mAh batteries provided in the kit. A battery cell checker also is provided (looks like the image given below). The first task is to check the cell voltages of 3 cells in each battery. Connect the cell checker to the balance plug of the battery as shown in the figure below and check the cell voltages of each battery.

Figure : Cell checker




12.5
350mAh
MINISTAR
3s 70C
11.1V

Figure : Cell cheker connection

Storage voltage : 3.8V per cell (While not using the battery for more than 1 day)
Full charge voltage : 4.2V per cell
Empty charge voltage : 3.3V per cell (While using the batteries in the theme, we shall not go below 3.5V per cell)

- The above voltages should be strictly followed. Since there is no active indicator on the battery, you need to proactively check the cell voltages while using the battery and not let it go below 3.5V each. If there is a negligence in this operating procedure, a cell can go below its rated voltage and can be a potential cause of fire. So use the battery while maintaining the rated voltages.
- To charge a battery, use the lithium battery charger provided in the kit. Insert the balance connector of battery inside the given charger and plug the charger to AC wall plug. If the battery is charging, the red lights will glow. Once the battery is fully charged, lights will turn green.

Figure : Battery charger connector

> WARNING: DO NOT leave the battery on charge in unattended. Although the charger is a balance charger and will stop charging the battery once fully charged, but the charger should not be kept on even after the battery is fully charged. Remove the battery from the charger after turning the charger off, or it may lead to draining of the battery cells

- Use a charged battery to connect to the flight controller and test if the lights turn on after plugging in into the battery.

Figure : Battery connection with flight controller

> Note: If you damage the flight controller at this step due to improper connection of battery wires or battery connectors, e-Yantra does not take any responsibility of the damage and you need to procure new hardware by your own to continue in the competition.

- Now connect the flight controller to the laptop/pc. Open betaflight configurator and click on connect. This time, you should be able to read the battery voltage on the top.

Motor testing

- Go to the motors tab on the left plane. Click on a toggle switch saying "I understand … " after reading all the warnings. You can test the motors individually by sliding the bars for motor 1,2,3,4. DO NOT slide the bars to high numbers, use very small magnitude to test the motor direction. Test all 4 motors individually and check if the direction of rotation matches the direction given in this diagram.

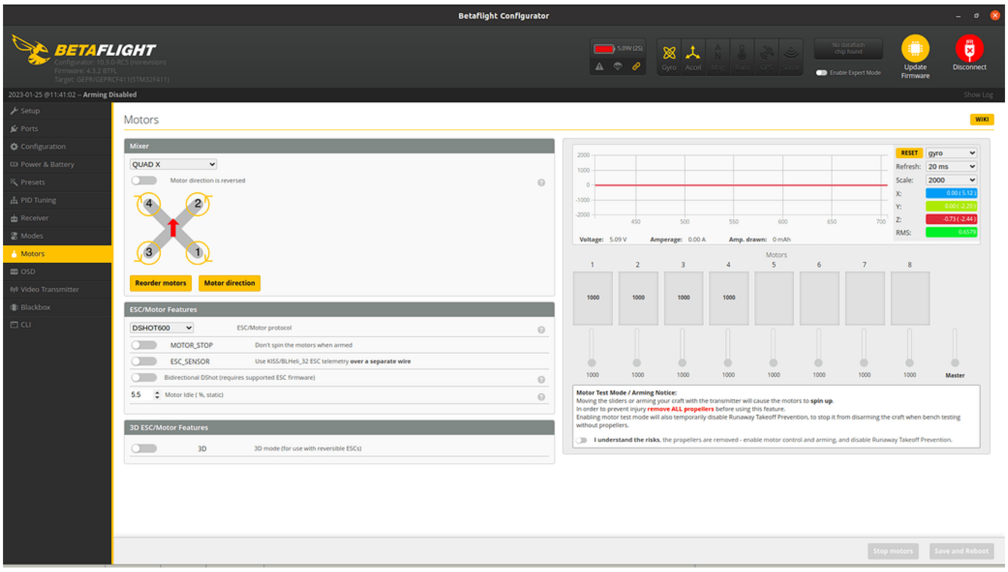
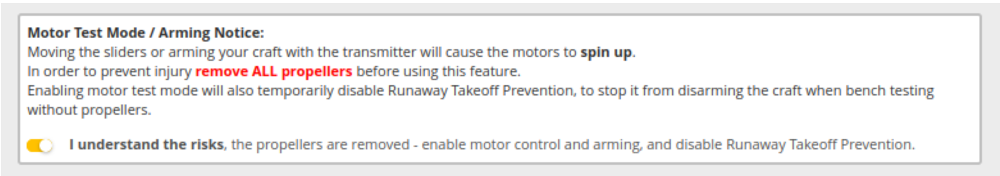


Figure : Motors Tab



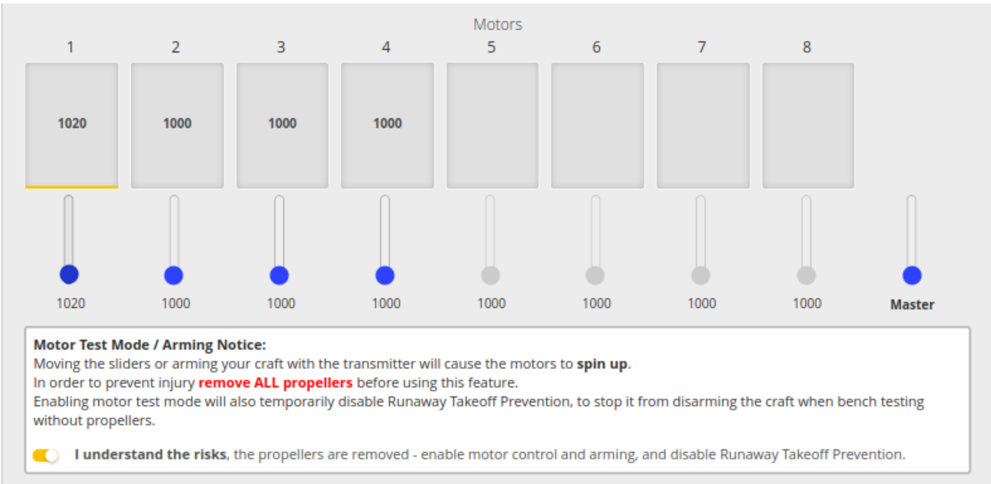


Figure : Motor testing

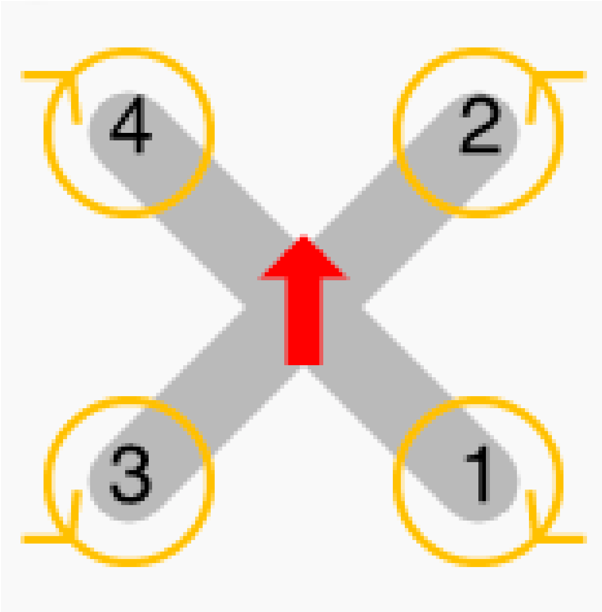


Figure : Motor directions

- If the motors' rotation direction does not match for one or more motors, then change the motor direction by clicking on Motor Direction, after reading the warnings, click on I understand the risks, and click on Wizard. Click on Start Motors, and then click on the motors what you want to reverse the directions. Make the changes (if required) such that all the motors rotate in the directions as per the directions in the above Figure.

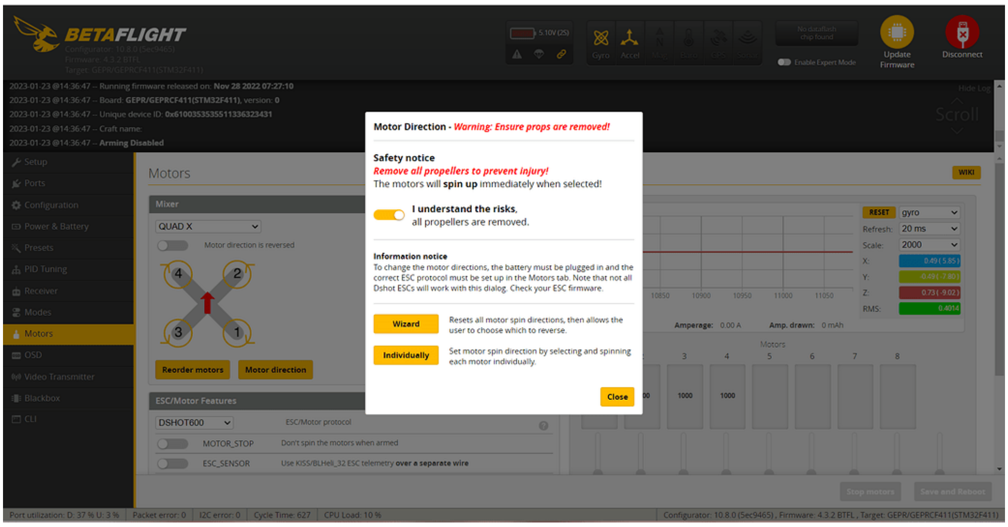


Figure : Motor direction wizard

Banana Pi preparation

- Banana Pi is the single board computer that is going to be used to interface the drone with ROS. It is an embedded computer but as good as a laptop/pc in terms of useability. It will have a Linux based operating system running on it and ROS installed and running like a normal laptop/computer.

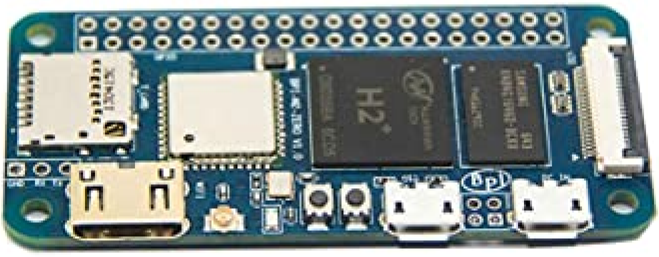
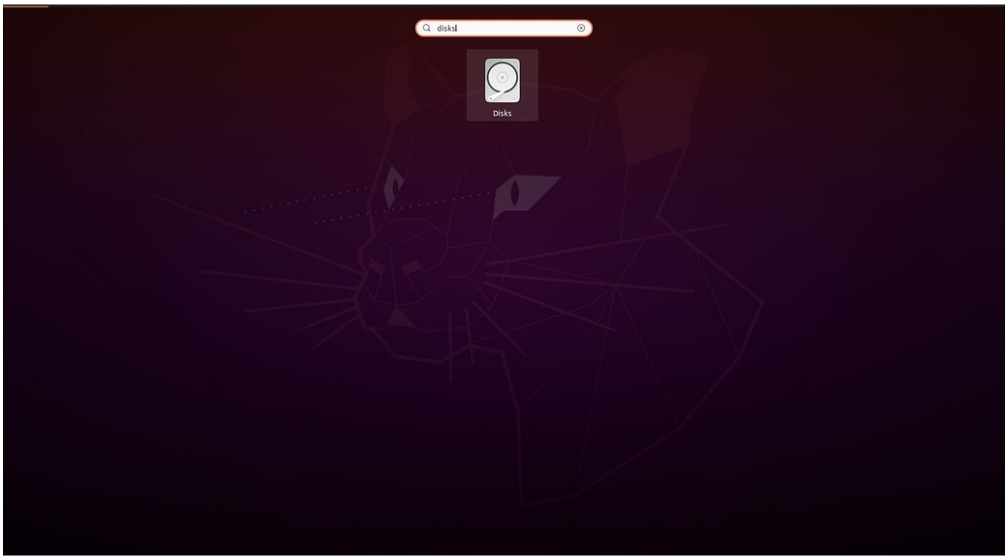


Figure : Banana Pi M2 zero

- First step is to prepare the SD card with the operating system and the software ready. Download **this** OS image. Once downloaded, unzip the .img file. You need to burn this image on the SD card given in the kit. Insert the SD card in your laptop/pc using any reader or adaptor as shown in the figure.

Figure : SD card readers

- Open disks in your laptop/pc from the start menu and identify the SD card. For example, the 32Gb disk is `/dev/sda` in the image shown below. Which means the SD card is `/dev/sda`.



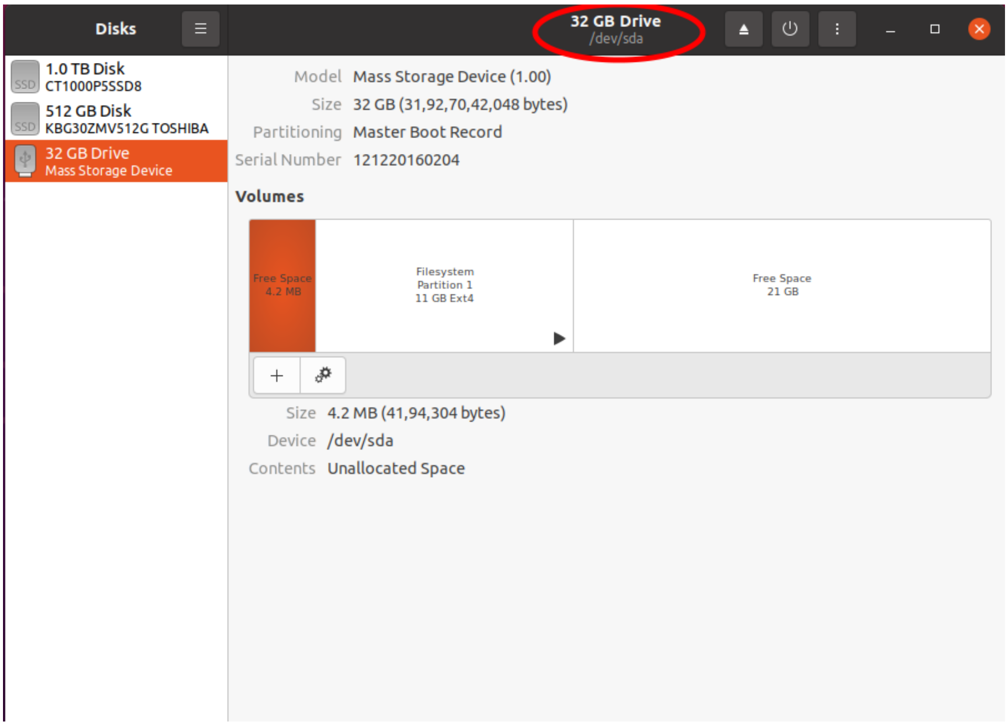


Figure : Disks

- To burn the downloaded image, use the following command

```
sudo dd if=~/Downloads/eyantra_drone.img of=<disk_name>  status=pro
```

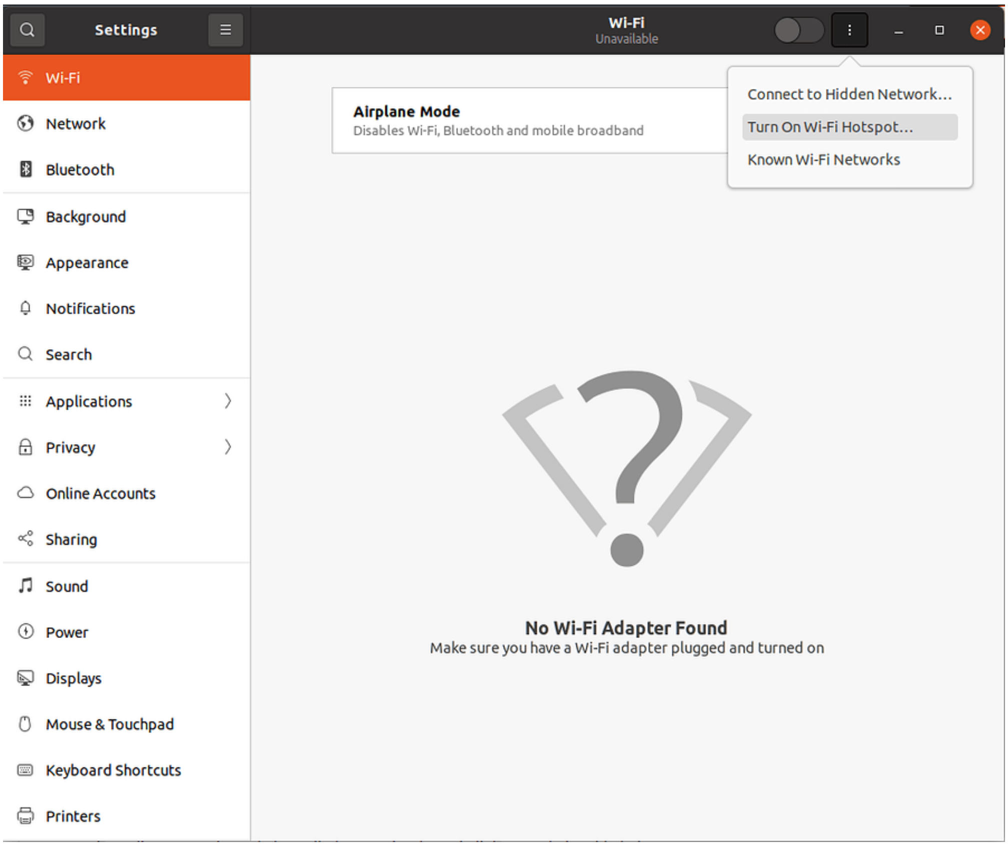
> Note: Identify the SD card disk carefully, putting wrong disk address might corrupt your other disks.
> eg. If your SD card disk is sdb then the command will be
> `sudo dd if=~/Downloads/eyantra_drone.img of=/dev/sdb status=progress`

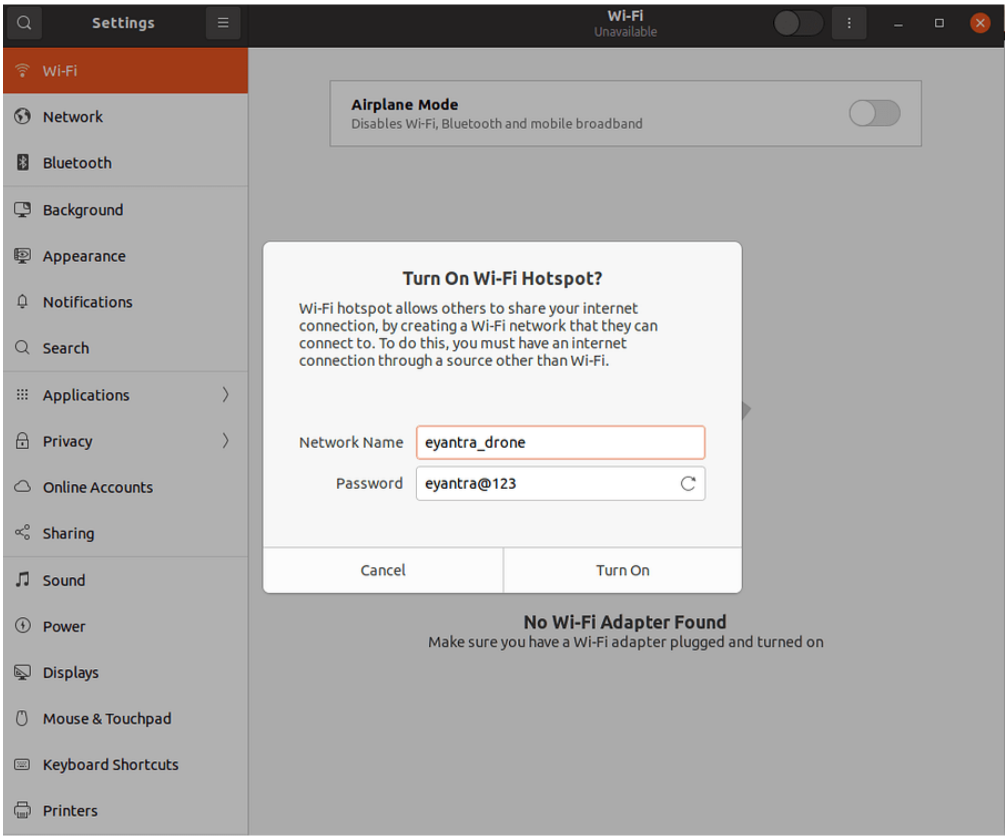
- Plug the prepared SD card in Banana Pi and plug the micro usb cable in the DC_IN in port of Banana Pi and other end in your laptop/pc. This should start the Banana Pi. If you have a display monitor, you can use the HDMI connector given in the kit to plug the HDMI cable to Banana Pi and display monitor and the micro usb OTG cable to connect a wired/wireless keyboard/mouse/both to Banana

Pi. This will create a working pc like setup and you can use it as a computer. Although, this should be done only for the initial setup and testing, later we will use SSH protocol to interface with Banana Pi computer via WiFi. If you don't have a HDMI based diaplay monitor, you can directly use SSH from this step onwards.

Figure : Banana Pi DC_IN

- Create a WiFi hotspot from your laptop/pc with the following settings
  SSID : eyantra_drone
  Password : eyantra@123


Settings
Wi-Fi
Unavailable
Wi-Fi
Network
Bluetooth
Background
Appearance
Notifications
Search
Applications
Privacy
Online Accounts
Sharing
Sound
Power
Displays
Mouse & Touchpad
Keyboard Shortcuts
Printers
Airplane Mode
Disables Wi-Fi, Bluetooth and mobile broadband
Connect to Hidden Network…
Turn On Wi-Fi Hotspot…
Known Wi-Fi Networks
No Wi-Fi Adapter Found
Make sure you have a Wi-Fi adapter plugged and turned on


Settings
Wi-Fi
Unavailable
Wi-Fi
Network
Bluetooth
Background
Appearance
Notifications
Search
Applications
Privacy
Online Accounts
Sharing
Sound
Power
Displays
Mouse & Touchpad
Keyboard Shortcuts
Printers
Airplane Mode
Disables Wi-Fi, Bluetooth and mobile broadband
Turn On Wi-Fi Hotspot?
Wi-Fi hotspot allows others to share your internet connection, by creating a Wi-Fi network that they can connect to. To do this, you must have an internet connection through a source other than Wi-Fi.
Network Name
eyantra_drone
Password
eyantra@123
Cancel
Turn On
No Wi-Fi Adapter Found
Make sure you have a Wi-Fi adapter plugged and turned on

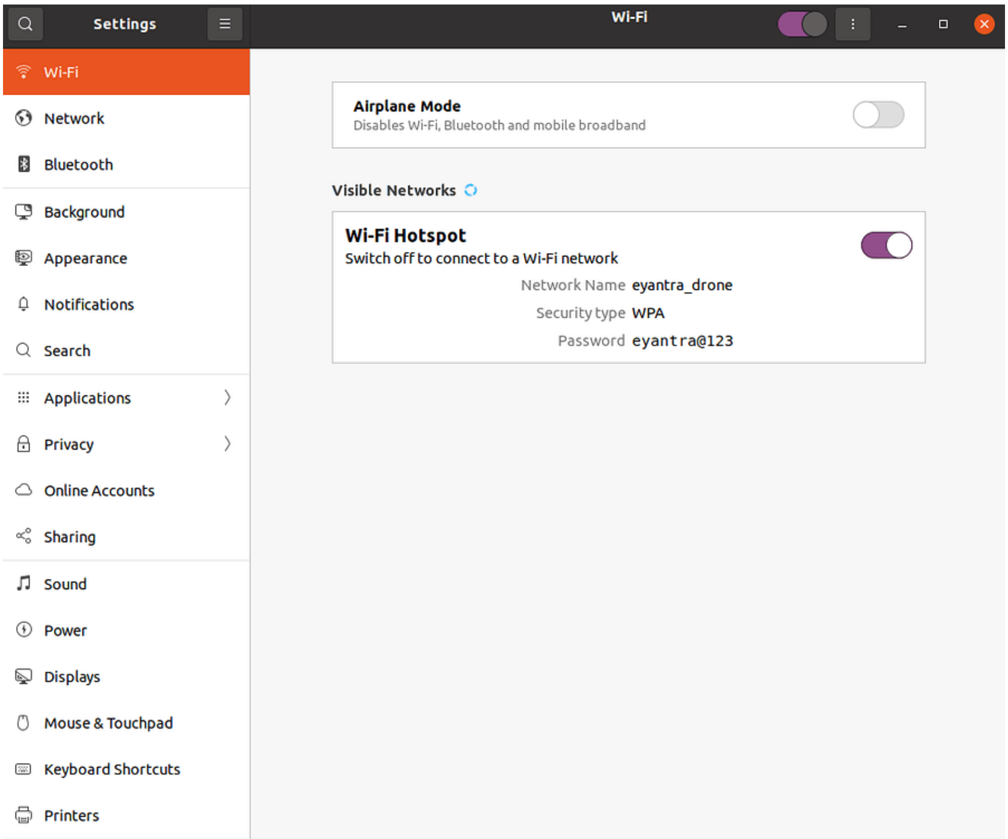


Figure : Creating WiFi hotspot

- Create this hotspot before powering up the Banana Pi. The Banana Pi is already configured to connect to a WiFi named eyantra_drone. Before proceeding to the next step, your laptop/pc and the Banana Pi have to be on the same network. This is ensured as you have created the WiFi hotspot form laptop/pc and the Banana Pi automatically connects to `eyantra_drone` WiFi.

- Next step is to know the IP address of the Banana Pi, to do that, run the following commands

```
sudo update-ieee-data
sudo apt install arp-scan net-tools
get-oui
```

Identify your WiFi interface name by the command

```
ifconfig
```

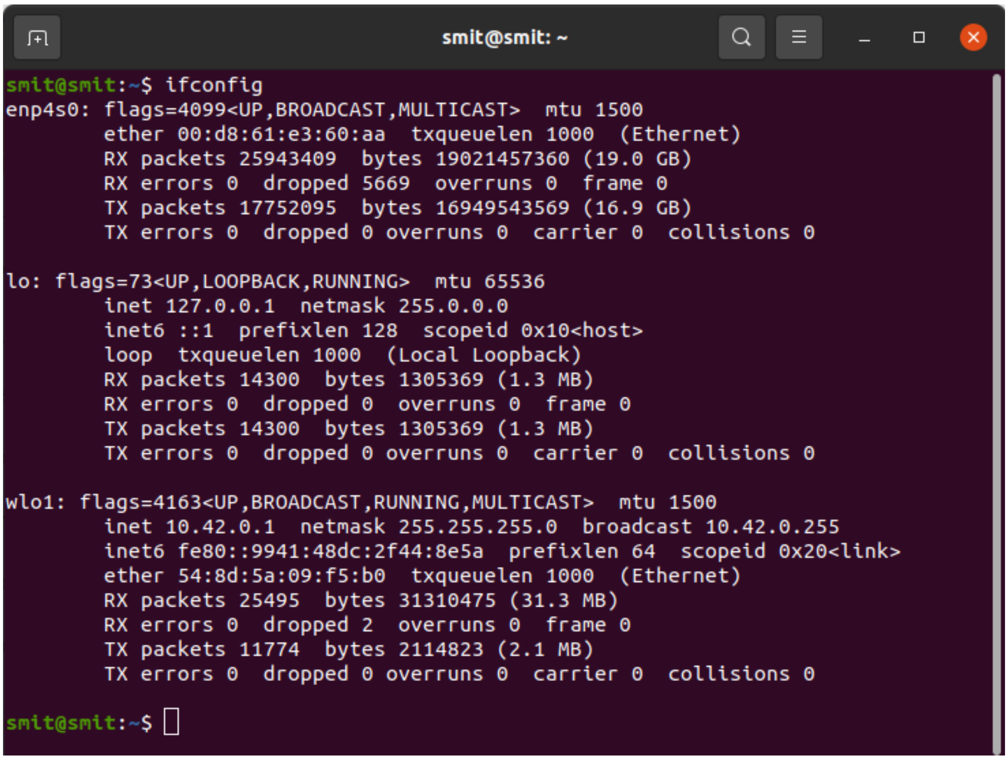


Figure : List network interfaces

We can identify the wirelss lan (WiFi) interface as `wlo1` with IP address (inet) as 10.42.0.1. This is the IP address of your laptop/PC and we need to remember this for future use.

```
sudo arp-scan --interface wlo1 -l
```

This will scan the devices connected to the WiFi hotspot and list them

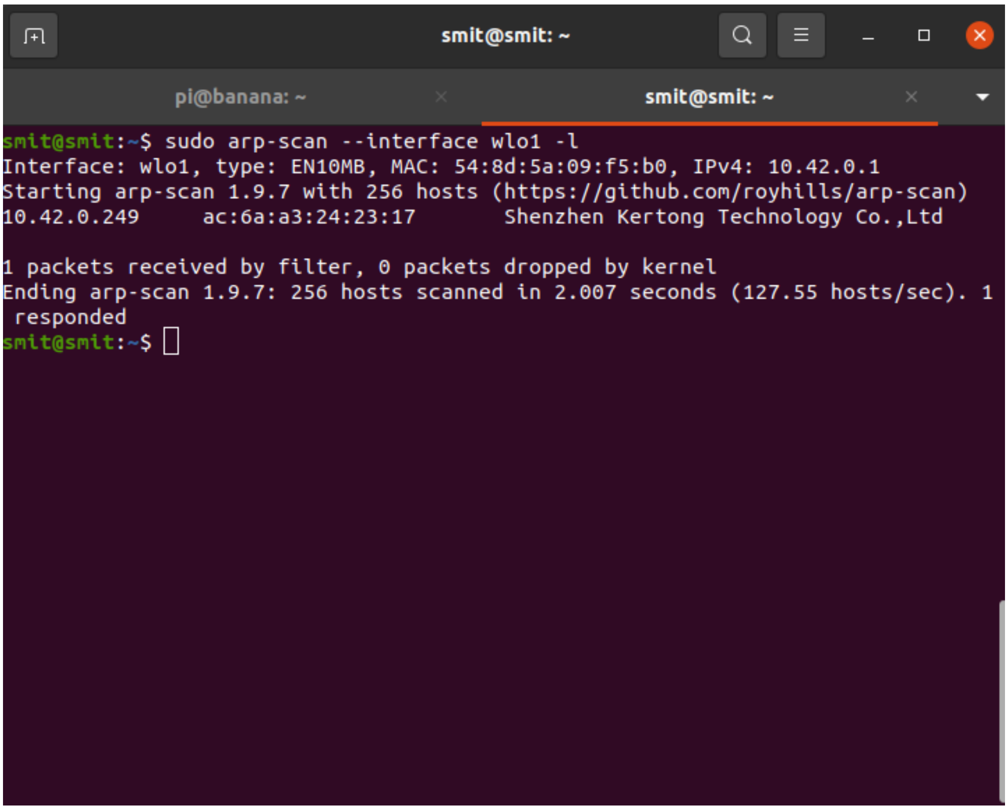


Figure : Arp scan

Identify Banana Pi with MAC address starting with `ac:6a:a3` and name as `Shenzhen Kertong Technology Co.,Ltd` The IP address in this case is 10.42.0.249. In your case, it will be different. Note this IP address as Banana Pi's IP address

> Note: The IP address of Banana Pi can change each time you restart the Banana Pi or the WiFi Hotspot, so use the above arp-scan command to know the correct IP address of Banana Pi

- Now use SSH to get access into Banana Pi

```
ssh pi@<ip_address>
```

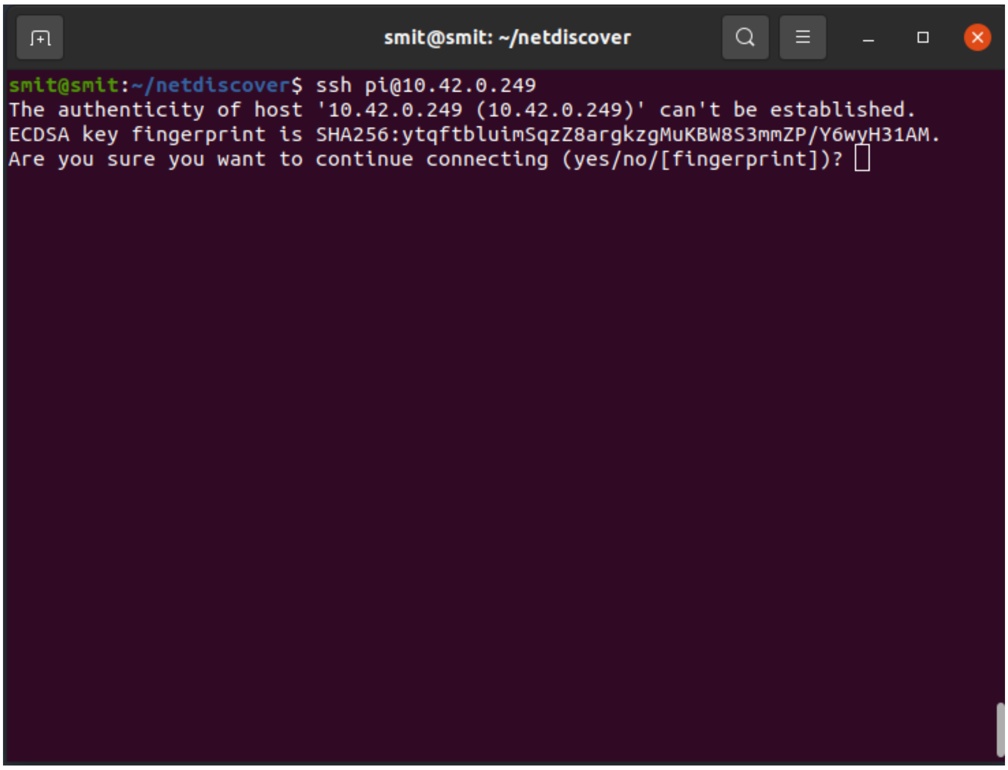


Figure : SSH into Banana Pi

If the Banana Pi is connected to the WiFi network and the IP address is correct, you will be asked for authenticity. Type `yes` and then you will be asked for a password. If the password prompt does not come, then either the Banana Pi is not connected to the same WiFi network as your laptop/pc or your IP address is incorrect.

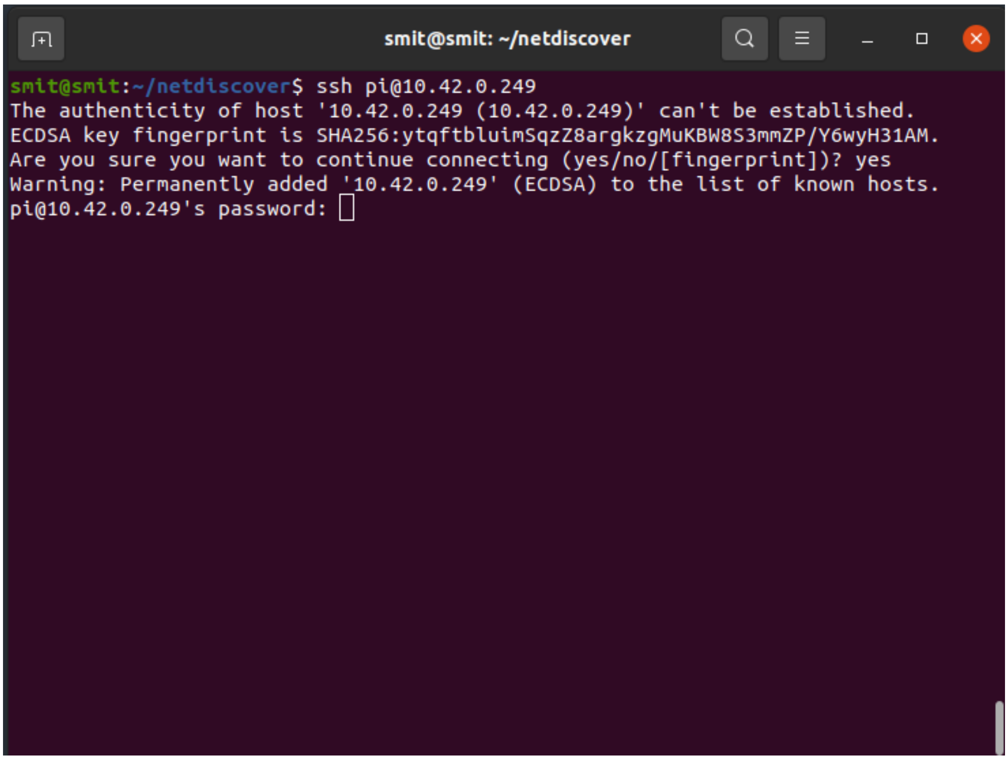
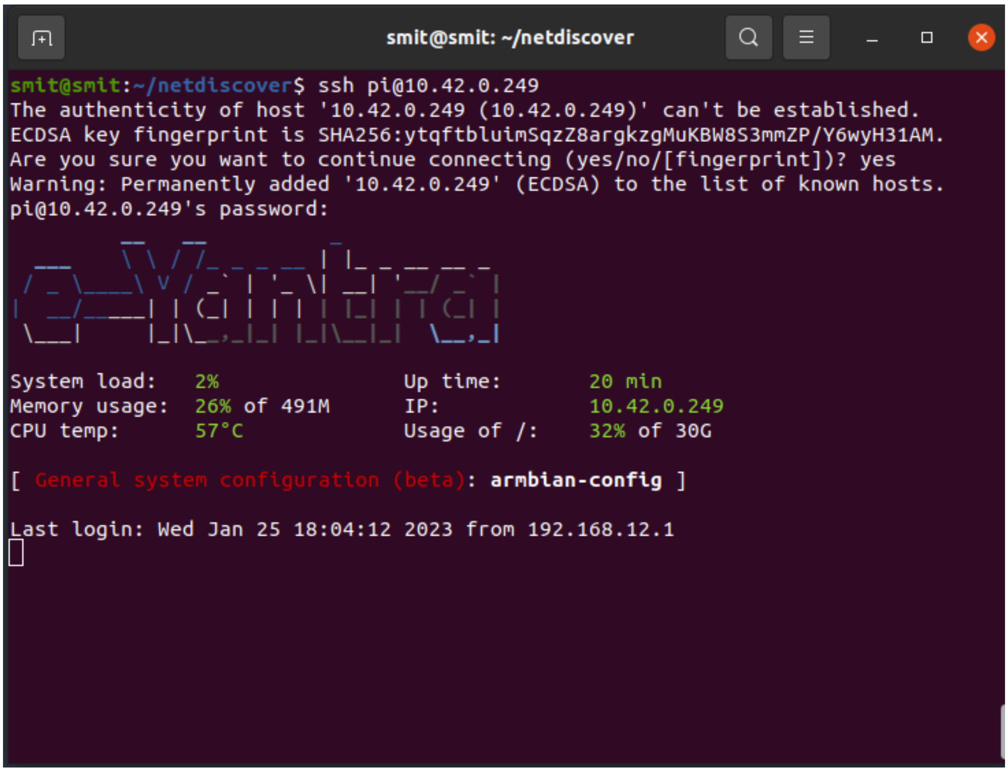


Figure : Password prompt

- The password for Banana Pi is **pass1234**. After you put the password, you will be inside the terminal of Banana Pi, as if you have opened a new terminal inside the Banana Pi. This terminal window is no more a shell in your laptop/pc but a shell in Banana Pi which you can access remotely. You can perform any operation that you want to run in Banana Pi using this terminal window. If you want to open more such terminal windows on Banana Pi then open a new terminal in your laptop/pc and run the ssh command again, and a new terminal access of Banana Pi will be available to you.



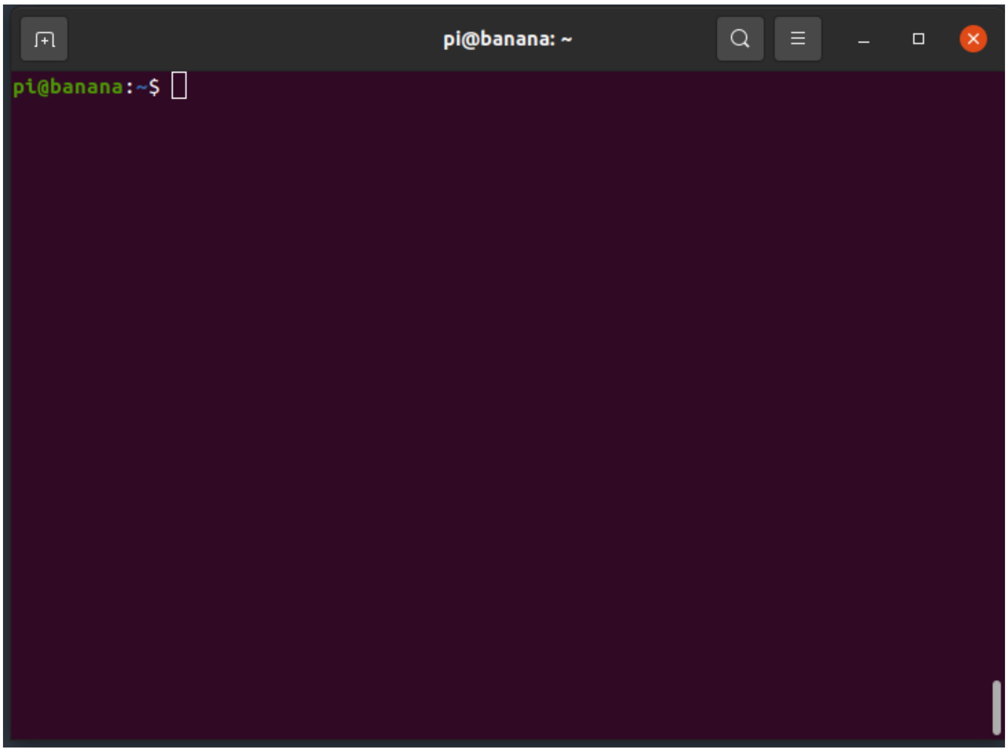


Figure : Banana Pi terminal

Notice that now your terminal window says ```pi@banana:~$```. This means you are inside the terminal shell of Banana Pi remotely

Connection of Banana Pi with flight controller

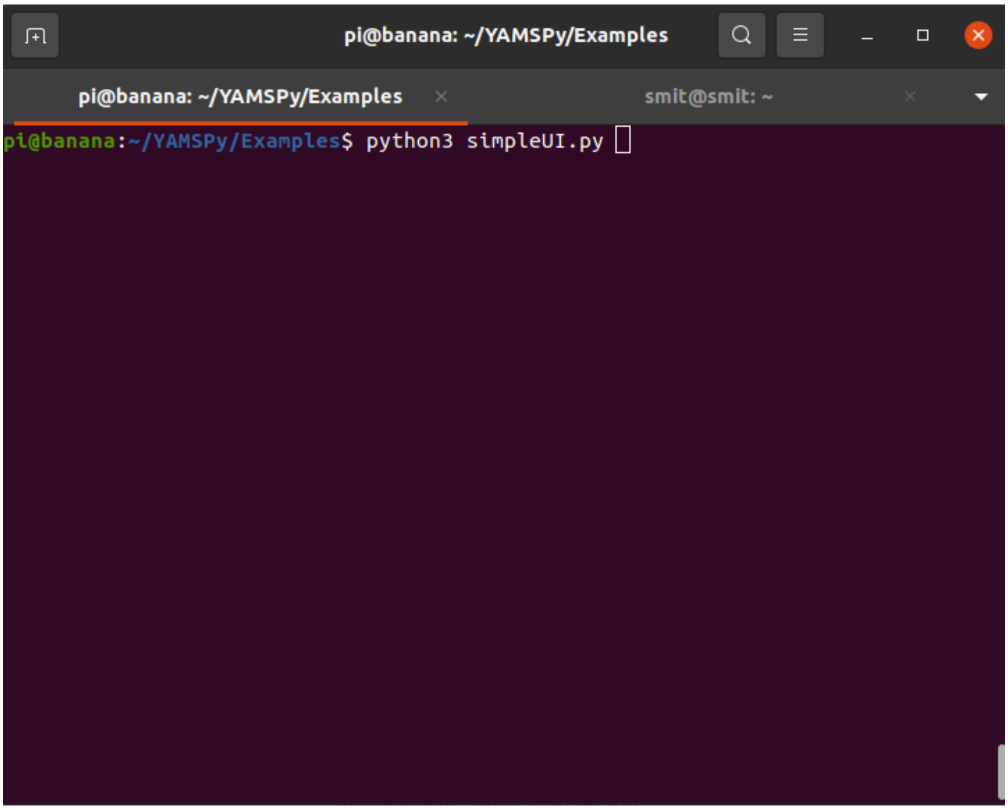
- After preparing the flight controller and the Banana Pi, its time to interface both devices. You need to connect the wires as shown in the video.

> WARNING : Again, be careful while soldering wires on the flight controller, if one does not have experience in soldering, take help from team mate who has done soldering before or take help from other person who has experience in your college/class. Before connecting power to boards after connecting/soldering anything, check for any visible short circuit paths between closely soldered joints and get a multimeter to check any short circuits

- After connecting the Banana Pi and flight controller, now test the communication between both boards. Connect the battery to the flight controller and using the balance plug of the battery, power on the Banana Pi. Before powering the Banana Pi, always make sure WiFi hotspot from your laptop/pc is turned on, else the Banana Pi will not connect to the WiFi.

- SSH into the Banana Pi using the previously shown method. Once in the terminal of Banana Pi, run the following commands

```
cd YAMSPy/Examples
python3 simple_UI.py
```



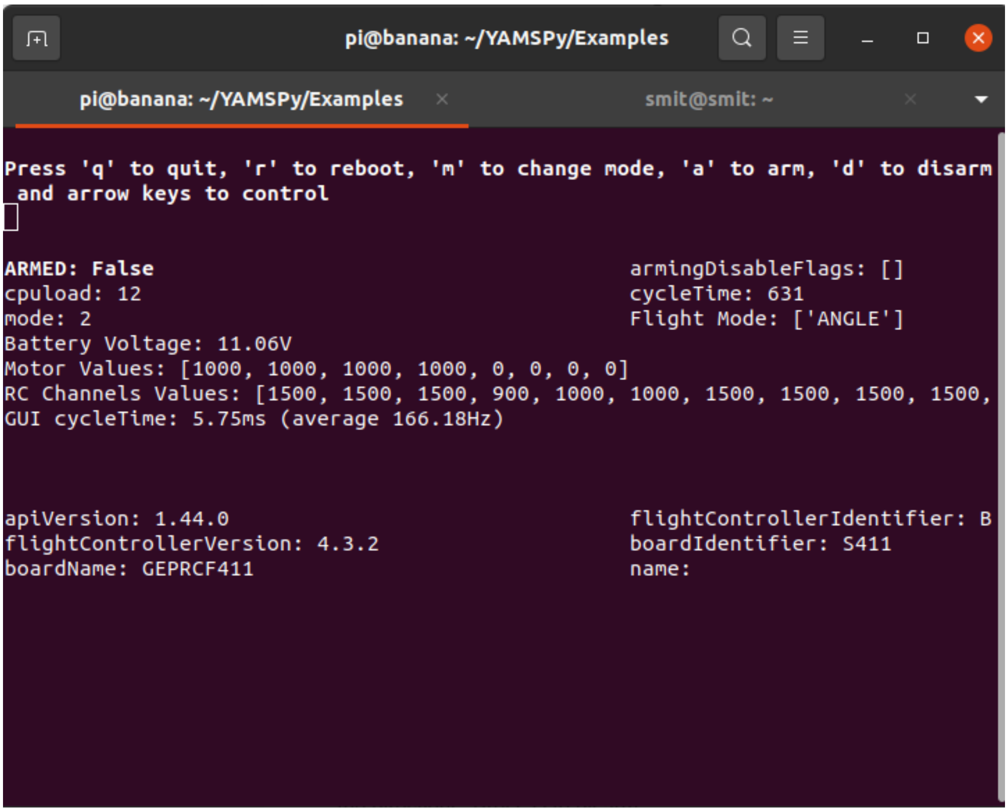


Figure : Simple Ui

This will open a window as shown above, this means the connection between the Banana Pi and flight controller is successful and you can send commands to the flight controller using the Banana Pi. Try to arm the motors by pressing A and check the rotation direction of all the motors and verify the directions. Press D to disarm.

- After successful arming and disarming, you can proceed for final assembly of drone

Full drone assembly and testing

- Follow the video for drone assembly.
- Before connecting the propellers, once again power both the boards using the battery and do a arming test, once again verify all the motor directions.
- You can now attach the propellers as shown in the video and the drone is ready to fly.
- Cut the WhyCon marker and stick it on a hard paper as shown in video, and then stick the paper on the holder using double side tape.
- The final drone assembly should like the figure below. Once again after assembling the entire drone, with propellers, power on the system (flight controller and Banana Pi), and perform the arm test. Make sure the air is pushed down by all the propellers and the motors are rotating in the desired directions.

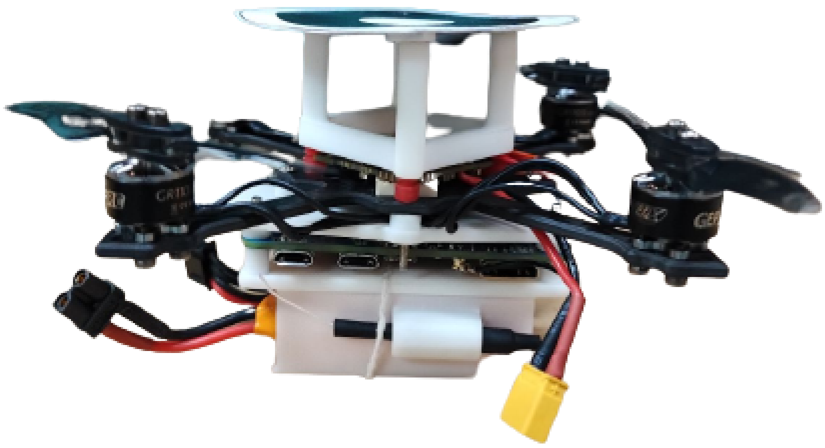


Figure : Full drone assembly

> WARNING: If the a motor(s) are set up incorrectly or the propeller(s) are attached incorrectly, then the air will be pushed up instead of down and the drone will flip instead of flying.

- This is the most important step, tie a string as shown in the figure and use tis string to hold the drone while testing phase and PID tuning phase. This will prevent 99 % crashes provided the end of the string is held by someone. Crashing the drone will break some parts or damage electronics, so always fly the drone tethered.

Pi Camera testing

> **It is assumed that you have created a WiFi hotspot and connected the Banana Pi to the WiFi network of your laptop/pc**

- Clone this **[Github repository]** on your PC. Inside video_stream folder, open server.py file.
  In line number 19, you will see:

```
serverip="192.168.0.137"
```

- Change the IP address with the IP address assigned to your PC. To check this,

  Make sure you have connected the pi camera to the banana pi.

> Note: It is advised to connect the camera to the pi and test it before attaching it to the drone mount.

- SSH into the Banana Pi, open the terminal and change the directory to video_stream in home directory. (repository is already updated)
- Inside the video_stream directory you will find 3 files. Open the `client.py` file using vim ,nano or any text editor.

```
cd video_stream
sudo nano client.py
```

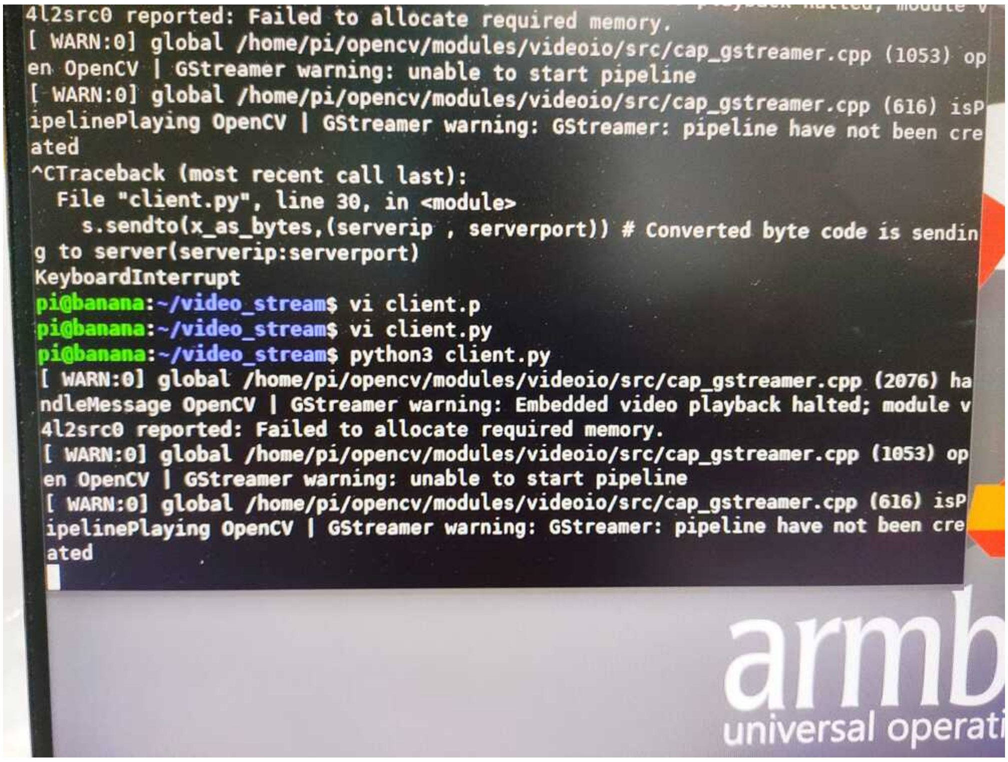
In line 19 you will see the following:

```
serverip="192.168.0.137"      # IP address of ROS master (PC)
```

Replace the server IP address with the IP address of your ros master(i.e. your PC IP address as your PC acts as ROS master)

Run the client.py file in banana pi using:

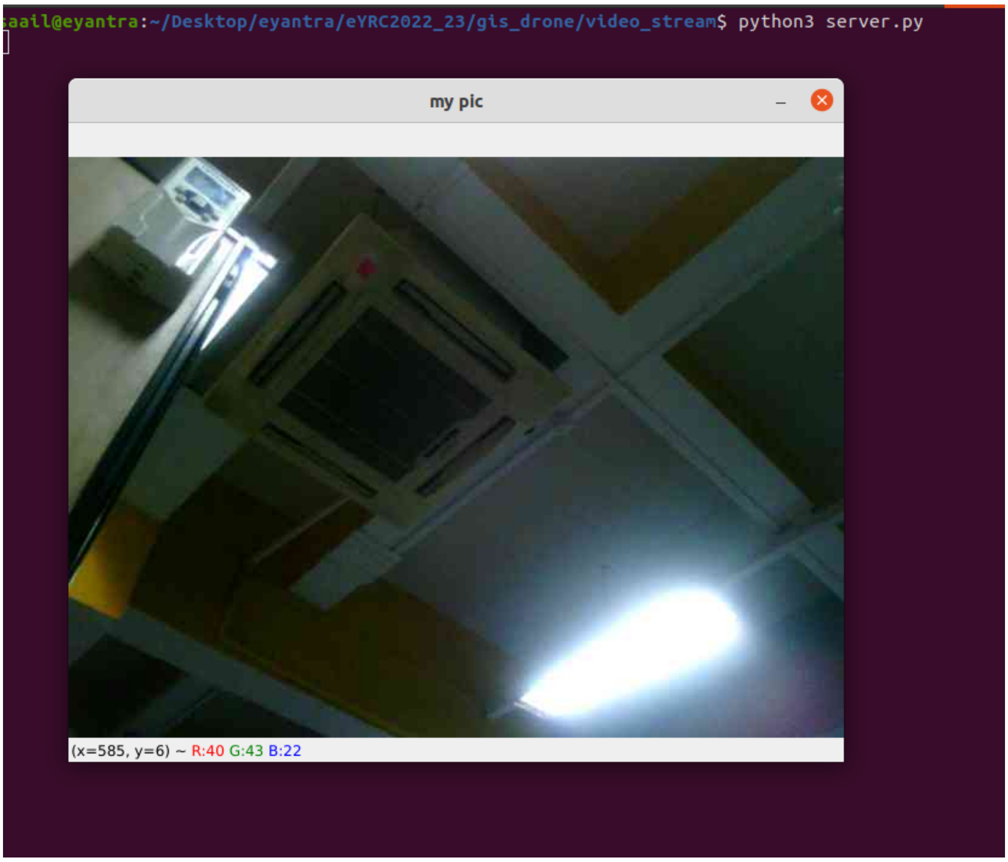
```
python3 client.py
```



In your **PC** , inside the cloned repo **video_stream** run the server.py file using:

```
python3 stream.py
```

This will stream the pi camera output.



> Note: Both client.py (in banana pi) and server.py (in your PC)should be running to get the stream in your system.

Recording and Submission Instructions:

- Take a video from any camera/smartphone showing the assembled drone and laptop/pc.
- Power the drone with the battery and wait for the Banana Pi to connect to the laptop/pc's WiFi hotspot
- Once the full drone assembly is completed, you need to submit a video showing the arm test and then camera stream seen on your PC. Submit the unlisted YouTube video link in place of task 3C
- Deadline for submitting this task is **30th January 2023 23:59**

All the Best !

[Buck converter confirmation]

[Task 4B: Detect colored object from the drone camera and find its pixel co-ordinates]

[Smit] Unlisted 2 January 16, 2023, 7:45am

[Smit] Closed 3 January 16, 2023, 7:45am

Smit Listed 4 January 26, 2023, 10:50am