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| BlueROV2 Dive Checklist for Oculus and Ping360 |

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tables

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# 

# purpose

This document outlines the necessary procedures to ensure that the BlueROV2 is safe and prepared for either deployment (pre-dive) or storage (post-dive). Inspiration has been taken from the BlueFin UUV pre-dive and post-dive checklists [refA] from SEA1778.

Particular steps are included to describe the integration and operation of the Oculus M1200d FLS. Scan data is recorded as both a sequence of binary files and a rosbag.

# references

Table ‑: Reference Table – Table Caption

| Ref. | Document No. | Title | Revision |
| --- | --- | --- | --- |
|  | 000-022-800 | BF9 Operator Pre-Dive Checklist | D |
|  | 61262349\_108-01 | BlueROV2 Dive Checklists | A |
|  |  |  |  |

# Forms

## Pre-dive Checklist

### Assemble vehicle

1. Mount the Ping360 using 2x screws (already on its mount)
2. Mount the Oculus M1200d
   1. Mount Oculus to 3D printed holder using 4x M5 screws
   2. Verify that the angle increment on the holder is set to 15 degrees
   3. Mount the Oculus holder to the BlueROV2 frame. This will require the black rod to be removed, the holder pushed on, then the rod re-inserted and screwed in place
   4. Connect the Oculus M1200d cable and zip tie excess cable to the frame
3. Re-grease the sensor enclosure SubConn if it is dry, then connect to sensor enclosure and tighten red locking sleeve.
4. Re-grease the main enclosure SubConn if it is dry, then connect to main enclosure (there is no locking sleeve).
5. Zip tie tether to thimble, and thimble to BlueROV2 as shown in Figure 1:



Figure - Tether attachment

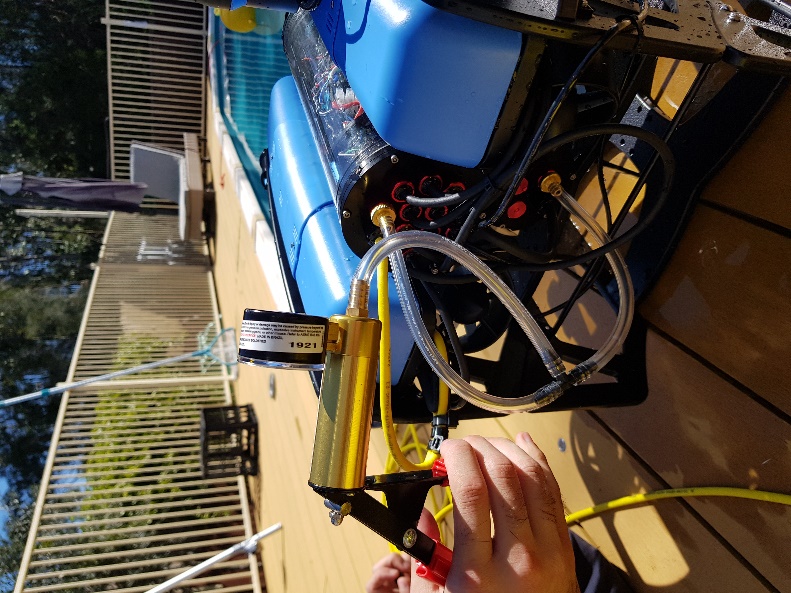
### Connect battery

In order to correctly connect the LiPo battery to the BlueROV2, the ROV must first be moved to a dry and secure area. The following procedure may then be followed:

1. Remove the vent plug from the vent penetrator, this can be identified as the plug with the ‘OK’ label. Place the vent plug in a safe place.
2. Remove the end cap from the battery enclosure on the side which the battery cable exist from, careful not to touch the grease on the O-rings.
3. Ensure the inside of the enclosure is dry.
4. Connect battery and place it in the battery enclosure.
5. Replace the end cap onto battery enclosure.
6. Replace the vent plug by twisting into position into the vent penetrator.
7. Check the remaining 3 cable connectors that enter into the enclosure are tightened to ensure a watertight seal.

### Vacuum test

The vacuum test requires the vacuum pump, which is located in the BlueROV2 equipment box. The vacuum test should be performed before each dive to ensure the containers housing are watertight. The procedure is as follows:

1. Remove the vent plugs labelled ‘OK’ from the electronics, sensor, and battery enclosures.
2. Insert one of the vacuum plugs into the now free vent plug casing on each of the three enclosures (there are two pumps with three plugs between them, so all three enclosures can be tested at once)
3. Pump each pump until the gauge reads 10 in. Hg [34 kPa] vacuum.
4. Wait for 15 minutes, leaving the BlueROV2 and pumps connected.
5. The enclosures are considered water tight and acceptable if the gauge reads above 9 in. Hg [31 kPa] vacuum after the allocated wait time.
6. If the gauge reads below 9 in. Hg [31 kPa], then the BlueROV2 should be thoroughly checked for any loose connections or sources of leakage. This can include checking:
   1. The screws on the front and back end caps of the battery and electronics enclosure. Tighten if required and perform the vacuum test again.
   2. Make sure the cable connections on the battery and electronics enclosure are fully tightened. If loose, tighten and perform the vacuum test again.
   3. Check for missing O-rings in the cable connectors. If absent, install then attempt the vacuum test again.
   4. Check the O-rings in the battery and electronics enclosures are present and in good condition, damaged or missing O-rings should be replaced. Perform the vacuum test again.

An example of the appropriate set up (for two of the three enclosures) for the vacuum test can be seen below:

### Connect with project laptop

Prior to deployment into water, the connection between the BlueROV2 and the project laptop must be made and checked to ensure it will operate correctly. The procedure is as follows:

1. Connect the additional length of tether to the tether spool and the Fathom-X Tether Interface Board. Ensure the connections are ‘locked’ in place by rotating the collars.
2. Boot the project laptop into Ubuntu or Windows
3. Using the USB-A to USB-B cable, connect the Fathom-X Interface Board to the project laptop. Upon connection with the BlueROV2, the two LEDs on the Fathom-X Interface Board will light up.
4. To start the Pi3 to Pi4 bridge, from a new terminal execute:
   1. ssh [pi@192.168.2.2](mailto:pi@192.168.2.2) (pwd: companion)
   2. nohup ./bridge\_script.sh
   3. ./remove\_eth0\_route.sh
5. In the Pi 4 terminal, run date and record the Pi 4 current time with respect to the real world time in the table below. Repeat every time vehicle power is cycled (this data can be used to assist synchronisation of Ping360 CSV file time stamps with real world time).

|  |  |  |
| --- | --- | --- |
| Power Cycle | Real world time (HH:MM:SS) | Pi 4 time (HH:MM:SS) |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |
| 6 |  |  |

1. Open QGroundControl
2. To set up the leak sensor, connect to RPi4 (Application Settings > Comm Links > BlueROV2) in QGroundControl. Then run the following command in the RPi4 terminal
   1. ssh [thales@192.168.2.4](mailto:thales@192.168.2.4) (pwd: Blutonomy@789)
   2. Python leakSensorMavlink.py
      1. Note that QGroundControl should say “Leak sensor script started” as the script starts
   3. If RPI4 option does not exist, set up a new connection with the following configurations
      1. Name: RPi4
      2. Type: UDP
      3. Listening Port: 14400
      4. Target Hosts: Click on Add, then enter 192.168.2.4, and confirm
      5. Now navigate to the previous screen and connect to the RPi4 option
3. Verify that QGroundControl enters manual flight mode (Disarmed)
4. If using a wired Xbox One controller, plug it into a USB port on the laptop. If using a wireless Xbox One controller:
   1. The Bluetooth module for the Xbox One controller should be inserted into an available USB port on the project laptop.
   2. Turn on the controller by pressing and holding the large central button, it will light up upon powering on.
   3. To connect the Xbox controller to the project laptop, press and hold the button on the Xbox Bluetooth module and the small button located on the back of the Xbox controller. The LED on the Bluetooth module and the main button on the controller will blink while they seek connection and will cease blinking and remain on when connection has been established. This connection should be confirmed by the project laptop’s connected devices.

### Hardware tests

#### Screws

The ensure the BlueROV2 is ready for deployment, the screws throughout its frame must be checked. These can be tightened using the hex keys that are located in the BlueROV2 equipment box. Locations to check include:

1. The screws that hold the frame to the centre and bottom panels
2. The screws that hold the back-end caps to the flange seals of the electronics and battery enclosures and the screws that hold the dome and the front battery end cap to the flange seals.
3. The screws that hold the clips to the electronics enclosure.

#### General Structure

Once the screws have all been checked and tightened, the general structure should be inspected prior to deployment. Recommended tests include:

1. Ensuring the ballast weights do not twist in position.
2. Ensuring the frame does not twist when pressure is gently applied.
3. Lightly pull on the cable connectors bundles and tether going into the electronics housing end cap to ensure they are secured.
4. Lightly pull on the cable connectors going into battery housing end cap to ensure they are secured.
5. Check that the ‘OK’ vent plugs are installed and tightened.
6. Conduct a visual inspection of all parts of the BlueROV2, ensuring all appears secure and operational.

## 

## VEhicle Operation

The following configurations are possible:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Laptop OS | Oculus M1200d | | Ping 360 | |
|  | Viewing | Recording | Viewing | Recording |
| Windows | N/A | N/A | Ping Viewer | Ping Viewer log |
| Windows | ViewPoint | ViewPoint log | *No live feed* | CSV |
| Ubuntu | N/A | N/A | Ping Viewer | Ping Viewer log |
| Ubuntu | ROS | Binary & rosbag | *No live feed* | CSV |

### Ping360 – Windows

Using Ping Viewer:

1. If the oculus bridge is already connected, reboot the Pi 4, and re-set up the Pi 3 bridge
   1. sudo reboot
   2. nohup ./bridge\_script.sh
   3. ./remove\_eth0\_route.sh
2. On Pi 4 ssh terminal:
   1. cd bluerobotics/ping-python/tools
   2. pingproxy.py --device /dev/ttyUSB1
3. On topside (windows) open Ping Viewer
4. Go to “Manual connection” and set:
   1. Device: Ping360
   2. Communication: UDP
   3. UDP Host: 192.168.2.4
   4. UDP Port: 9090
5. Click “Connect”
6. Ping360 will start recording log data automatically

Using Python script to save CSV:

1. Kill Pingproxy if already running (ctrl+c)
2. On an ssh terminal connected to the Pi 4:
   1. cd ~/bluerobotics
   2. ./ping360.sh
3. A single scan will be recorded to the directory printed on screen
4. Record scan frequency, range parameters for reference

### Oculus – Windows

1. To start Pi4 to Oculus M1200d bridge, from the same terminal execute:
   1. ssh [thales@192.168.2.4](mailto:thales@192.168.2.4) (pwd: Blutonomy@789)
   2. nohup ./bridge\_script.sh
   3. ./remove\_eth0\_route.sh
2. Open ViewPoint
3. Click connect button (fan shape) in top left
4. Oculus will connect automatically
5. Flip display using buttons on bottom right to align image with camera orientation
6. Start log recording by clicking button (circle) on bottom left of screen

### Oculus – Ubuntu

1. To start Pi4 to Oculus M1200d bridge, from the same terminal execute:
   1. ssh [thales@192.168.2.4](mailto:thales@192.168.2.4) (pwd: Blutonomy@789)
   2. nohup ./bridge\_script.sh
   3. ./remove\_eth0\_route.sh
2. To start the MAVProxy session to enable QGroundControl and MAVROS to connect simultaneously to the BlueROV2, in a new terminal execute:
3. python ~/.local/bin/mavproxy.py --master=udp:192.168.2.1:14550 --out=udp:192.168.2.1:14560 --out=udp:192.168.2.1:14570 --streamrate=-1
4. To start QGroundControl, in a new terminal execute:
5. ./QgroundControl.AppImage
6. Once QGroundControl opens, navigate to “Application Settings > Comm Links > BlueROV2” and click “Connect” (shown in **Error! Reference source not found.**)

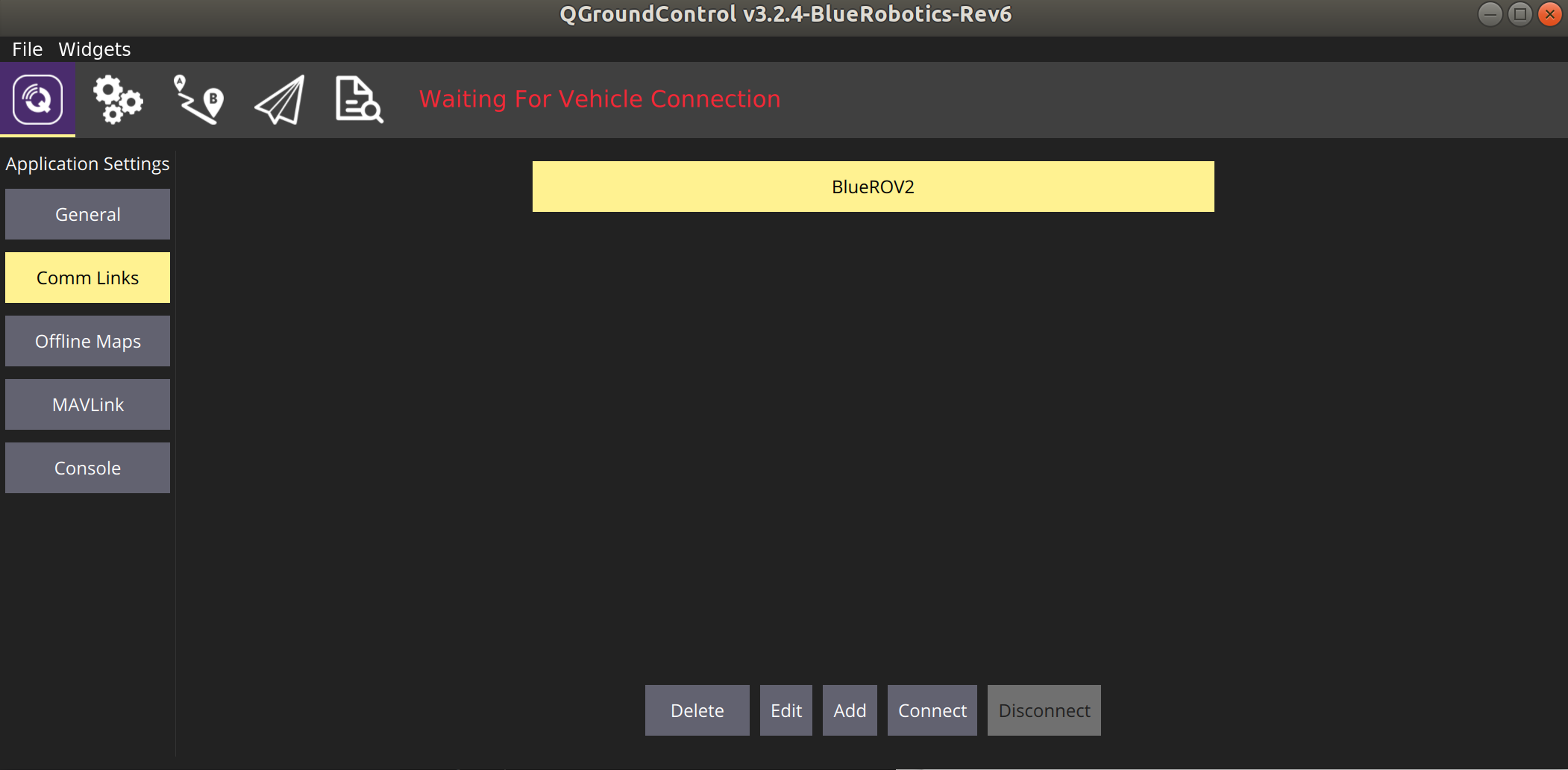


Figure 2 - Connection to BlueROV2 in QGroundControl

1. Verify that QGroundControl enters manual flight mode (Disarmed)
2. To start MAVROS for MAVLINK communication with vehicle, in a new terminal execute:
3. roslaunch mavros apm.launch fcu\_url:=udp://192.168.2.1:14560@
4. To configure streaming rates, in a new terminal execute:
5. rosservice call /mavros/set\_stream\_rate 0 10 1 (All streams @ 10 Hz default)
6. rosservice call /mavros/set\_stream\_rate 1 10 1 (Raw sensor to 10 Hz (imu/data\_raw))
7. rosservice call /mavros/set\_stream\_rate 10 10 1 (Position to 10 Hz (imu/data))
8. Connect an external drive for data logging
9. Open the following file and change line 88 to the external directory where scans should be stored:

/home/thales/matt\_thesis/catkin\_ws/src/slam\_thesis/oculus\_node/include/oculusInterface.hpp

1. To prepare the Oculus M1200d recording terminal, in a new terminal execute the following:
2. cd ~/matt\_thesis/catkin\_ws
3. catkin\_make\_isolated
4. source devel\_isolated/setup.bash
5. To prepare the rosbag recording terminal, in a new terminal execute the following:
6. cd /media/thales/<name of data logging drive>
7. To open an RQT session for data monitoring, in a new terminal execute:
8. cd ~/matt\_thesis/catkin\_ws
9. source devel\_isolated/setup.bash
10. rqt

After all previous steps have been undertaken:

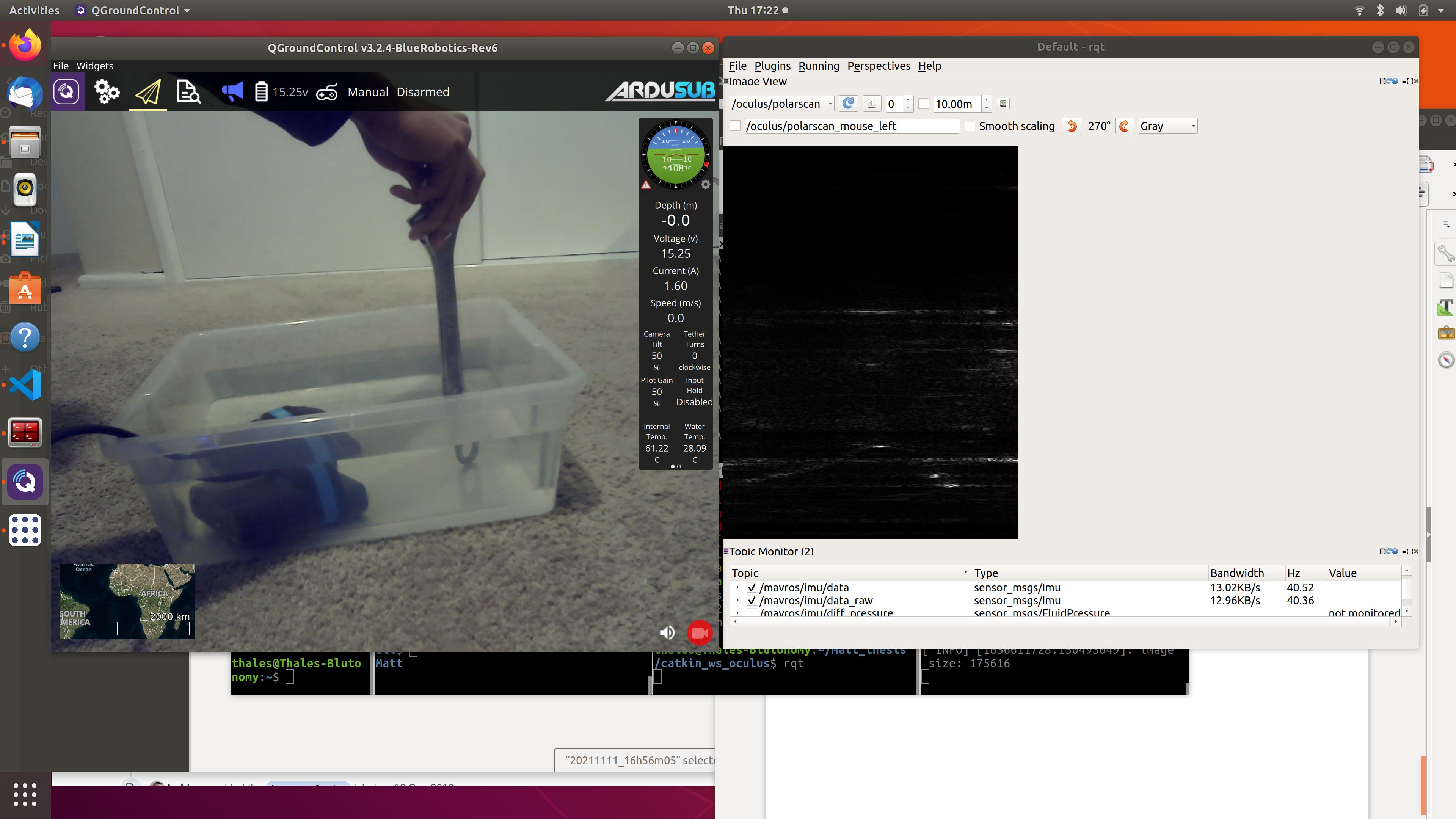
1. Place the BlueROV2 on flat ground near the poolside
2. Verify by observing in RQT that:
   1. Topic /mavros/imu/data has f=10 Hz
   2. Topic /mavros/imu/data\_raw has f=10 Hz
3. Launch drone and move into position over test area. Start recording drone video.
4. Start Oculus M1200d logging by executing in the Oculus terminal:
   1. rosrun oculus\_node oculus\_node
5. Start rosbag logging by executing in the rosbag terminal:
   1. rosbag record -a
6. Do not touch the BlueROV2 for 10 seconds (to get an IMU baseline)
7. Place the BlueROV2 in the water
8. Verify by observing in RQT that image is received on /oculus/polarscan topic and /oculus/header is published
9. Verify that scans are being logged to the selected binary file directory

Figure 3 - Successful RQT image and IMU topics

1. After driving test pattern, kill the rosbag and Oculus terminals with (ctrl+c)

### Ping360 - Ubuntu

*Same as Section 3.2.1 – using python script to save CSV*

### Tether management during operation

1. When diving the BlueROV2 tether should be watched to ensure entanglement does not occur. Failure to do so may cause extensive damage to the tether and/or the BlueROV2 itself and will complicate retrieval.
2. Keep the tether away from any external objects in the environment these may include:
   1. Propellers or jets if you are operating on a boat, including those of other water vehicles.
   2. Sharp objects or other foreign objects in the environment.
3. Do not deploy too much tether. This can lead to entanglement as well as increase the amount of drag on the ROV in the water.
4. Do not step on the tether.

## Post-dive Checklist

### Data check

To check Oculus binary and rosbag recordings:

1. Use crtl+c to kill MAVROS
2. Play back rosbag by executing in the rosbag terminal:
   1. rosbag play <bag name>
3. Verify good IMU and image data (sonar and visual) is received in RQT:
   1. Topic /mavros/imu/data has f=40 Hz
   2. Topic /mavros/imu/data\_raw has f=40 Hz
   3. Topic /oculus/header is published
   4. Topic /oculus/polarscan is published (visual)
4. Open binary file sequence in MATLAB and verify that images are good

### Retrieval

The BlueROV2 can be retrieved by utilising its connection through the tether.

1. The ROV pilot should cease driving the ROV to ensure there is no active resistance during retrieval.
2. The assisting operators can then pull in the tether slack, gently pulling the ROV back into a retrievable position.
3. Once in a retrievable location, disarm the ROV.
4. Pick up the ROV directly using the frame, two people are recommended for this due to the ROV’s weight.
5. Remove the ‘OK’ vent plug from the battery enclosure and disconnect the battery.

### Post dive

1. Conduct a physical and visual inspection of the ROV to ensure no parts were damaged or loosened during operation.
2. Rinse down with fresh water to avoid corrosion, especially if deployed in saltwater. Allow time to dry or dry manually.
3. Avoid excessive sun exposure where possible. Store BlueROV2 in a shaded area or covered if additional dives are to be conducted. If no further dives are to be conducted, return ROV to storage case (once received).
4. – BlueROV2 Controls
   1. Default Key Bindings (Logitech)

XBox key bindings will vary. Before trial





1. - Checklist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 612xxxxx\_xxx-01\_revA  BlueROV2 Operator Pre-Dive Checklist  (To be completed before each vehicle launch) | | | | |
| Date: | | Operator: | | |
| Start Time: | End Time: | Vehicle Number: | | |
| Ship/Location: |  |  |  | |
| 1. Communications | | | | |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 1.1 Ethernet |  | ROV has connected to QGroundControl |  |  |
| 1.2 Oculus |  | Able to ping 192.168.2.10 (Oculus) from topside computer |  |  |
| 2. Power & Battery | | | | |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 2.1 Battery Cell Count |  | 4 Cell (4S) |  |  |
| 2.2 Battery Cell Voltage Variance |  | <=0.1VDC between highest and lowest cell voltages |  |  |
| 2.3 Battery Total Voltage |  | >12VDC & <16.8VDC |  |  |
| 2.4 Battery Physical Condition |  | No puffing of battery, no punctures or dents, cables are sturdy, no black marks on cables |  |  |
| 3. Environmental | | | | |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 3.1 Leaks |  | All indicators OK |  |  |
| 4. Devices | | | | |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 4.1 Oculus M1200d (ROS) | Topic Hz: | RQT views scans on /oculus/polarscan  And headers on  /oculus/header |  |  |
| 4.2 Oculus M1200d (binary) |  | Binary files can be opened in MATLAB |  |  |
| 4.3 IMU | Topic Hz: | RQT views 40 Hz topics:  /mavros/imu/data  /mavros/imu/data\_raw |  |  |
| 5. Payloads | | | | |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 5.1 Test Lights |  | Lights power on |  |  |
| 5.2 Disable power to lights |  | Light power off |  |  |
| 5.3 Camera Test |  | Video feed is visible through QGroundControl with no latency |  |  |
| 6. Mechanical | | | | |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 6.1 Electronics Enclosure Inspection |  | No cracks, dents, scratches, deformities**, screws and penetrators are tightened** |  |  |
| 6.2 Battery Enclosure Inspection |  | No cracks, dents, scratches, deformities**, screws and penetrators are tightened** |  |  |
| 6.3 Cable Inspection |  | No damaged insulation, kinks or breaks. Cables are tied down and are not loose – no risk of entering thrusters |  |  |
| 6.4 Buoyancy Inspection |  | Buoyancy covers/foam are sturdy and held down tight. No cracks or deformities |  |  |
| 6.5. Seal Inspection |  | Enough lubrication on endcaps, O-rings are in place and not cracked, |  |  |
| 6.5. Vacuum Test |  | Passes vacuum test – **gauge** from 10 in. Hg [31 kPa] only drops to minimum of 9 in. Hg [31 kPa] **after sitting for** 15 minutes |  |  |
| 6.5. Tether |  | No scratches, kinks, no obstacles in way of tether, tether thimble firmly in place |  |  |
| 7. Controls |  |  |  |  |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 7.1 Xbox Controller |  | Xbox controller is powered (if wireless) and successfully connected to surface laptop & QGroundControl |  |  |
| 7.2 Arm/Disarm Mode |  | Vehicle Arms & Disarms successfully using both the controller & QGroundControl |  |  |
| 7.3 Thrusters |  | Thrusters spin according to joystick inputs.  **\*WARNING\***  Do not run the thrusters for more than 10 seconds in air to avoid overheating |  |  |
| 7.4 Camera |  | Camera tilts according to joystick inputs |  |  |
| 7.5 Flight Modes |  | Vehicle successfully enters & exits Depth Holding Mode |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 612xxxxx\_xxx-01\_revA  BlueROV2 Operator Post-Dive Checklist  (To be completed before each vehicle launch) | | | | |
| Date: | | Operator: | | |
| Start Time: | End Time: | Vehicle Number: | | |
| Ship/Location: |  |  |  | |
| 1. Power & Battery | | | | |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 1.1 Battery Cell Count |  | 4 Cell (4S) |  |  |
| 1.2 Battery Cell Voltage Variance |  | <=0.1VDC between highest and lowest cell voltages |  |  |
| 1.3 Battery Total Voltage |  | >12VDC & <16.8VDC |  |  |
| 1.4 Battery Physical Condition |  | No puffing of battery, no punctures or dents, cables are sturdy, no black marks on cables |  |  |
| 2. Physical | | | | |
| Item/Procedure | Readings | Specifications | Initials | Notes |
| 2.1. BlueROV2 |  | BlueROV2 especially thrusters are thoroughly rinsed with fresh water and wiped dry with towel |  |  |
| 2.2. Thrusters |  | Thrusters clear of obstructions |  |  |