Live build your submarine step by step

Juanmi Taboada

Canonical Ubuntu
Ubuntu Summit 2024
The Hague, Netherlands
October 25 – 27

Live build your submarine

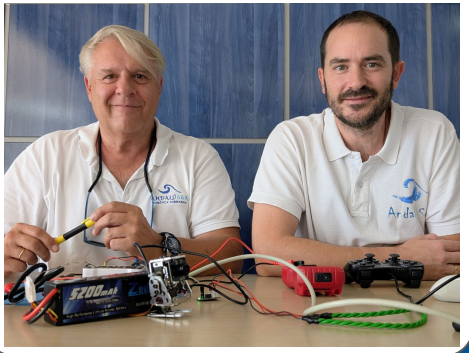
May I see your license and registration, please?

VETURIS

Job Joy

ANDALÚSEA
ROBÓTICA SUBMARINA

https://andalu-sea.com



QuantUMA
UNIVERSIDAD DE MÁLAGA
https://quant.uma.es

life

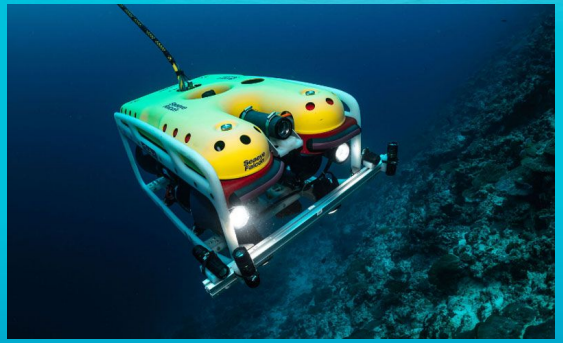
open south code

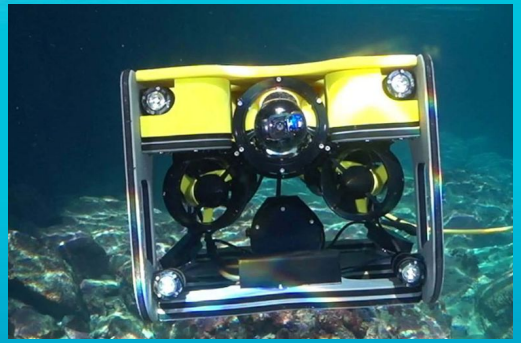
OpenSouthCode.org
20-21 June 2025 - Málaga (Spain)

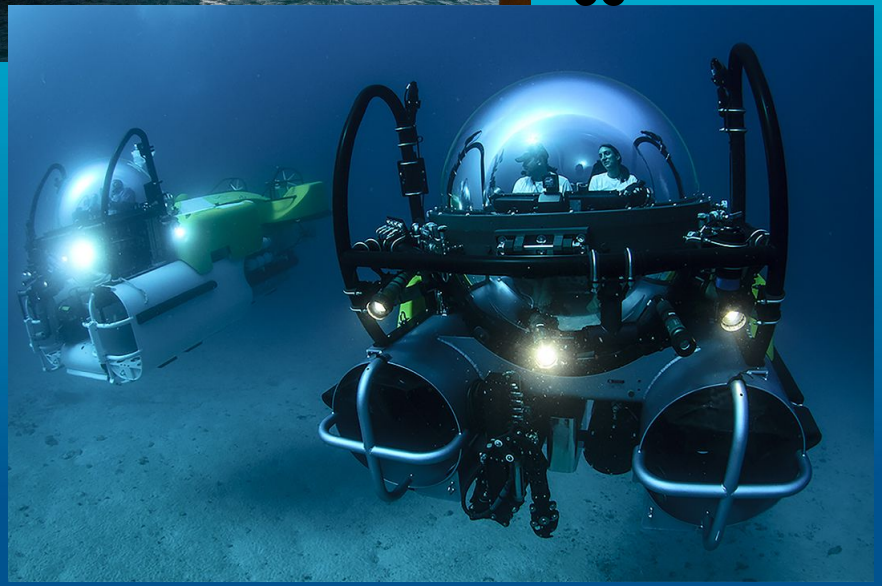
Juanmi Taboada

Live build your submarine

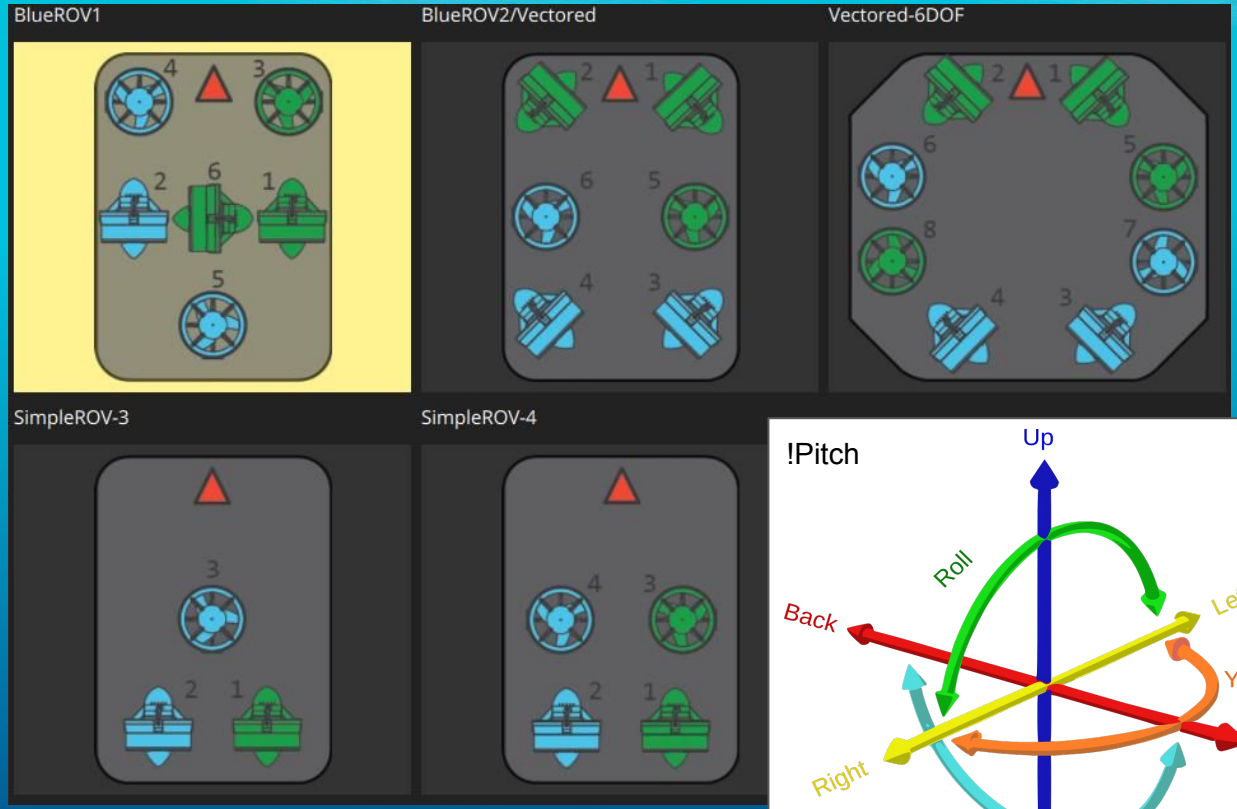
Submarines vs ROVs

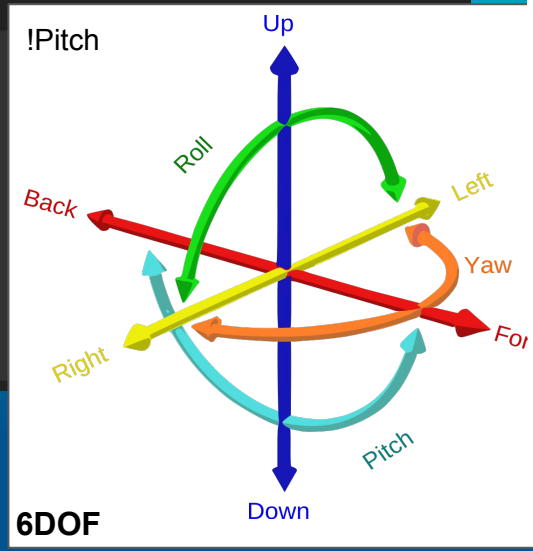


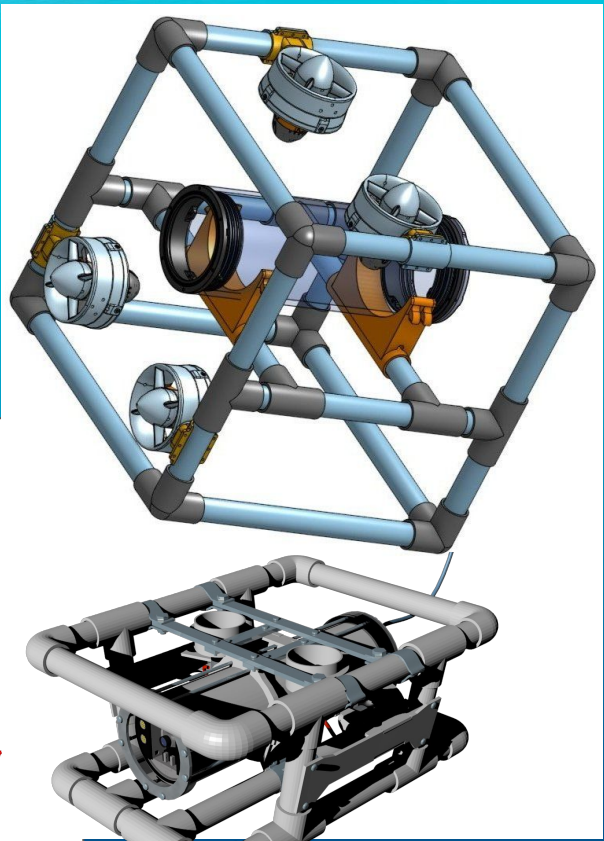




Choose a frame configuration



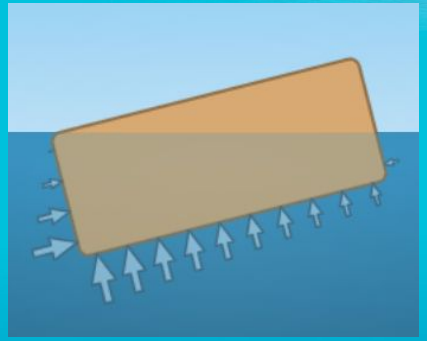


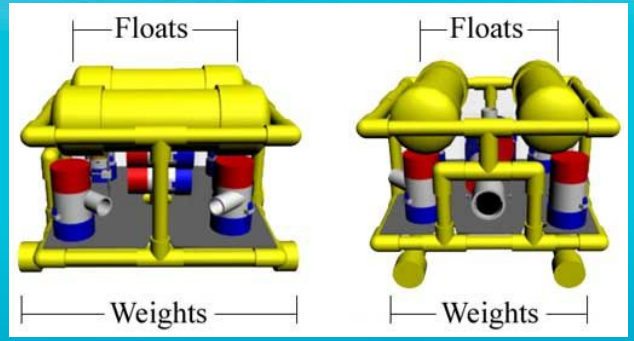


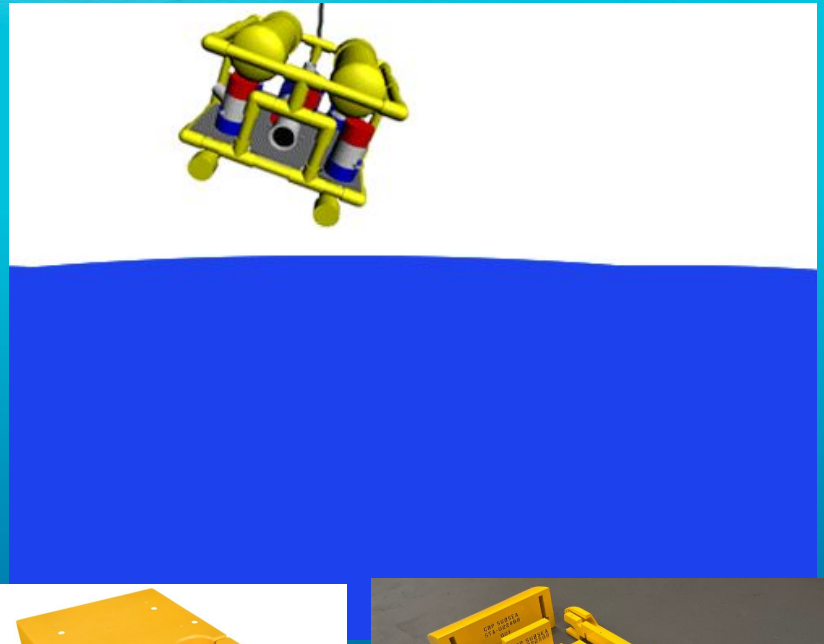
Six degrees of freedom

Juanmi Taboada

Ballast and buoyancy foam



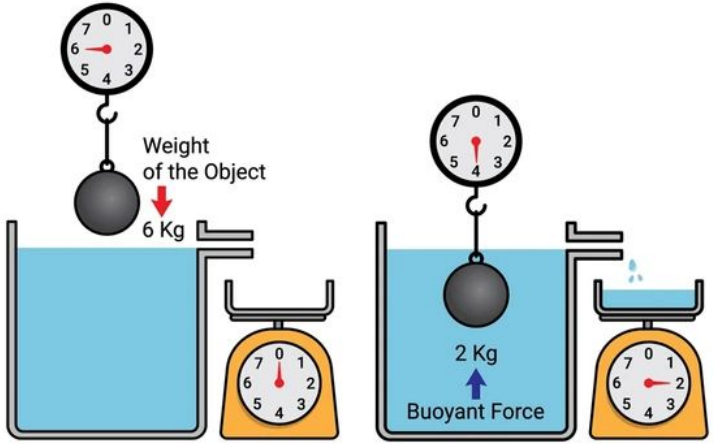




https://ciechanow.ski/naval-architecture/

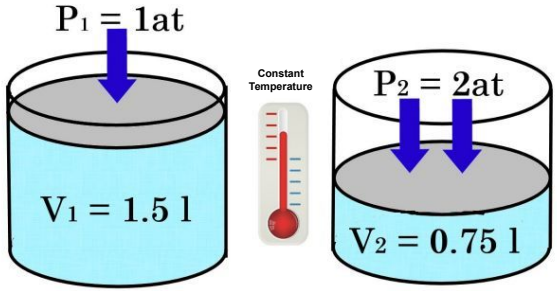
Archimedes Principle:

Any object, totally or partially immersed in a fluid or liquid, is buoyed up by a force equal to the weight of the fluid displaced by the object.



Boyle-Mariotte law:

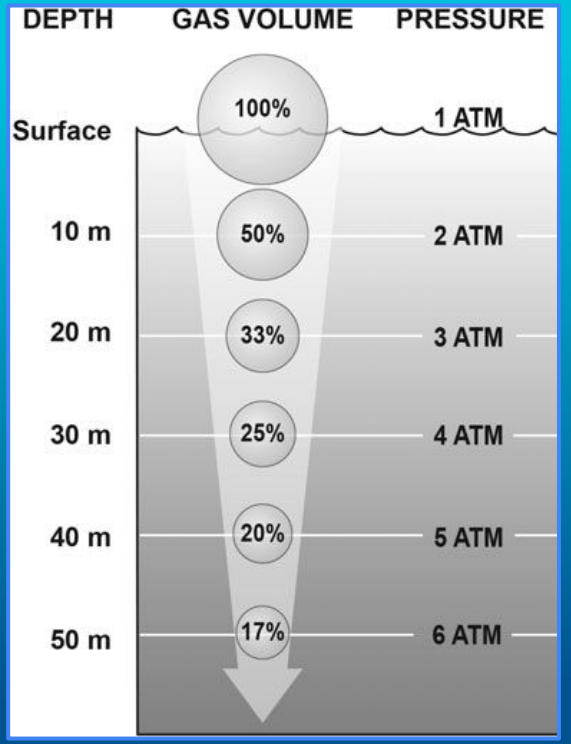
At constant temperature (and “low pressure”) the volume of a gas mass is inversely proportional to its pressure.



$$P_1 * V_1 = k = 1.5 = P_2 * V_2$$

Boyle's law visualized

Sealing
Material strength
Material fatigue



The motive (2018-2023)

https://www.juanmitaboada.com/alioli-rov-submarine-drone-diary

Flight controller

ARDUPILOT

Chris Anderson & son (2007) Drone Arduino

Jordi Muñoz, Chris Anderson, and Jon Callaghan

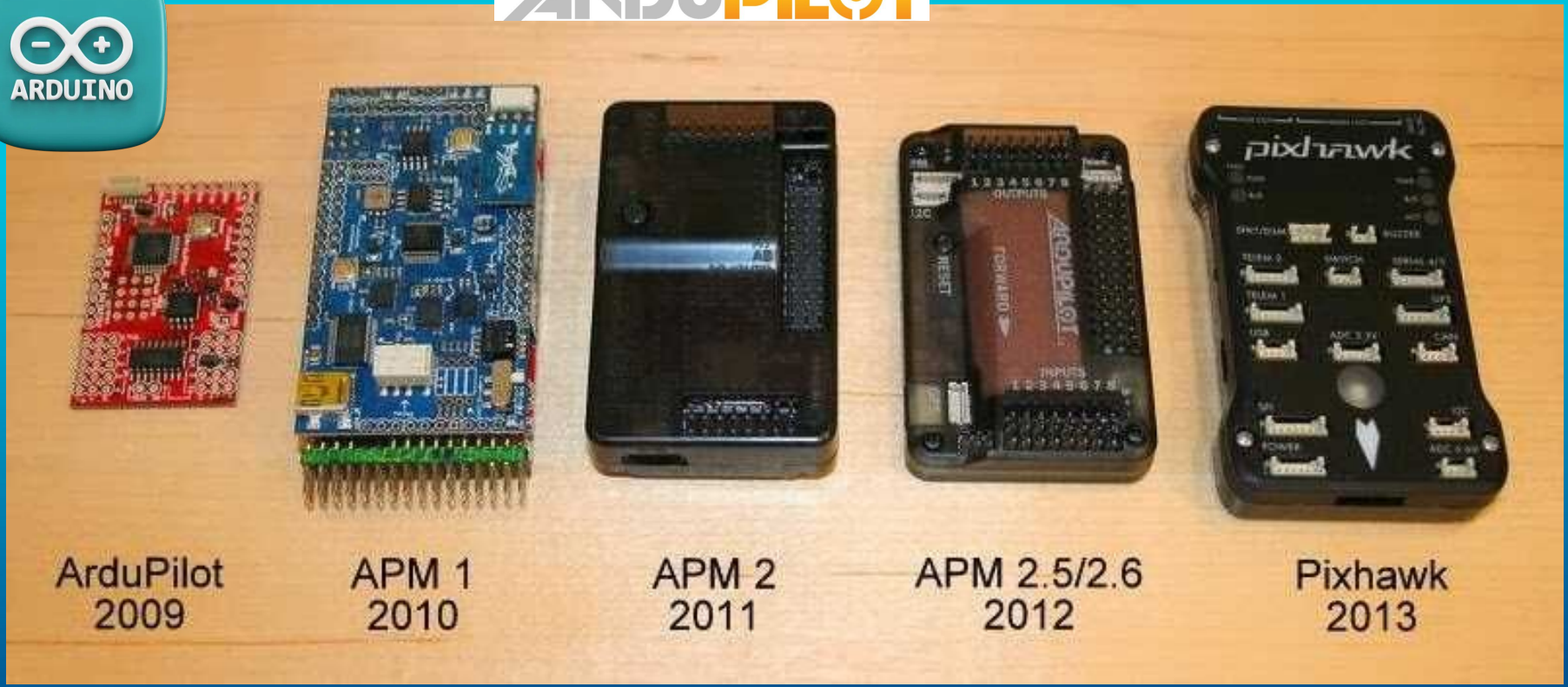
DIY DRONES
The Leading Community for Personal UAVs

true Ventures

3DR

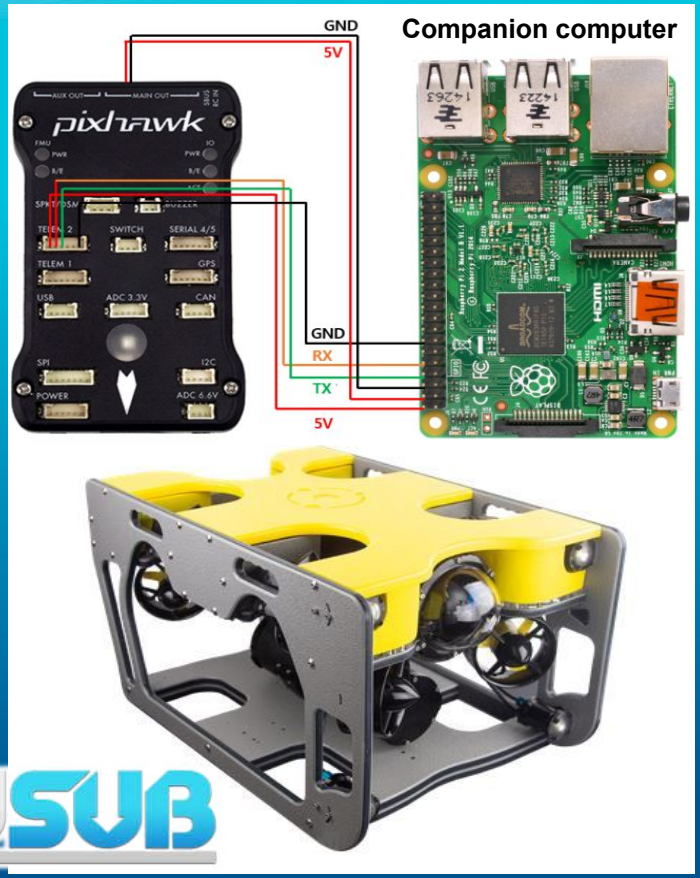
Juanmi Taboada

Flight controller

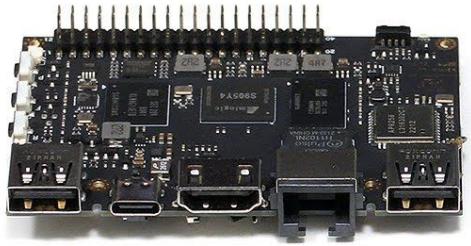


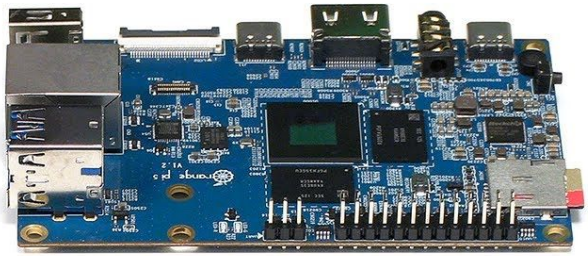
Flight controllers

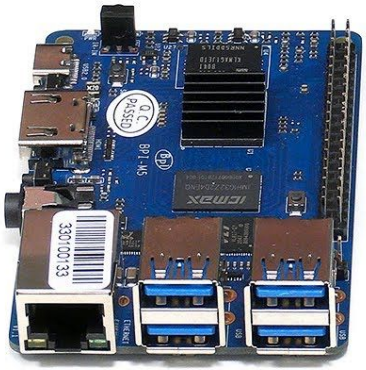
Ardupilot -> Ardusub

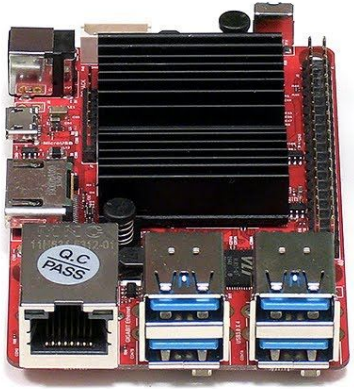


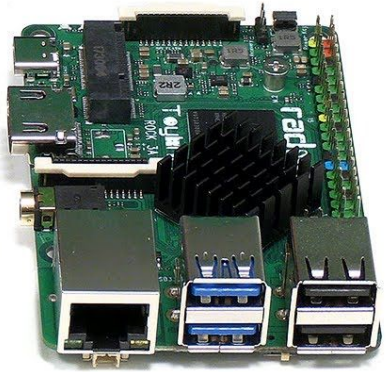
Companion computers

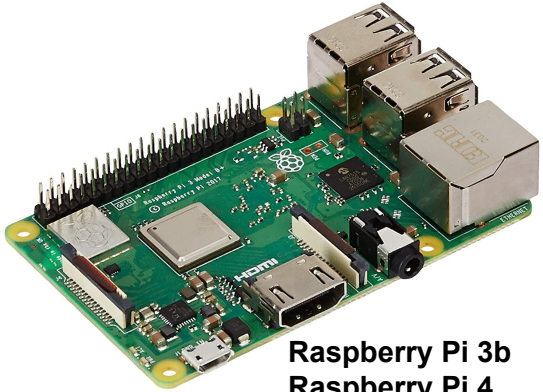








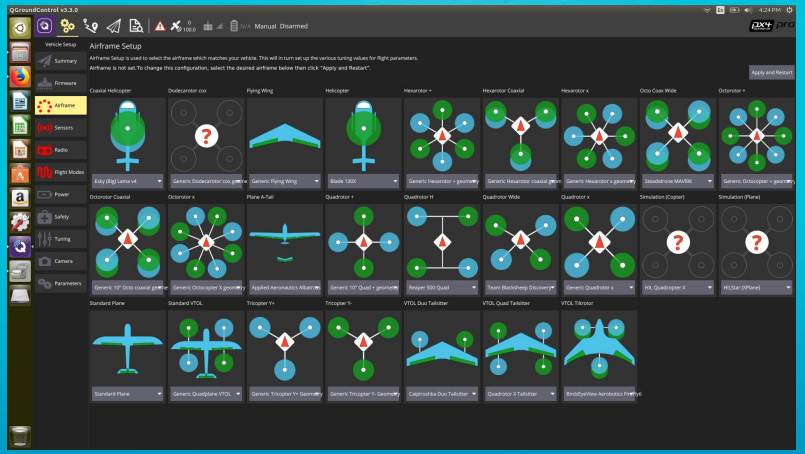


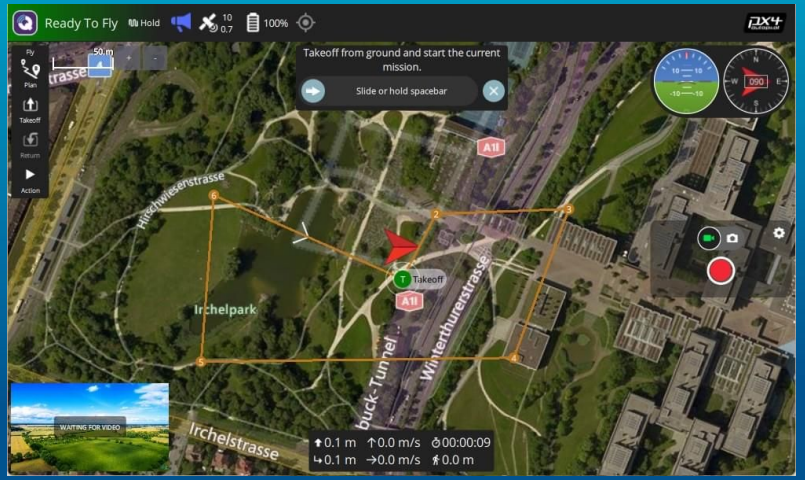


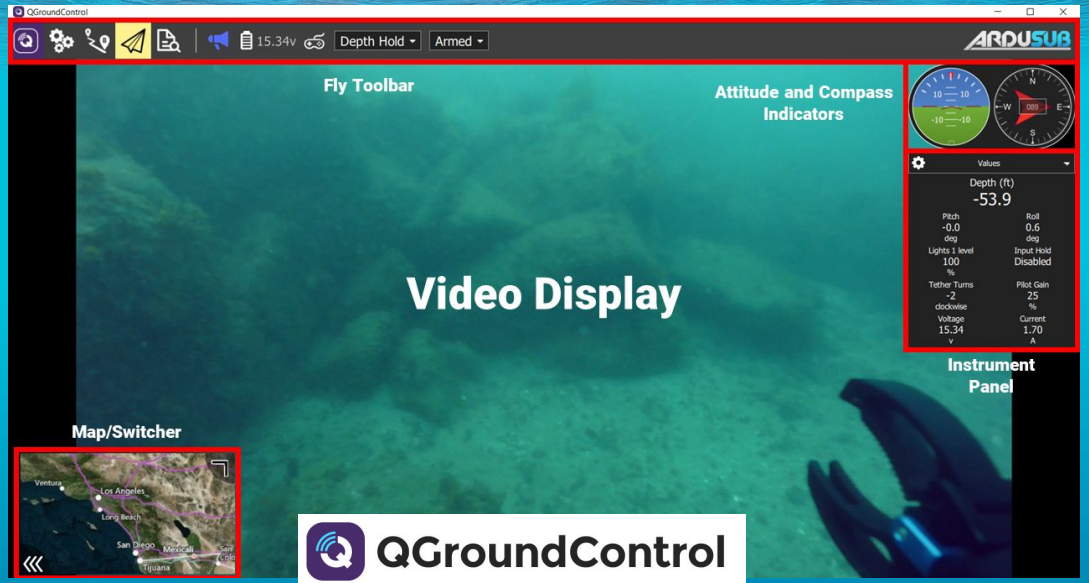
Raspberry Pi 3b
Raspberry Pi 4

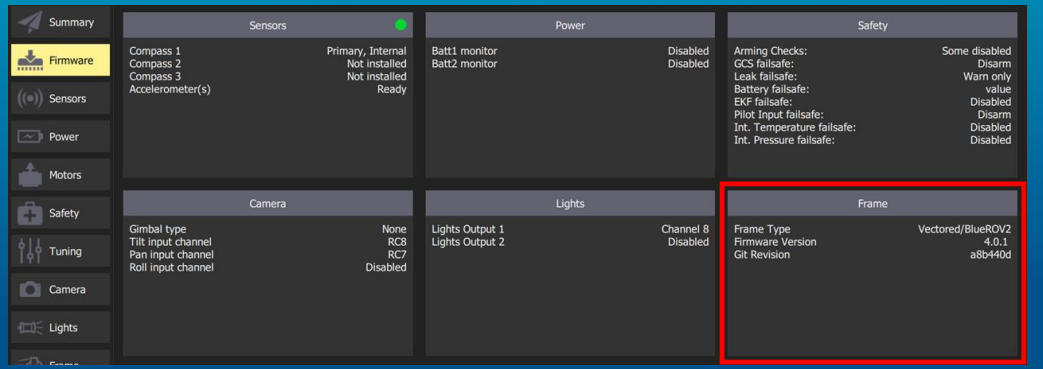
ARDUSUB

Live build your submarine



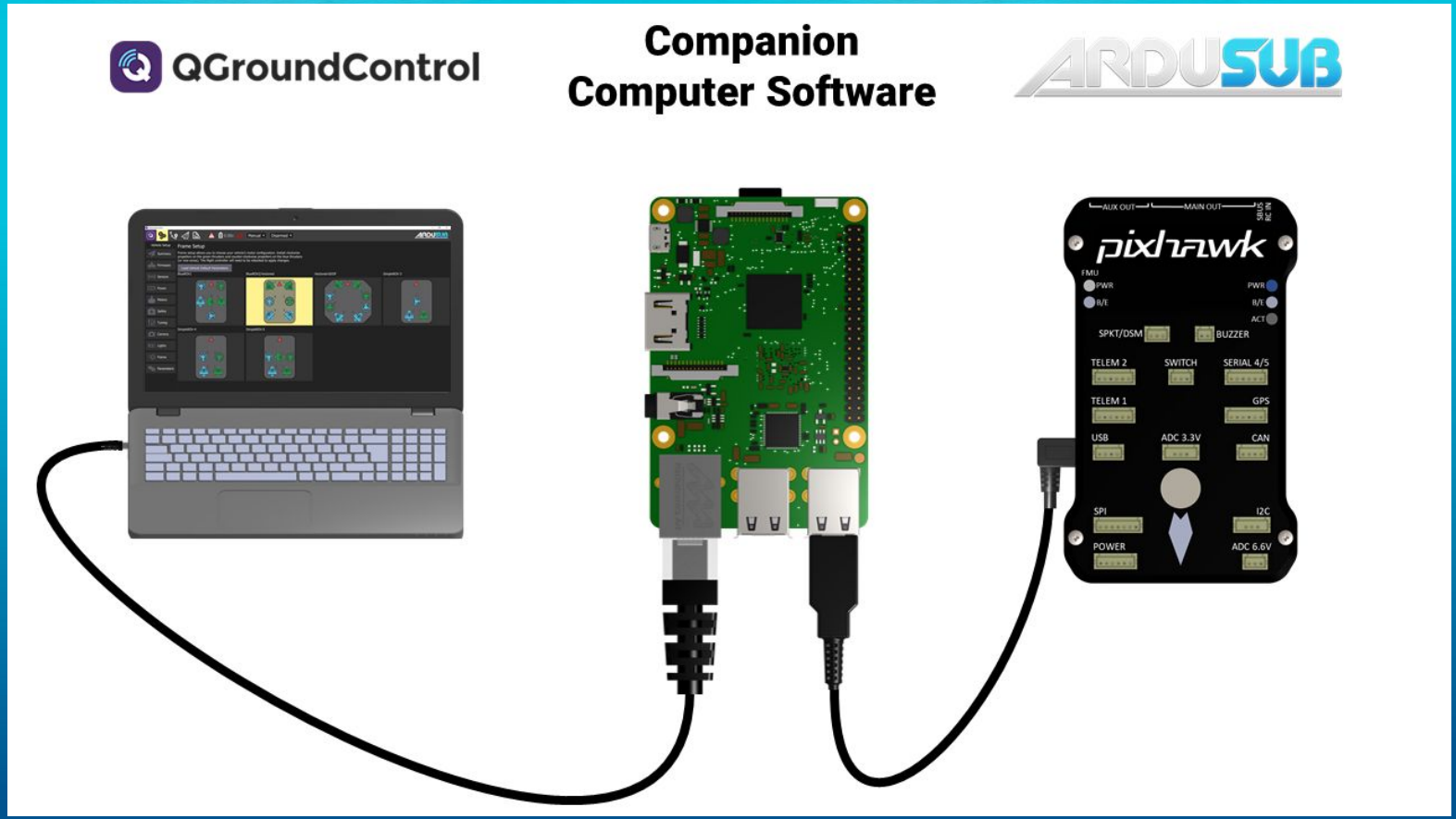




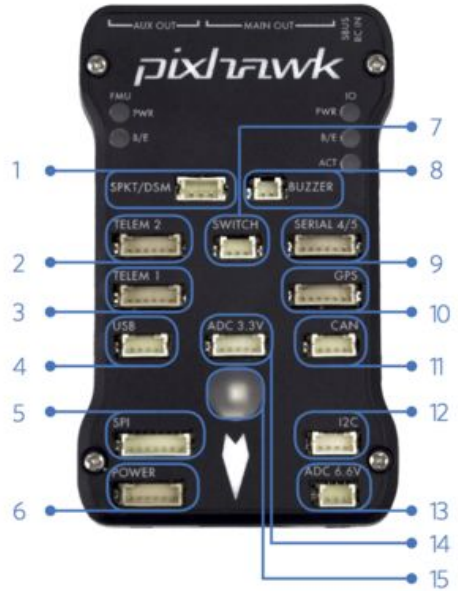


Juanmi Taboada

Basic design

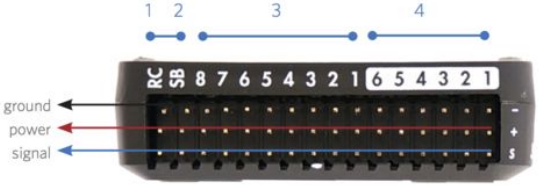


Pixhawk flight controller



1 Spektrum DSM receiver
2 Telemetry (radio telemetry)
3 Telemetry (on-screen display)
4 USB
5 SPI (serial peripheral interface) bus
6 Power module
7 Safety switch button
8 Buzzer
9 Serial
10 GPS module
11 CAN (controller area network) bus
12 IPC splitter or compass module
13 Analog to digital converter 6.6 V
14 Analog to digital converter 3.3 V
15 LED indicator

1 Radio control receiver input
2 S.Bus output
3 Main outputs
4 Auxiliary outputs



1 Input/output reset button
2 SD card
3 Flight management reset button
4 Micro-USB port

32-bit ARM Cortex M4 core with FPU - 168 Mhz/256 KB RAM/2 MB Flash - 32-bit failsafe co-processor

pixhawk

Firmware: Autopilot

QGroundControl

ARDUSUB

Vehicle Setup

Summary

Firmware

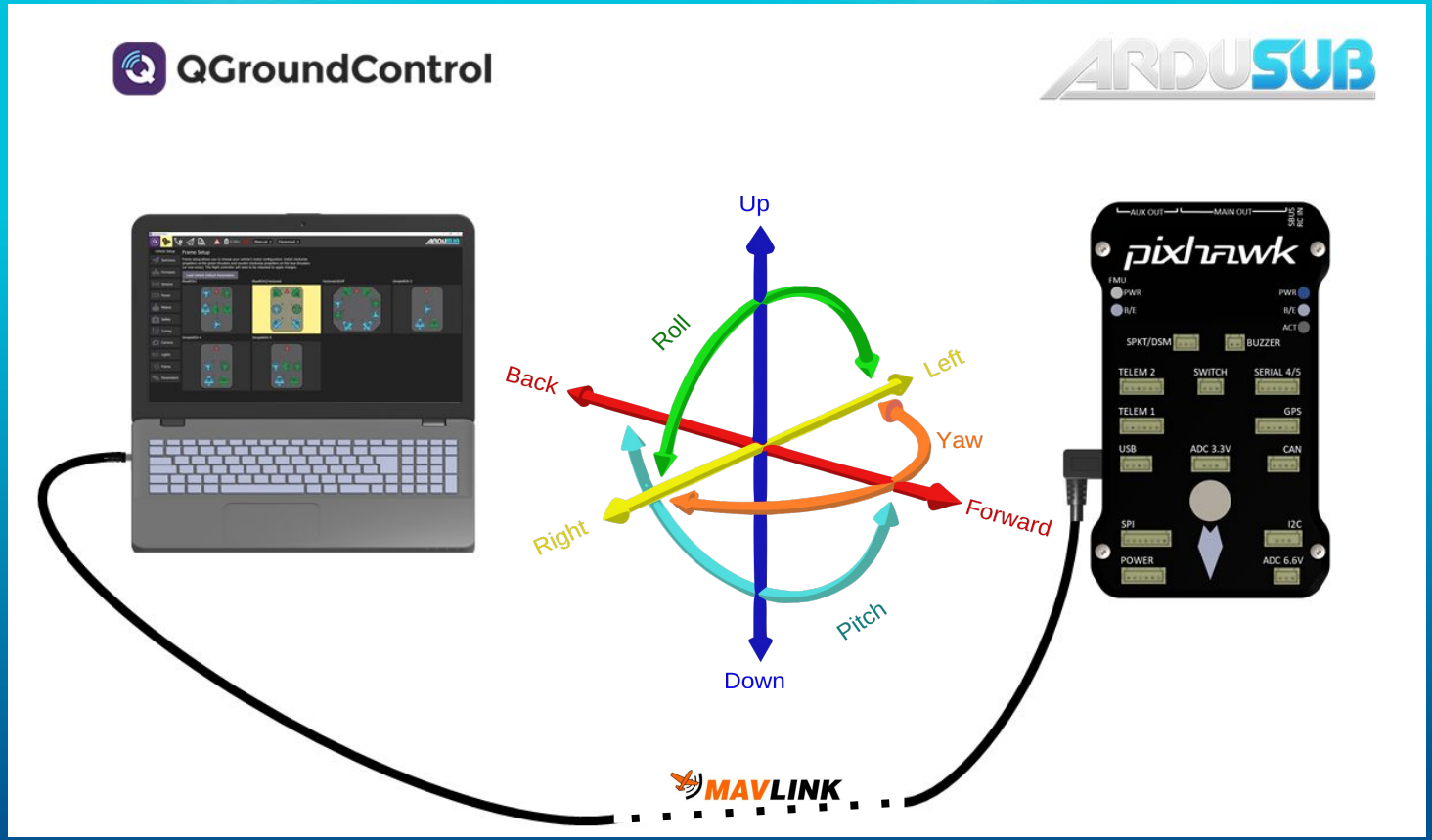
FIRMWARE

QGroundControl can upgrade the firmware on Pixhawk devices, SiK Radios and PX4 Flow Smart Cameras.

Plug in your device via USB to start firmware upgrade.

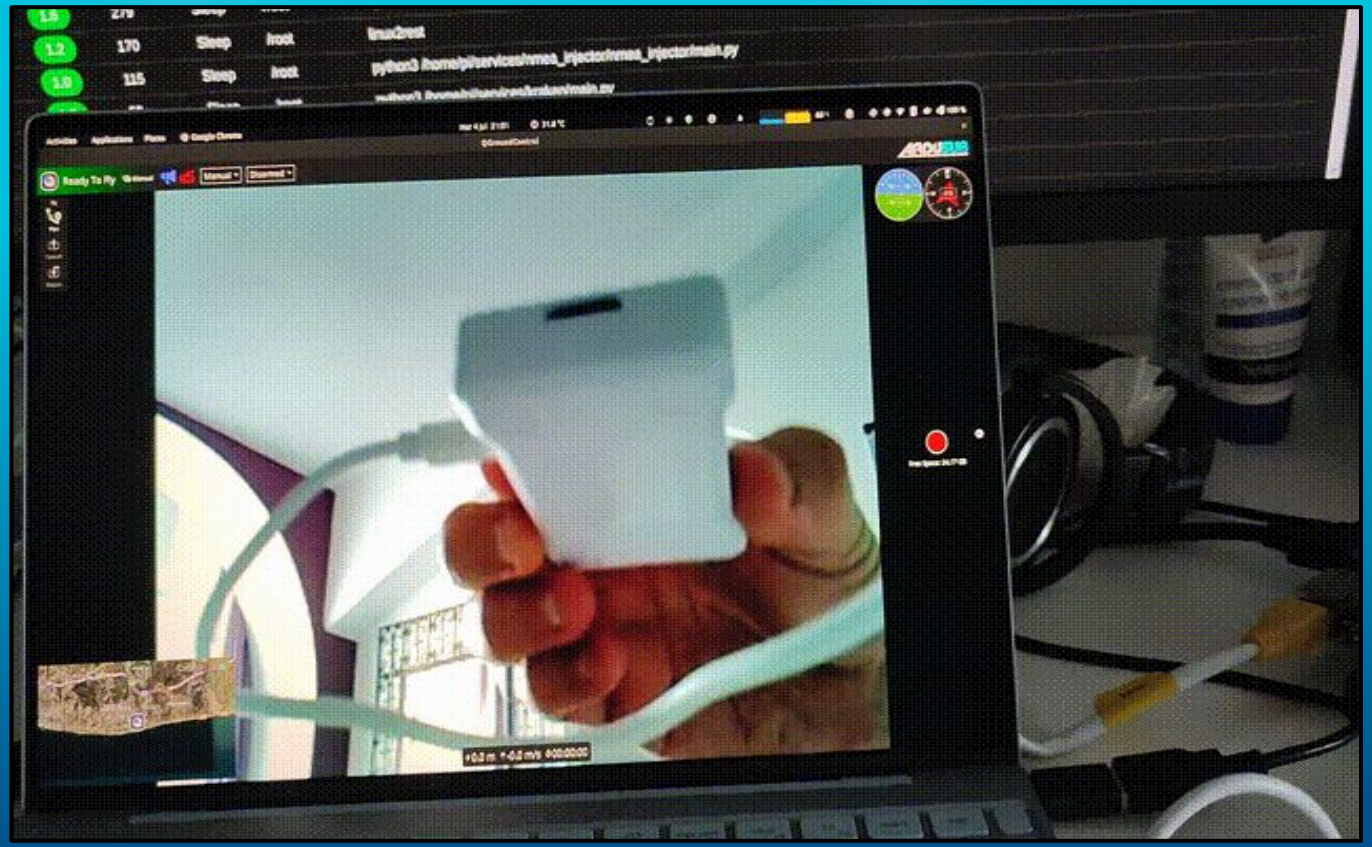
Found device: Pixhawk
Connected to bootloader:
Version: 4
Board ID: 9
Flash size: 2080768
Downloading firmware...
From: http://px4-travis.s3.amazonaws.com/Firmware/stable/px4fmu-v2_default.px4
Download complete
MAV_AUTOPILOT = 12
Successfully decompressed parameter_xml
Successfully decompressed airframe_xml
Successfully decompressed image
Erasing previous program...
Erase complete
Programming new version...
Program complete
Verifying program...
Verify complete
Upgrade complete

6DOF


QGroundControl
ARDUSUB
Up
Roll
Back
Left
Yaw
Forward
Right
Pitch
Down
pixhawk
MAVLINK

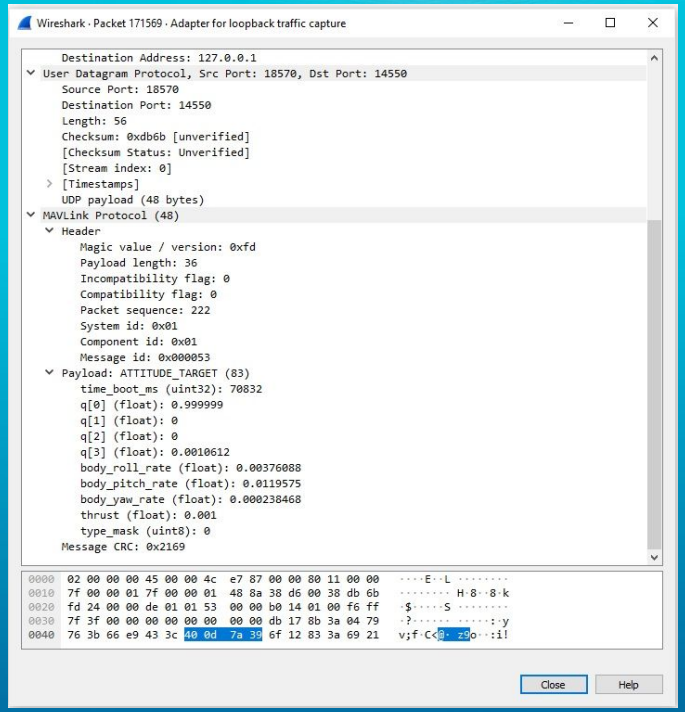
Live build your submarine

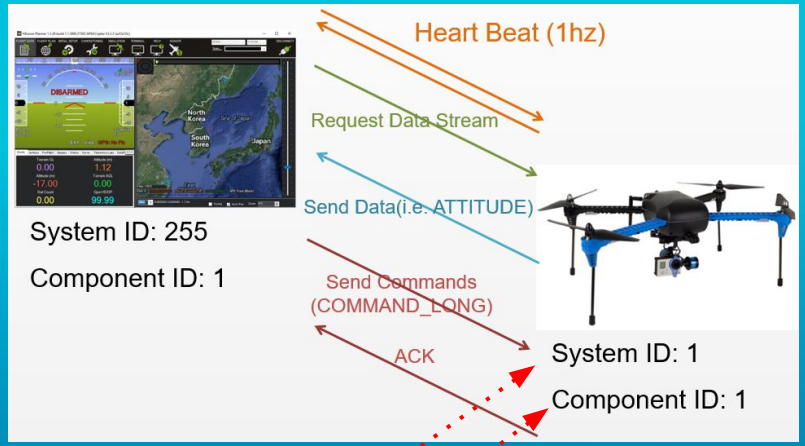
6DOF

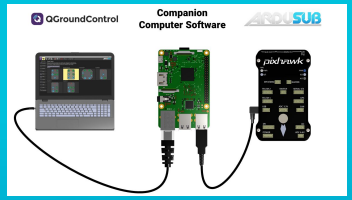


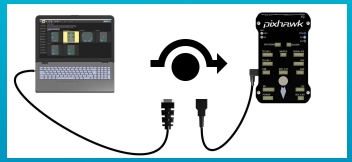
Mavlink

MAVLINK
MICRO AIR VEHICLE COMMUNICATION PROTOCOL

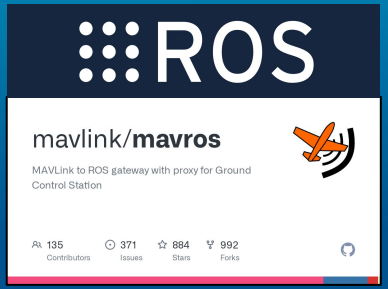








Multi-vehicle
Multi-component
HMAC-SHA256



MAVLink v2 Frame(12 - 280)

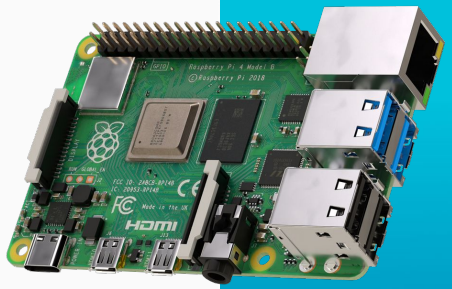
STX	LEN	INC FLAGS	CMP FLAGS	SEQ	SYS ID	COMP ID	MSG ID (3 bytes)	PAYLOAD (0 - 255 bytes)	CHECKSUM (2 bytes)	SIGNATURE (13 bytes)

Juanmi Taboada

Firmware: Companion Computer

ARDUSUB

Raspberry Pi



Operating System

RASPBERRY PI OS (32-BIT)

Storage

GENERIC STORAGE...

WRITE

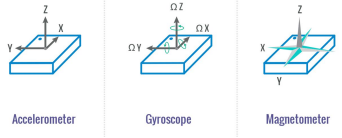
Writing... 69%

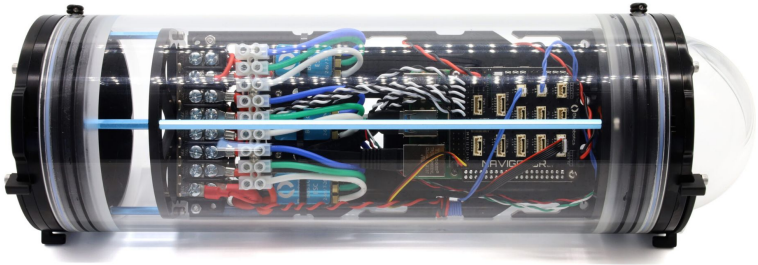
CANCEL WRITE

Ingredients

pixhawk

- Telemetry (IMU) -> Positioning
- Control (Outputs) -> Thrusters
- Pressure
- Temperature
- Servo camera

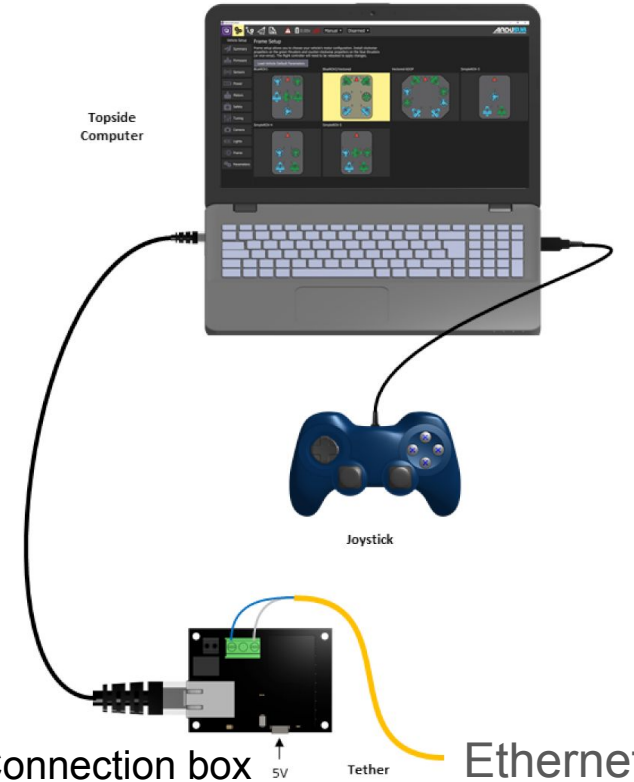




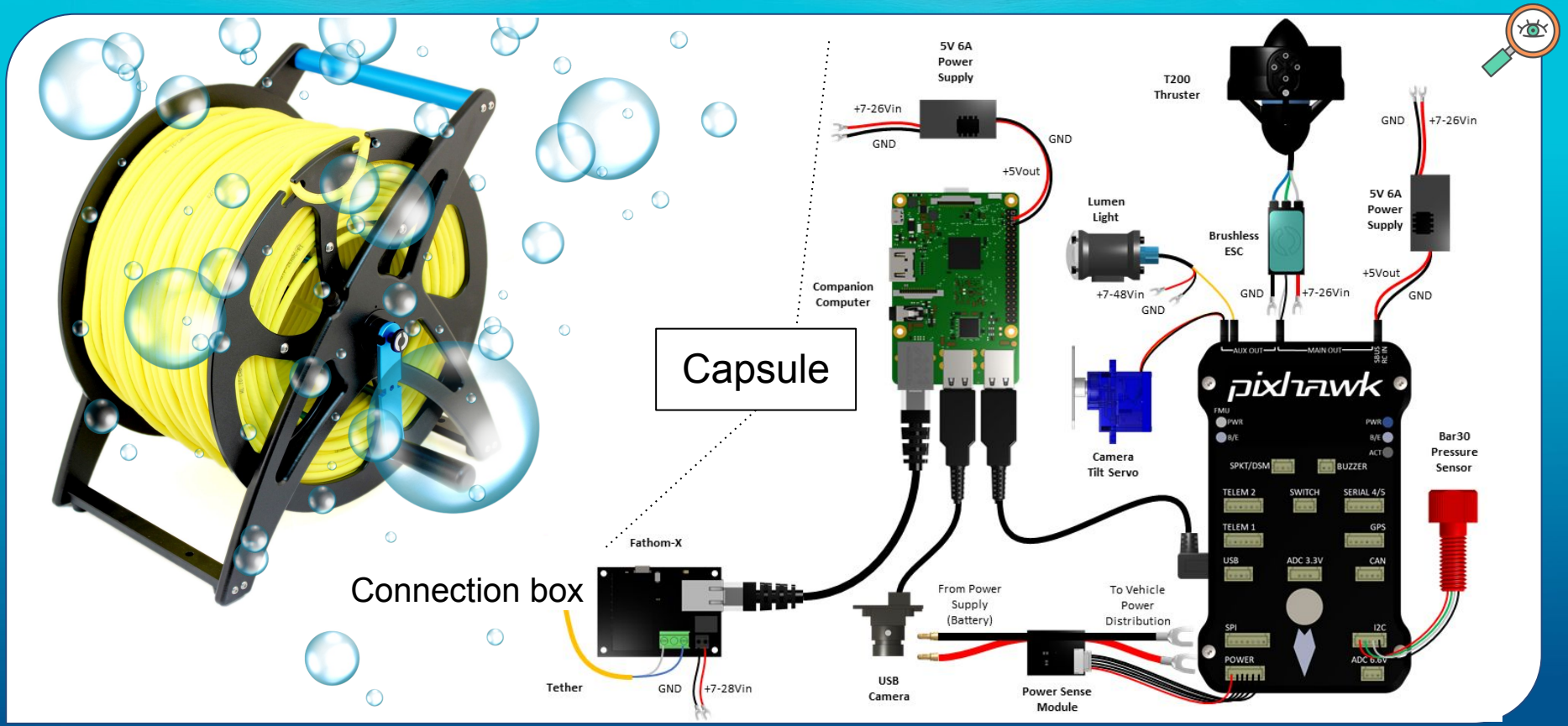
Ourselves

- Lights
- Camera
- Leak sensor
- Depth sensor
- Capsule (Hull)
- Frame

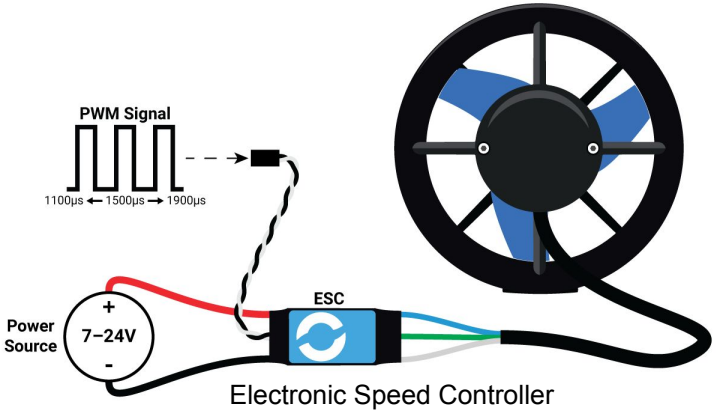
Top side


Topside
Computer
Joystick
Connection box
5V
Tether
Ethernet connection

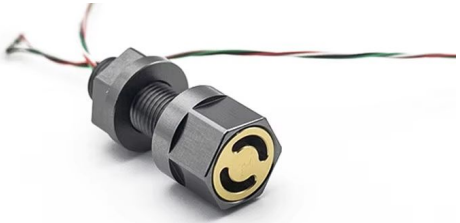
Bottom side


5V 6A
Power
Supply
+7-26Vin
GND
GND
+5Vout
T200
Thruster
GND
+7-26Vin
5V 6A
Power
Supply
+5Vout
GND
Lumen
Light
+7-48Vin
GND
Brushless
ESC
GND
+7-26Vin
Companion
Computer
Capsule
Camera
Tilt Servo
AUX OUT
MAIN OUT
SBUS
RC IN
pixhawk
FMU
PWR
B/E
PWR
B/E
ACT
SPKT/DSM
BUZZER
TELEM 2
SWITCH
SERIAL 4/5
TELEM 1
GPS
USB
ADC 3.3V
CAN
SPI
I2C
POWER
ADC 6.6V
Bar30
Pressure
Sensor
Fathom-X
Connection box
Tether
GND
+7-28Vin
USB
Camera
From Power
Supply
(Battery)
To Vehicle
Power
Distribution
Power Sense
Module

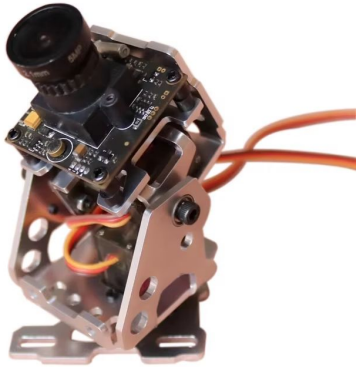
Devices



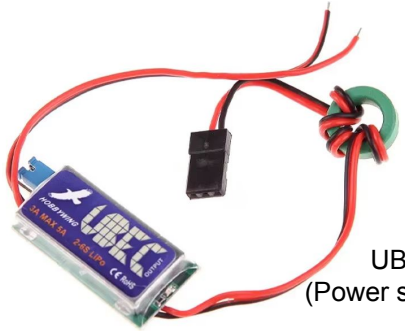
Electronic Speed Controller



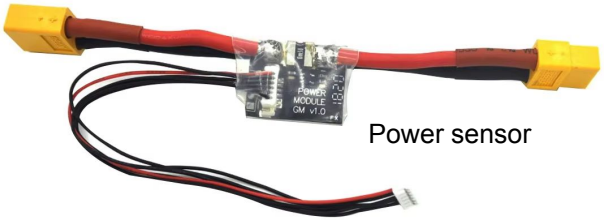
Pressure and temperature sensor



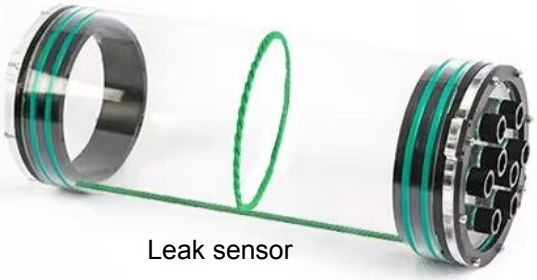
Camera + Servo



UBEC
(Power stabilizer)



Power sensor

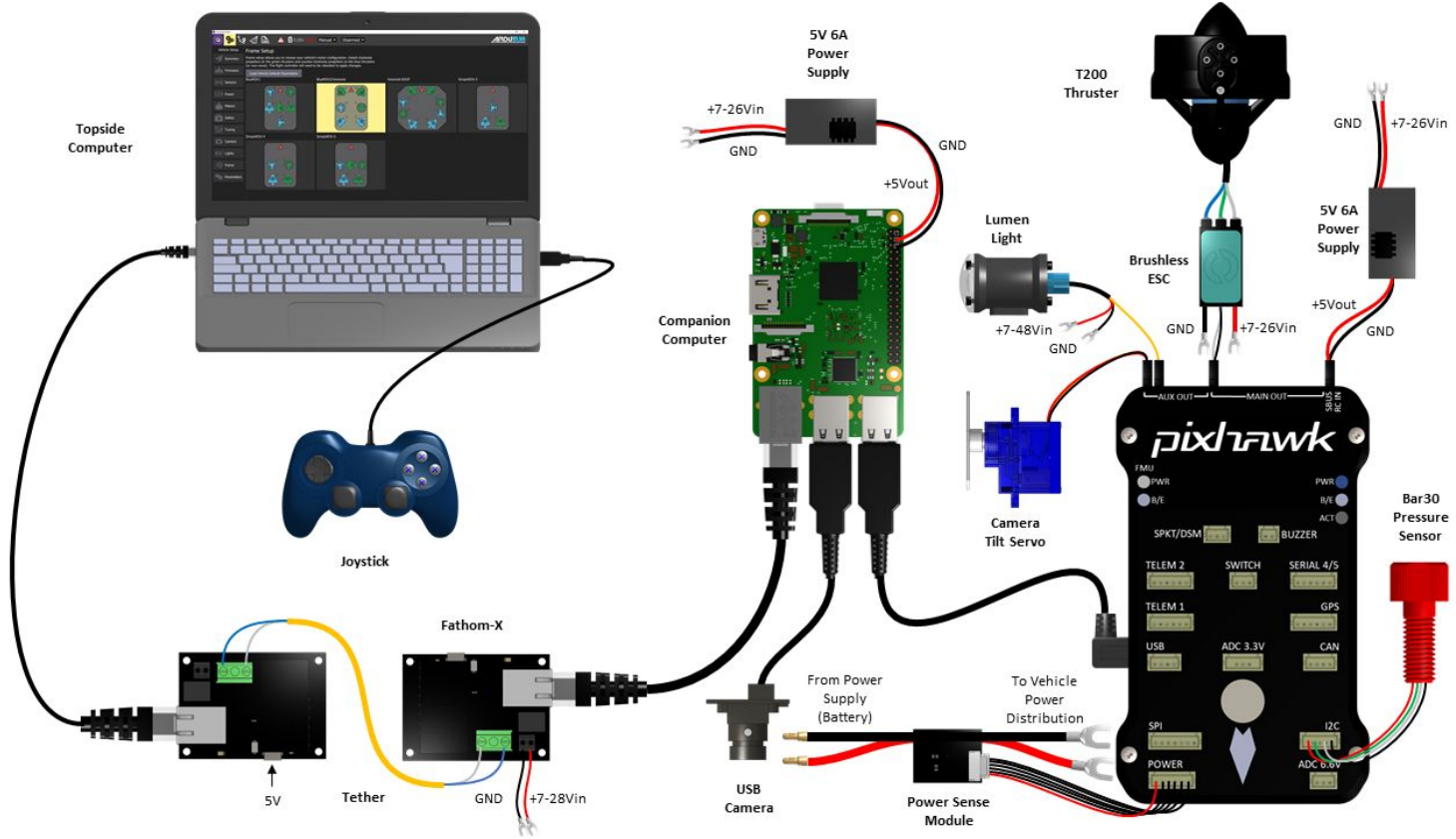


Leak sensor

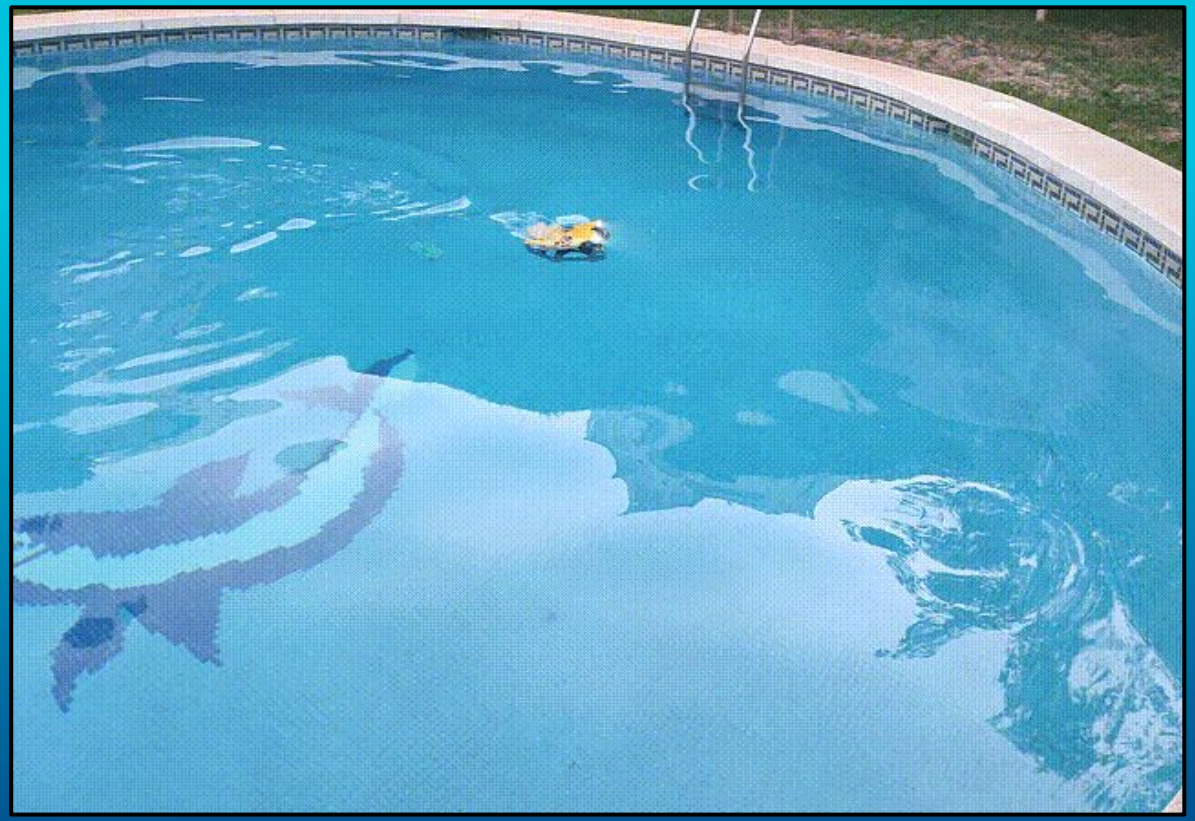
Lights 💡

Light is a game changer

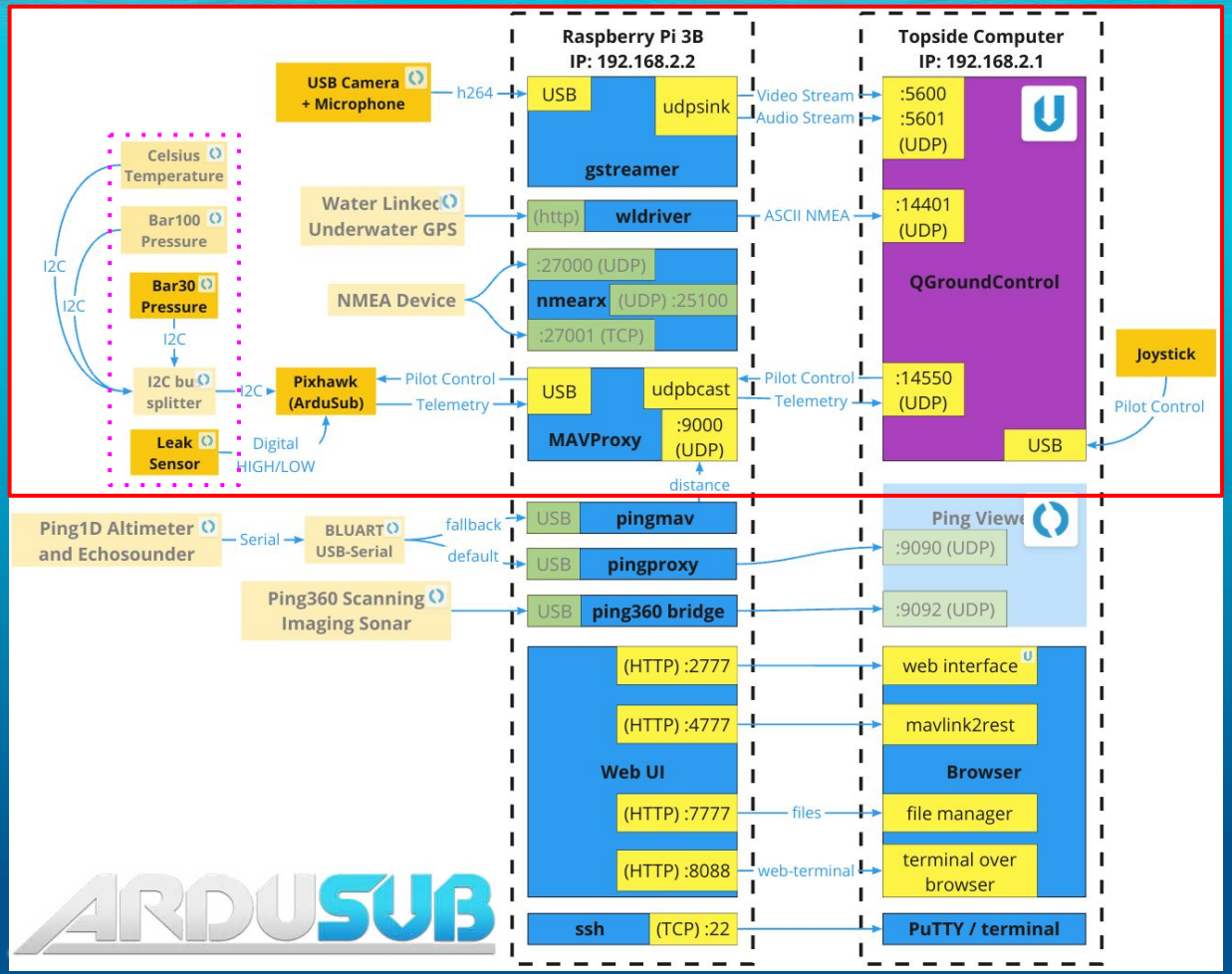
Hardware Connection Diagram



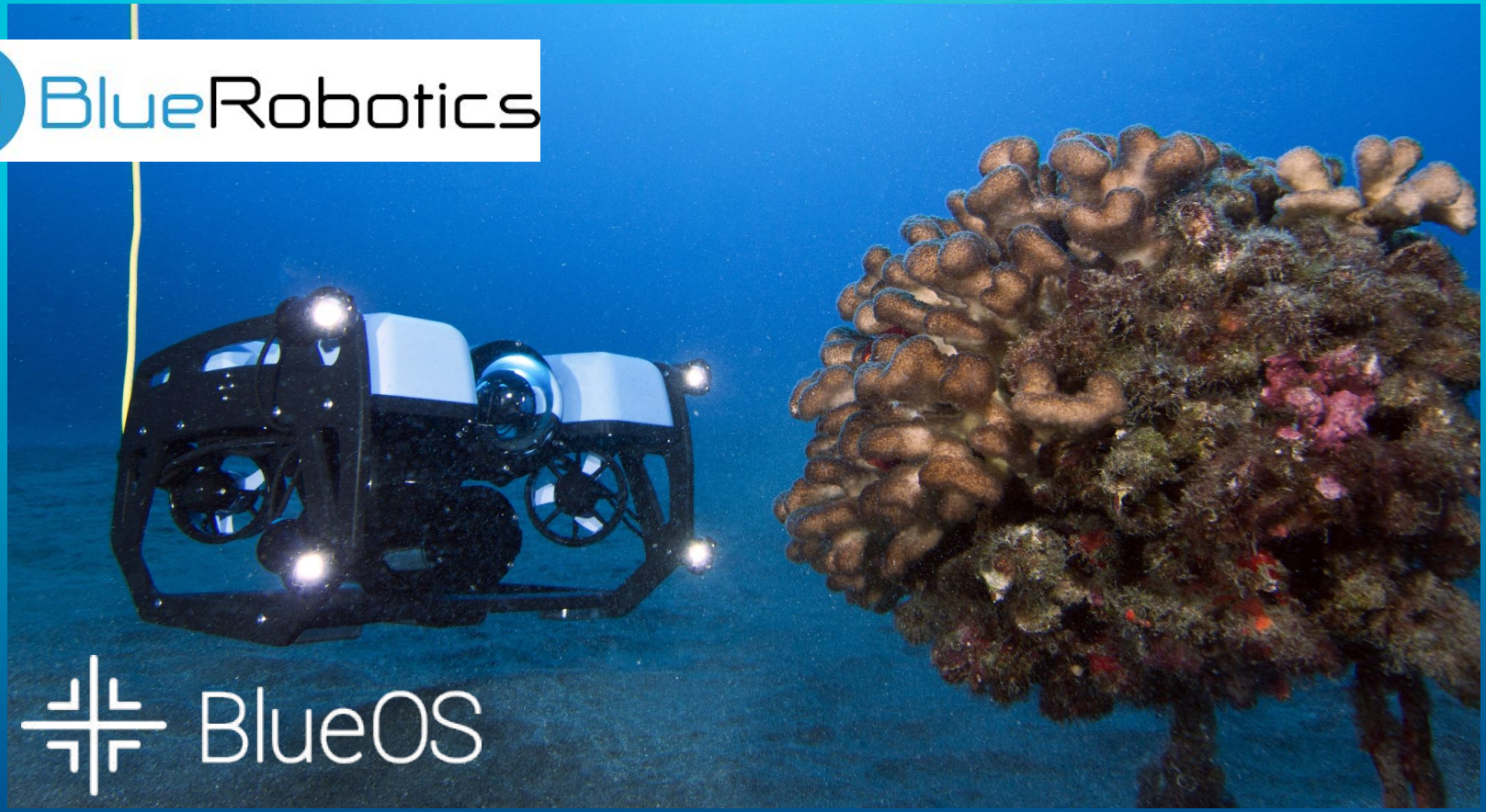
Hardware Connection Diagram

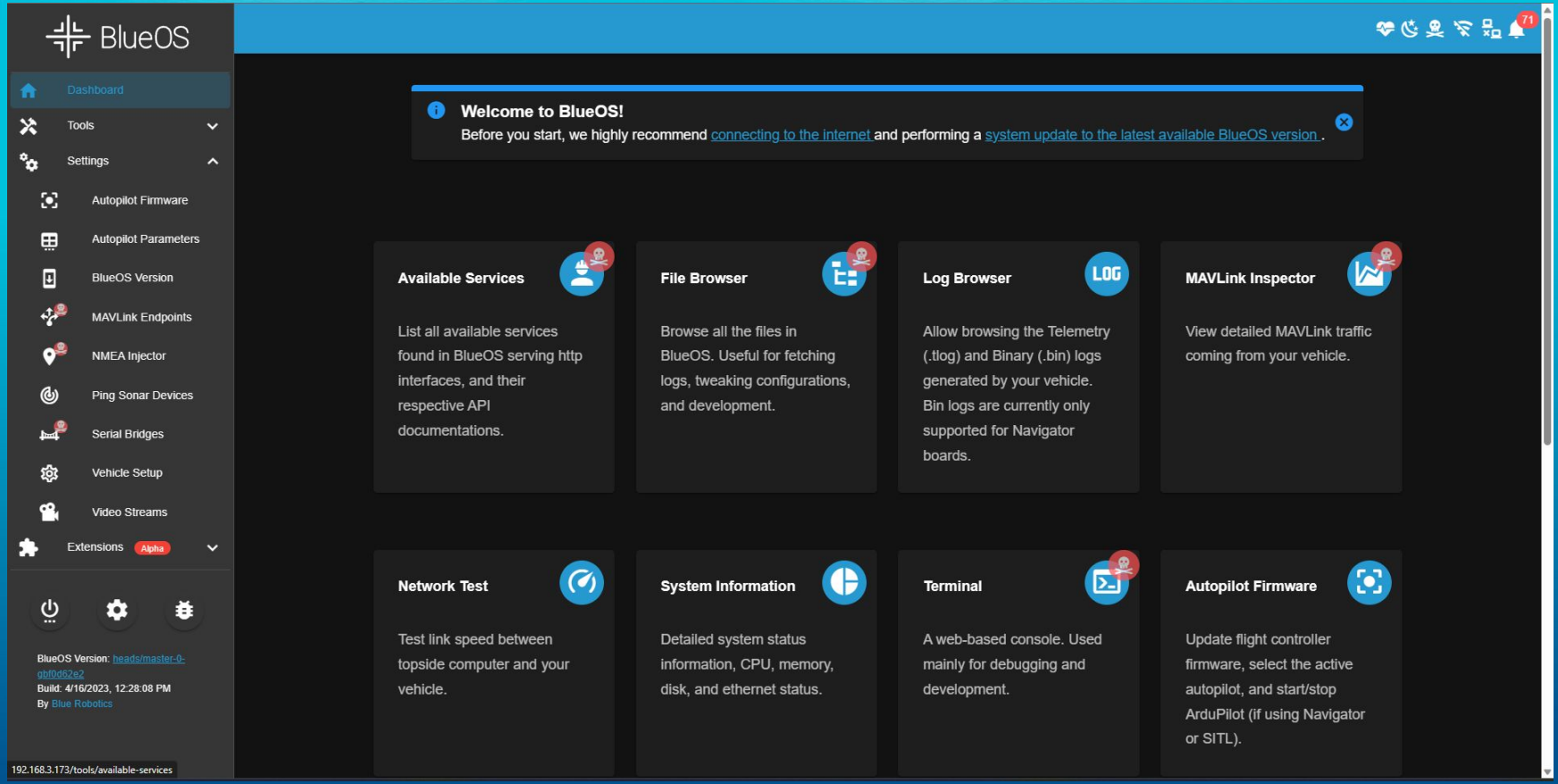


Connection Software Diagram



Juanmi Taboada


BlueRobotics
BlueOS


BlueOS
Dashboard
Tools
Settings
Autopilot Firmware
Autopilot Parameters
BlueOS Version
MAVLink Endpoints
NMEA Injector
Ping Sonar Devices
Serial Bridges
Vehicle Setup
Video Streams
Extensions
Alpha
BlueOS Version: heads/master-0-gbf0d62e2
Build: 4/16/2023, 12:28:08 PM
By Blue Robotics
192.168.3.173/tools/available-services
71
Welcome to BlueOS!
Before you start, we highly recommend connecting to the internet and performing a system update to the latest available BlueOS version.
Available Services
List all available services found in BlueOS serving http interfaces, and their respective API documentations.
File Browser
Browse all the files in BlueOS. Useful for fetching logs, tweaking configurations, and development.
Log Browser
LOG
Allow browsing the Telemetry (.tlog) and Binary (.bin) logs generated by your vehicle. Bin logs are currently only supported for Navigator boards.
MAVLink Inspector
View detailed MAVLink traffic coming from your vehicle.
Network Test
Test link speed between topside computer and your vehicle.
System Information
Detailed system status information, CPU, memory, disk, and ethernet status.
Terminal
A web-based console. Used mainly for debugging and development.
Autopilot Firmware
Update flight controller firmware, select the active autopilot, and start/stop ArduPilot (if using Navigator or SITL).

BlueOS: Cockpit

Live build your submarine

BlueOS: Vehicle Setup

DEMO

BlueOS

BlueROV

- Autopilot Firmware
- Autopilot Parameters
- BlueOS Version
- Cockpit
- Extensions Alpha
- Log Browser
- Network Test
- Ping Sonar Devices
- System Information
- Vehicle Setup
- Video Streams
- ZeroTier Manager

BlueOS Version: tags/1.1.0-beta.23-0-g08b21dc7
Build: 6/14/2023, 10:17:34 PM
By Blue Robotics

OVERVIEW | PWM OUTPUTS | CONFIGURE

Vehicle

Flight Controller	Pixhawk1
Firmware	ArduSub 4.1.0 (stable)
Onboard Computer	Raspberry Pi 3 B
Frame	Vectored

Autopilot Sensors

Sensor	Type	Bus	Address	Status
ACC_MPU6000	INS	SPI 1	0x04	Calibrated
ACC_LSM303D	INS	SPI 1	0x02	Calibrated
LSM303D	1st Compass (internal)	SPI 1	0x02	Calibrated
MS5611	Freshwater Pressure	SPI 1	0x03	1019.10 hPa
MS5611	Freshwater Pressure	I2C 1	0x76	1019.10 hPa

Ping Sensors

Video

H264 USB Camera: USB Camera
udp://192.168.2.1:5600

mmal service 16.1
No streams configured

Lights

- Channel 8
- Aux 9

Gripper

Aux 10

Leak

Leak sensor 1:
Pin: Pixhawk Aux6
Logic: Low
Leak sensor 2:
Disabled
Leak sensor 3:
Disabled
Failsafe: Warn only

Battery Monitor

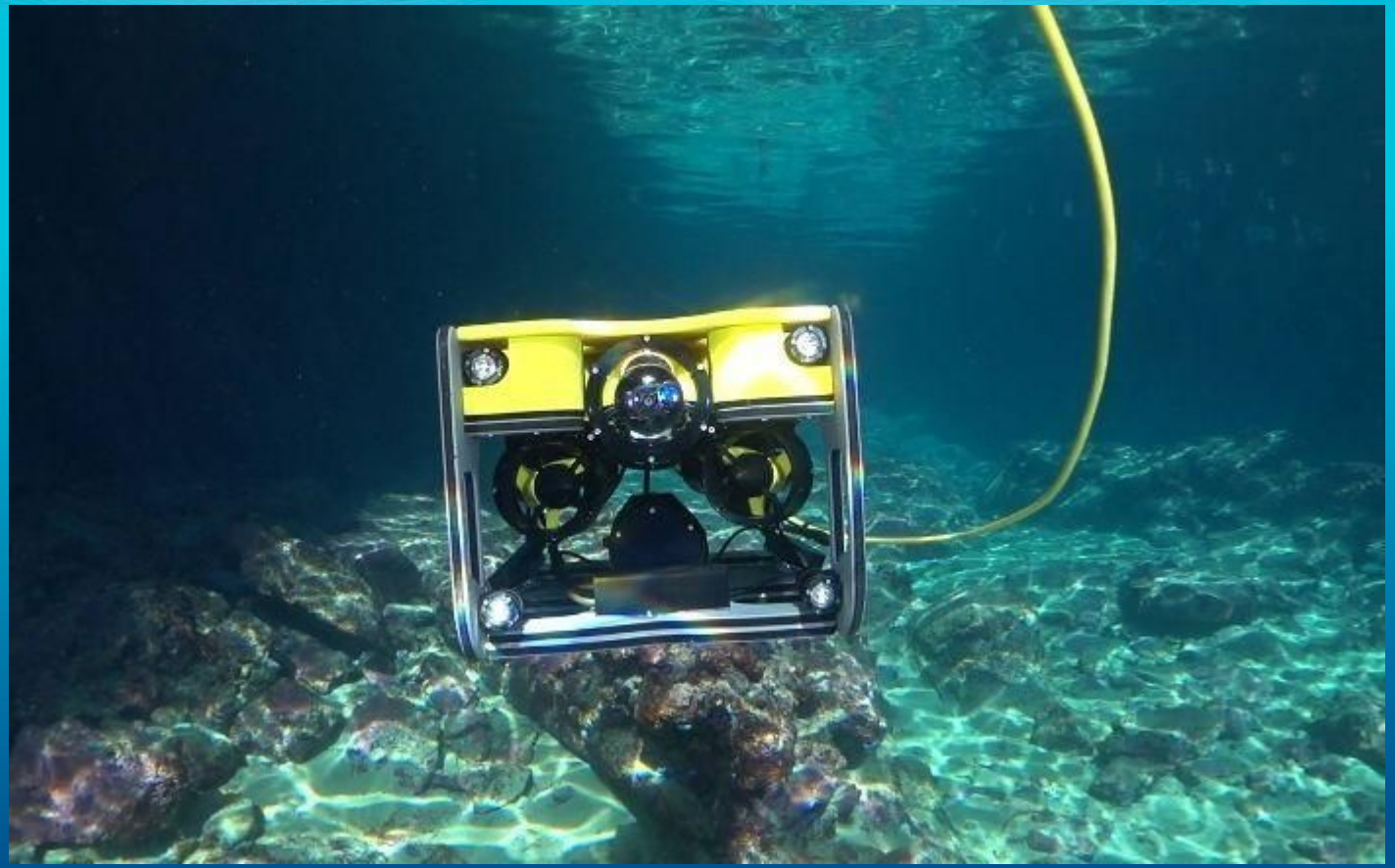
Voltage: 16.26 V **Current:** 0.58 A

Blue Robotics Power Sense Module
Low Voltage Failsafe: None
Low Voltage Level: 12.00
Critical Voltage Failsafe: None
Low Voltage Level: 12.00

EXAMPLE

Juanmi Taboada

Questions?



Thank you

Dive and discover

Juanmi Taboada