DESIGN : POINTS OVERVIEW

SHELL/FRAME/BODY OF THE DRONE

4 KEY ASPECTS

- THE FRAME SHOULD HOLD ALL COMPONENTS IN A GOOD RELATIVE ORIENTATION.
- THE FRAME SHOULD BE WATERPROOF OR CONTAIN WATERPROOF CASINGS
- THE FRAME SHOULD BE HYDRODYNAMIC
- THE FRAME SHOULD HAVE A GOOD CONFIGURATION OF MOTORS
- THE FRAME SHOULD PROVIDE NEUTRALLY BUOYENCY

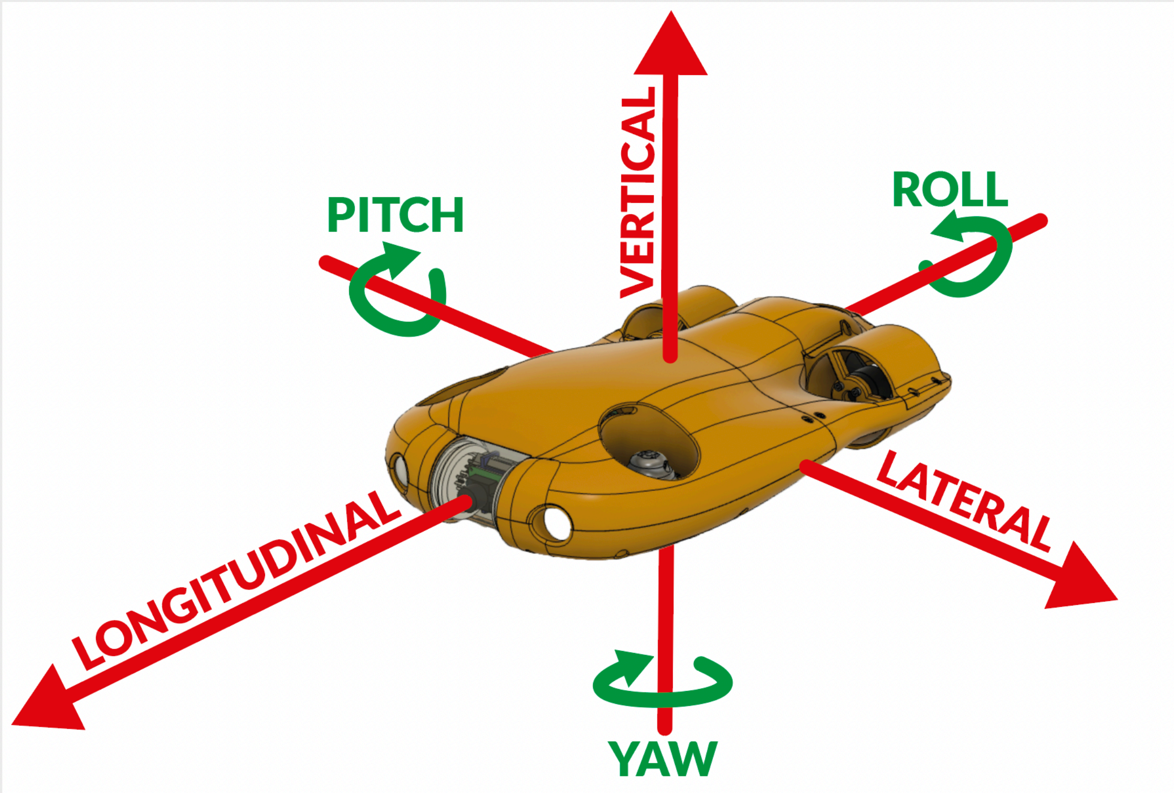
NEUTRALLY BUOYENCY
IT IS WHEN A OBJECT IN FLUID DOES-NOT SINK OF FLOAT BUT STAYS AT THE SAME DEPTH , ASSUMING THE WATER IS STILL.

WHICH MEANS
DENSITY(drone) = DENSITY(water)

IE , **VOLUME(drone) cm^3 x DENSITY(water) 1gm/cm^3**
= mass(drone) g

DEGREES OF FREEDOM

Reminder: Every object can have a maximum 6 ways in which it can move through space or "degrees of freedom" and we will refer to them with their actual names in this lesson. See all of them in the picture below:

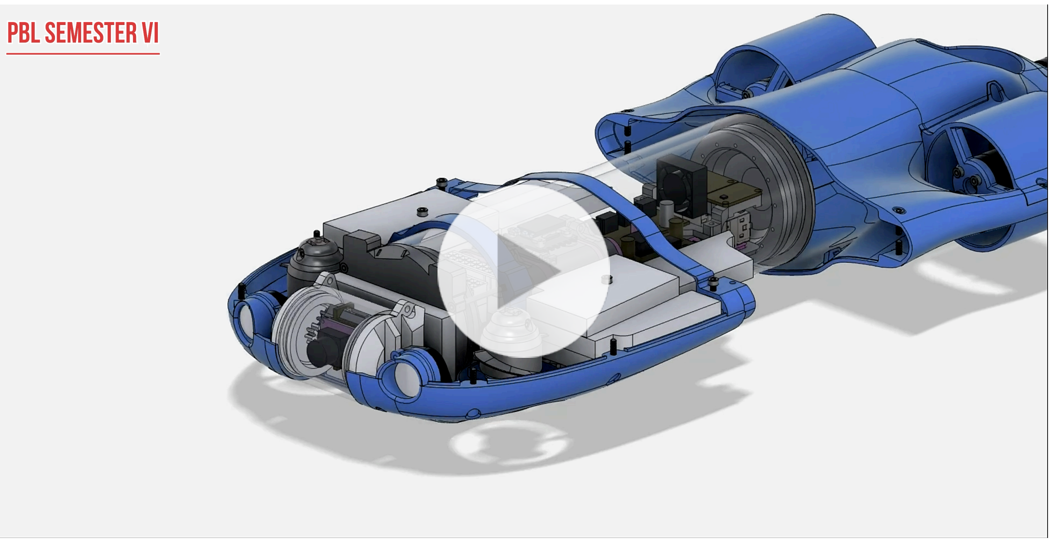


Interesting rule of thumb: **You can have as many degrees of freedom** in an underwater drone design **as thrusters**. For example, our drone has 5 motors and therefore - 5 degrees of freedom. You can also have more motors than degrees of freedom if they are spaced out more poorly.

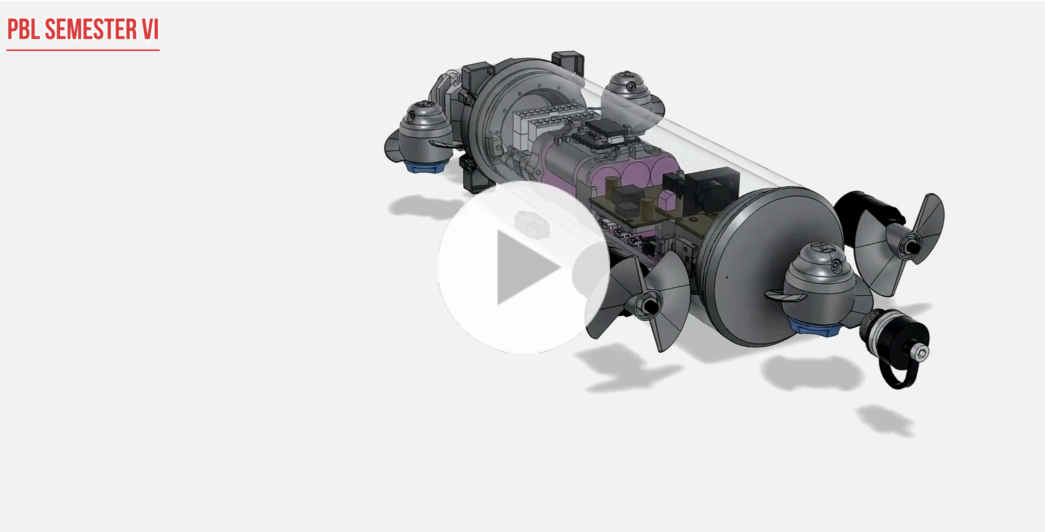
MOTIONS :

1. Longitudonal
2. Vertical
3. Pitch
4. Yaw
5. Roll

ELECTRONICS & SHELL

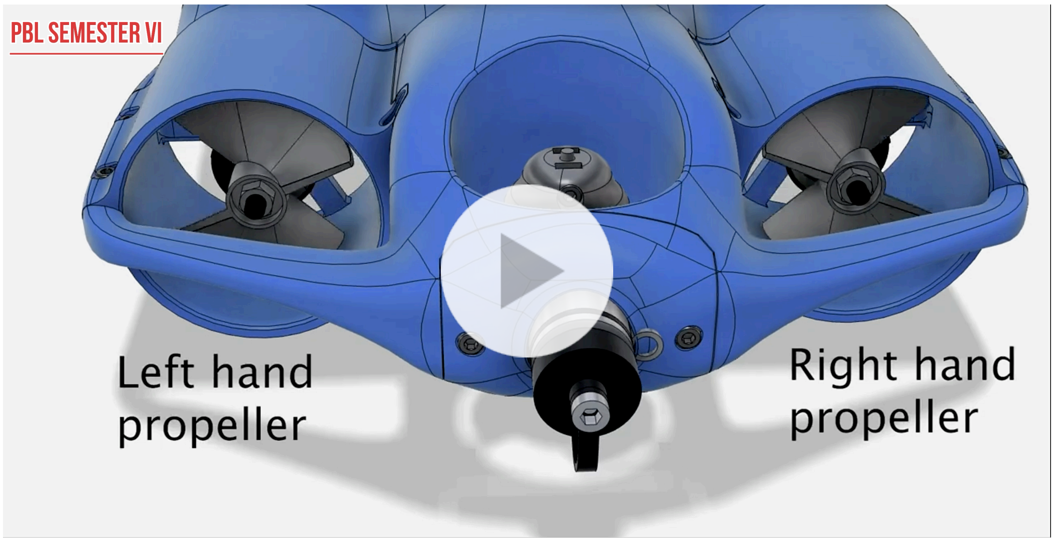


MOTORS & ELECTRONICS

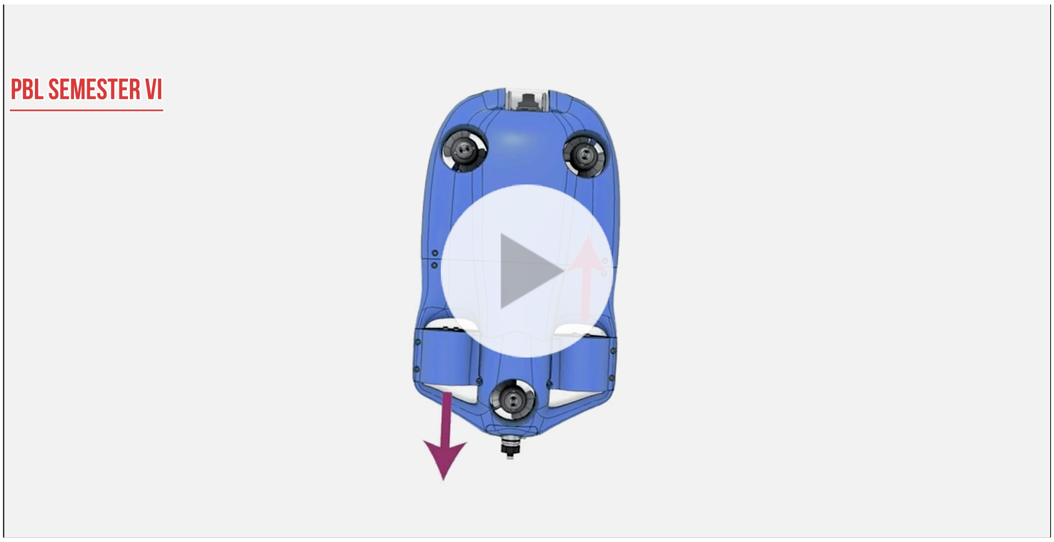


CARTESIAN MOMENTS (ALL)

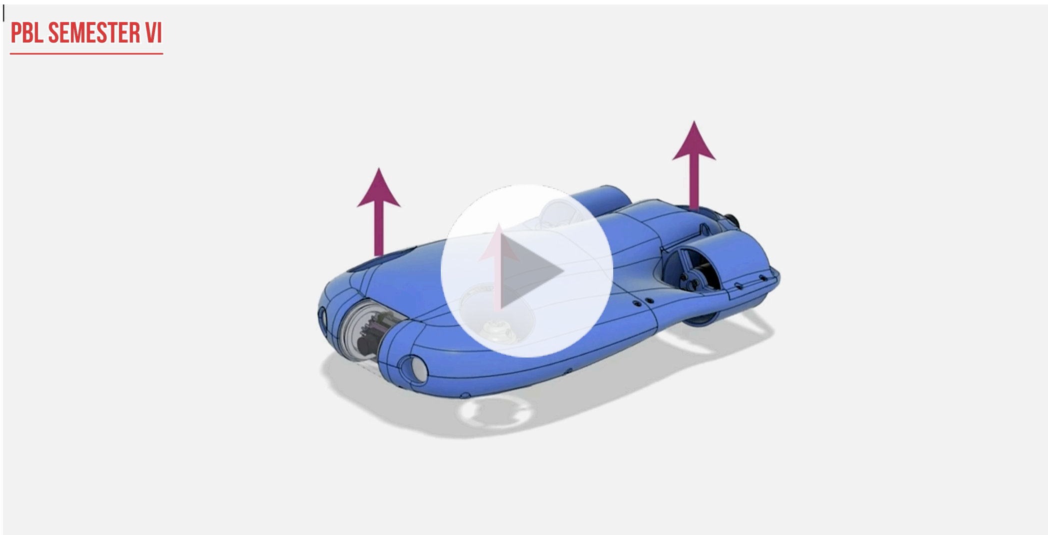
LEFT HAND & RIGHT HAND PROPELLERS



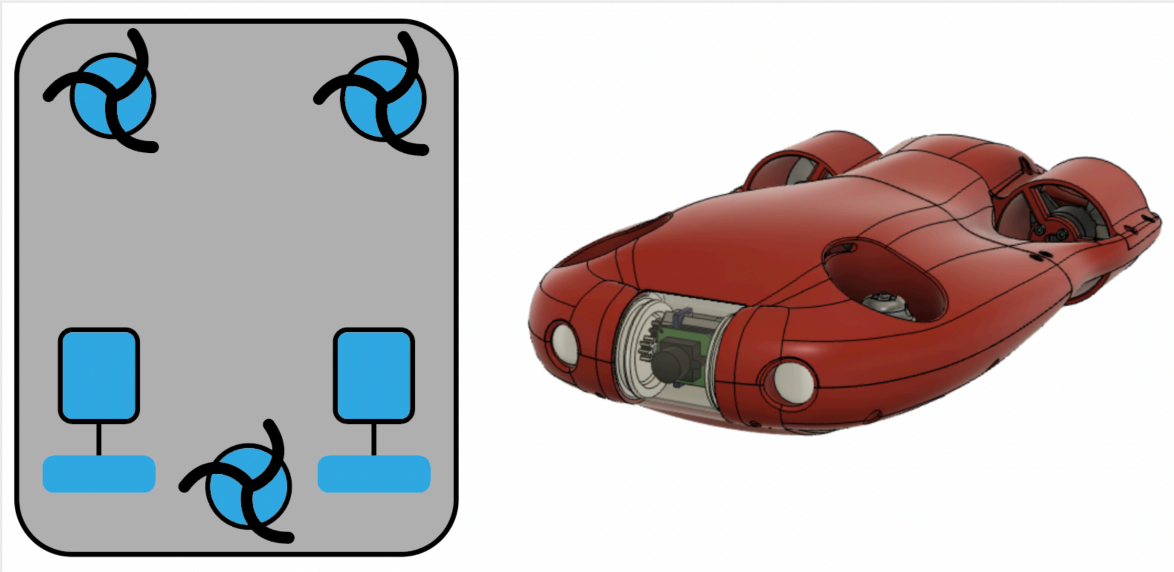
LONGITUDANAL & YAW MOTIONS



VERTICAL , ROLL & PITCH



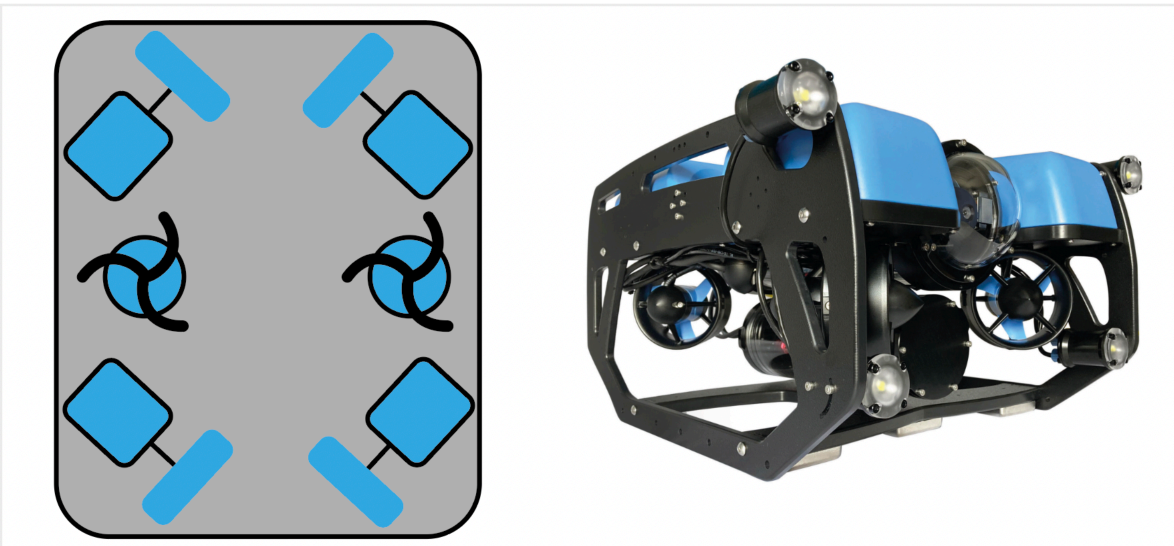
Our drone



Motor configuration: Has a 5-motor, **5 degrees-of-freedom** motor configuration. It allows it the drone to perform every kind of motion other than **lateral**, left/right motion. It also makes it very stable underwater, with active self-leveling.
Frame manufacturing: The frame of the drone is **fully 3D printed** and features a streamlined, hydrodynamic design.

BLUEROV2

An ROV manufactured by **BlueRobotics.**



Motor configuration: The BlueROV 2 has a total of **6 motors** and **5 degrees of freedom**. It features a vectored motor configuration with each horizontal motor being at a 45 degree angle to the next one. Because of this, the vehicle can use all four motors to perform both **lateral** and **longitudinal** motion - this is very useful for holding a **specific position** underwater. This vehicle **cannot pitch by itself** though - it only has two vertically mounted motors. Because of this, **active self levelling is not an option**. This is solved by a couple of metal weights at the bottom of the structure (passive self leveling).
Frame manufacturing: The frame of the BlueROV 2 is made out of **laser-cut,**

high density polyurethane. Multiple pieces of it are then screwed together.

Pros of this frame design:

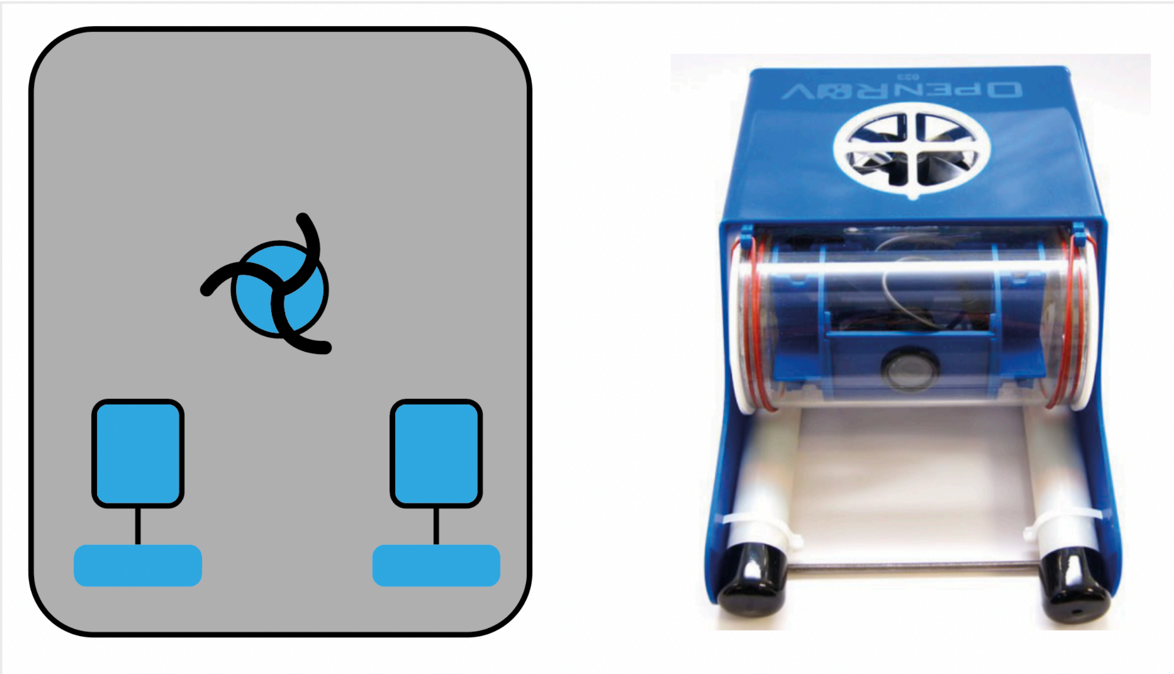
- **Expandability -** the frame has multiple mounting spaces for optional attachments,
- **High maneuverability** - the motor configuration allows the ROV to move both vertically and horizontally

Cons of this frame design:

- **High drag -** the frame is not very hydrodynamic and thus the ocean currents can influence it more than it would a more streamlined design

OPENROV

An open-source, DIY project started by OPENROV.



Motor configuration: The OpenROV featured a 3 motor configuration, which meant that it only had 3 degrees of freedom. It was able to perform **vertical motion**, **longitudinal motion** and **yaw.** It's pitch and roll were stable because of a single weight located at the bottom of the drone.

Frame manufacturing: The OpenROV's frame is made out of **laser-cut acrylic** parts. The acrylic parts are then glued together.

Pros of this frame design:

- **Low cost** - Three motors and laser part acrylic parts are making this design relatively inexpensive

Cons of this frame design:

- **Lack of self-leveling, low maneuverability** - The ROV may be unstable if the water is not particularly still,

- **High drag** - the frame is not very hydrodynamic and thus the ocean currents can influence it more than it would a more streamlined design

Fifish V6

An ROV manufactured by Fifish.

Motor configuration: This frame features 6 motors, giving it full, independent 6 degrees of freedom. With that, it still has a nice, hydrodynamic body instead of the "boxy" design seen in previous examples.

Frame manufacturing: The Fifish v6's frame is made out of injection molded plastic.

Pros of this frame design:

- **Super-high maneuverability,**
- **Small package** - the ROV is very small when you take into consideration its capabilities

Cons of this frame design:

- **Expensive to manufacture** - **injection molding** is very expensive in low quantities

iBubble

An ROV manufactured by **iBubble**.

Motor configuration: This ROV features whopping 7 motors, giving it full, 6 degrees of freedom.

Frame manufacturing: The iBubble's frame is made out of injection molded plastic.

Pros of this frame design:

- **Super-high maneuverability,**

Cons of this frame design:

- **Expensive to manufacture - injection molding** is very expensive in low quantities