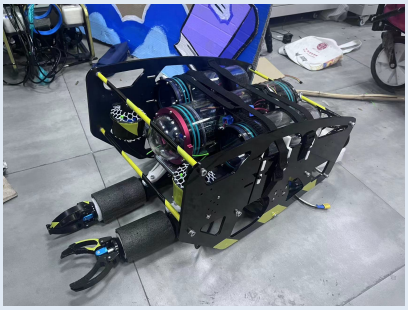
DARK BLUE ROV

Beijing New Talent Academy
Beijing, China
MATE Ranger 2024



ABSTRACT

Dark Blue is a student-led organization affiliated with Beijing New Talent Academy in Beijing, China. Dark Blue strives to develop innovative & advanced ROVs aligned with the United Nations' 17 Sustainable Development Goals and exploring the profound mysteries of this world. As its name, we are eager to enter the darker water, which the more profound meaning is to go further in the journey of science.

To contribute to a cleaner environment, we produced a ROV, Dolphin, named because of its flexibility & intelligence. Dolphin is made to protect the ocean & marine life by incorporating a range of functional systems, including photographic system and two manipulators with different directions, etc. It is consist of environmental-friendly materials in order to reduce the damages to oceans & marine life which might cause by non-safe materials of ROV.

One of the best features of Dolphin is its highly modular design, that can improve the manufacture procedures, especially for quickly disassembly and assembly. Moreover, despite of our tehcnologies & design, Dark Blue is committed to sharing its robotics and engineering experience and popularizing the ocean exploration. In our mind, the ocean holds infinite potential and probabilities, however, the current human exploration of the oceans has been negligible.

PROJECT MANAGEMENT

Dark Blue is not only foucus on sophisticated technologies, but also put the concept of "the team, the family" in the main position, which means there are no clear division for eveyone's positions, but we still had a general one: The company is split into several subgroups—ROV Design, Documentation, and Commerce & Media—to break up the overall mission into easier tasks. Most of time, all company members work together, which allows the company has a extremely great inner communication & cooperation.

Subgroup Name	Leader	Responsibility
ROV DESIGN	STEVE	Design & manufacture the products of company; Operating the ROVs
DOCUMENTATION & MEDIA	LEO	Community outreach; Technical Documentation; etc.
COMMERCE & FINANCE	HILBERT	Finances; Sponsors; Marketing Display; etc.

As the mentioned above, "the family" is often more vital than the competition & champion. During the preparation period and our daily life, Dark Blue participated in a range of on-campus activities as a gruop, whether ROV or not. Generally, our company carry out the activities at 5.00pm to 6.10pm on Tuesday and Thursday. The members are able to work overtime if they want.

SAFETY

Dark Blue prioritizes safety by creating rigorous safety procedures and enforcing them carefully. Before enter the pool, Dolphin and members must meet the safety requirements for equipment below.

General Safety Checklist
- All equipment properly waterproofed
- No exposed sharp edges
- Hazardous/caution labels marked
- All power within a 30 amp limit
- Tools are a safe distance away from the pool
- No romp in the workplace/pool

Basic Safety Procedures
- Ensure everything is shrouded
- Double-check that wires are properly connected to the poolside/control system
- Abide by all pool guidelines
- Maintain attentive and professional behavior
- Put away all materials and tools in correct area after using


All thrusters are properly shrouded as shown

The electrical & structure safety will b demostrated here. All members clearly know how to circuit welding properly when they first joined into this company, therefore, safe electrical connection is the basic mind for all members. Members additionally follow the electrical safety procedures listed below.

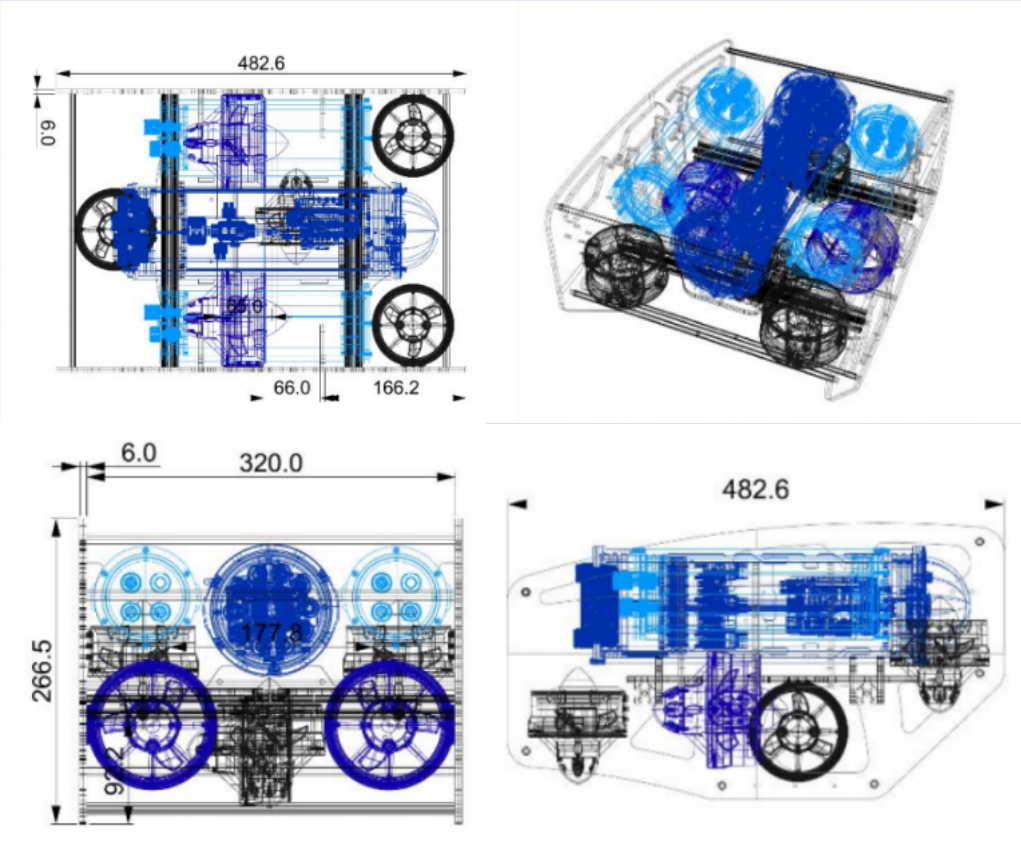
Electrical and Structure Safety Procedures
- Connect all wires to correct gauges
- Ensure no exposed wiring and or fuses
- Unplug tools when not in use
- Be cautious about possible emergencies
- Allow proper time for organizing work area
- Ensure personal items are a reasonable distance away from work area
- All power has required voltage, no outlets are overpowered

DESIGN RATIONALE

The design process for Dolphin involved careful consideration of various factors. The engineers, Steve and Emon, made a list with some idea---a range of functions & features that Dolphin should satisfied. First of all, Dolphin is used to undersea survey and exploration, so it need to carry out simple sampling and filming operations. Additionally, it should also design to conform to "high speed" requirment with multi-degree-of-freedom movement in order to improved efficiency. Adaptability to various underwater environments is extremely vital, too, which means Dolphin is capable of handling impacts, high pressure, and different kinds of water flow. The last idea is "highly modular", which might tightly connect with the innovative technologies of the future.

Finally, we divided the Dolphin's framework into 5 modules initially: Underwater Survey Module, Mechanical Operation Module, Power Propulsion Module, Main Body Frame Module (also providing buoyancy), and Watertight Compartment Module. In further design, we selected materials, shapes, and costs for each module. For main body frame, we chose acrylic side panels and aluminum connectors for the Dolphin, so that both the rigid & flexible requirement can be satisfied. In addition, we do not spent too much money on those modules depite of power propulsion module.

Structure Design



Overview of Dolphin's Structure (excluding mechanical operation module)

Main Body Frame Module

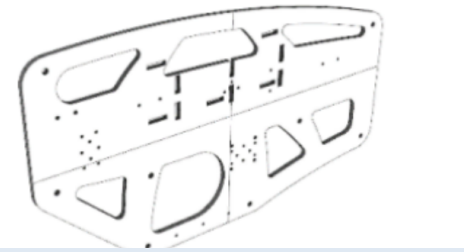


figure1

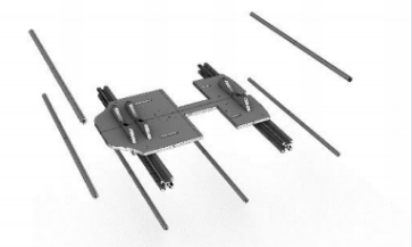
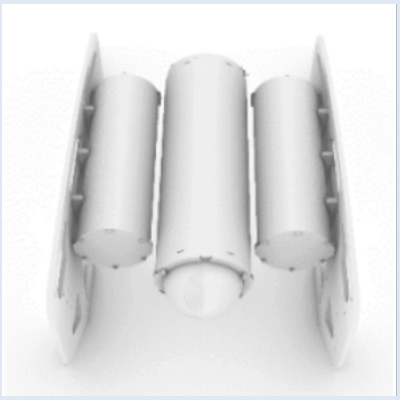


figure2

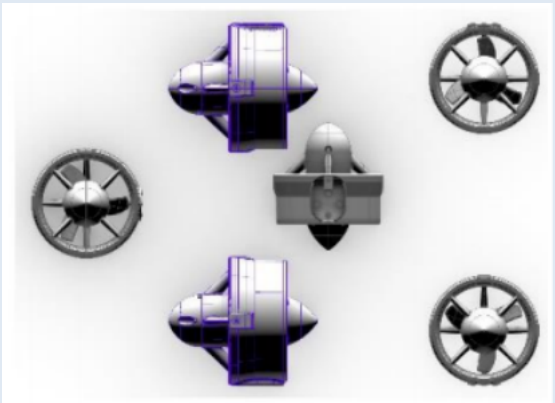
Custom cut from acrylic sheets as shown in Figure 1, for connecting main structure, installing reinforcements, and mounting thrusters. There is a range of advantages, include high customization, low cost, light weight, and high strength. But we are considering to replace this material by carbon fiber due to the lighter weight & higher strength. Bottom plate and connectors as shown in Figure 2, which located between side panels, connecting main cabin and thrusters. Connectors are aluminum with sufficient strength. Aluminum pipes connect side panels, and aluminum profiles connect side panels, bottom plate, and manipulator. Aluminum profiles also offer expandability for attaching different external devices in different underwater environments.

Watertight Compartment Module



The Dolphin has 3 watertight compartments, 2 small 90mm compartments on sides, and 1 large 110mm compartment in the center. The small side compartments house other accessories if there is a requirement, while the large central compartment holds main electronic equipment. Compartment covers are secured with straps, enabling quick disassembly for modularity and maintenance. The compartments themselves provide buoyancy, eliminating the need for a separate buoyancy tank. The small side compartments also serve this purpose, improving space utilization.

Power Propulsion Module



The ROV uses 5 large thrusters and 1 small thruster. 3 large thrusters control ascent/descent and pitch, 1 small thruster controls lateral movement, and other 2 large thrusters provide forward/reverse and rotational thrust. All thrusters are located inside the main frame, protecting internal equipment in the event of a collision.

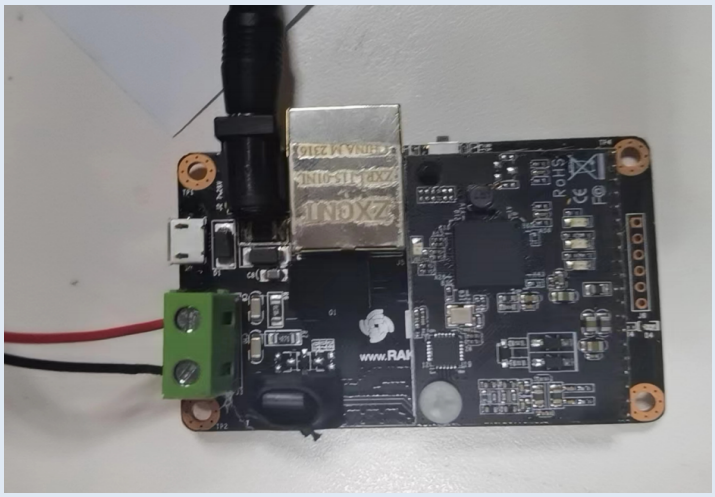
Other Modules

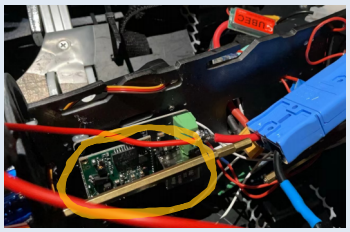
Underwater Survey Module includes camera and lighting modules. The Dolphin's camera is located at the front of the main compartment and can pivot. Lighting is provided to adapt to underwater darkness and assist high-definition filming.

For Mechanical Operation Module, Dolphin is equipped with 2 manipulators, one vertical and one horizontal, for different underwater tasks. We are considering to replace those two manipulators by multi-degree-of-freedom manipulators with 3D printed.

Control / Electrical Systems

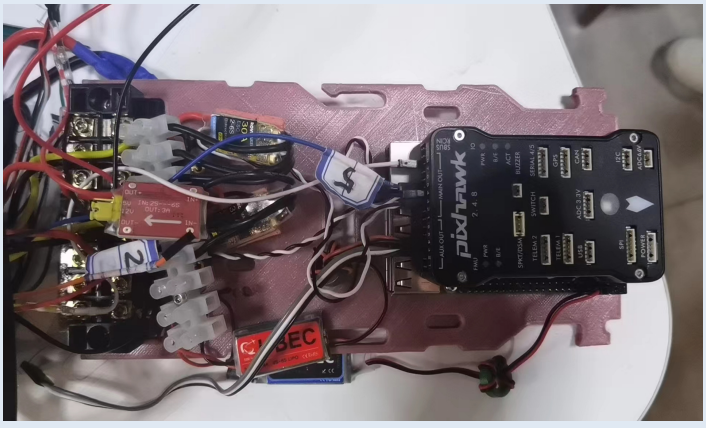
The control system for Dolphin is built around a Raspberry Pi located in the Watertight Compartment Module, as shown below.





located here

Dolphin also contain a Pixhawk because it can autonomously control the dolphin's balance and form with its gyroscope and other built-in features. The connection also shown below.



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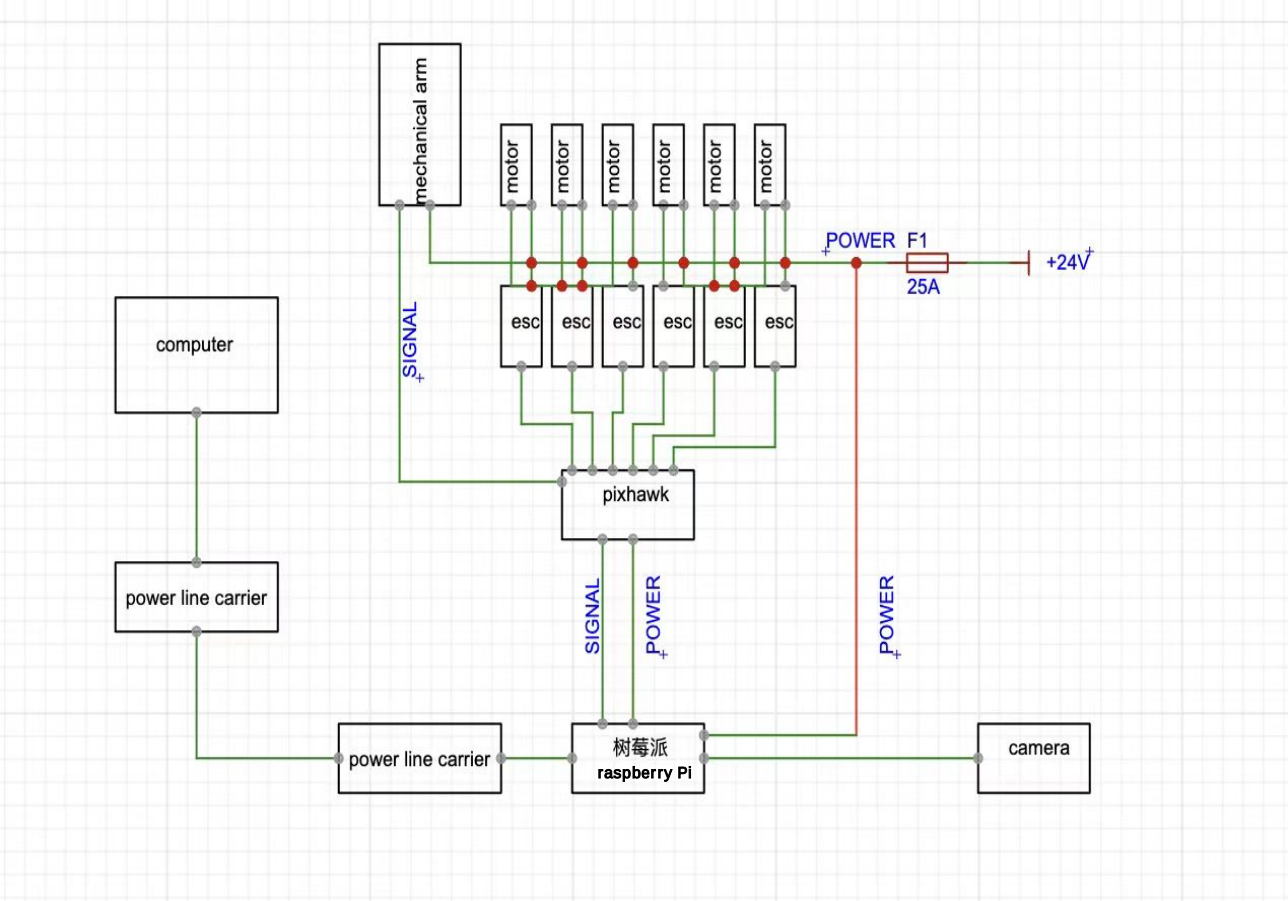

ACCOUNTING

About our consumption view, we believe that we can spend money on some important components if it can improve our ROV, but we also save money by recycling & DIY. Therefore, the costing produced by some reused components are not included in this table.

Project Costing

Material	Cost(CNY)
steering engine *4	470
carbon fiber bottom plate *1	108
print poster *1	22.25
several screw	9.9
watertight compartment *1	399

Material	Cost(CNY)
large thrusters *5	2580
total	3589.4