REMOTELY OPERATED VEHICLE (ROV)

By: Azizi Bin Mohamad Tambi (1919661)

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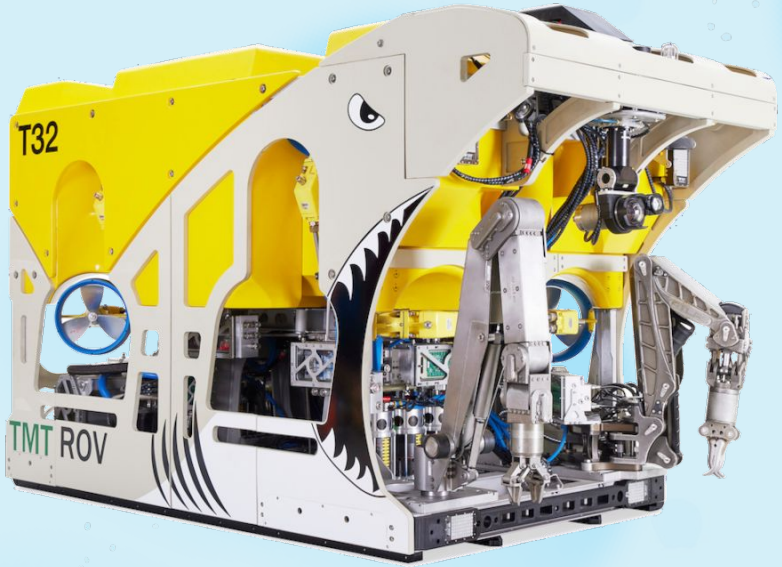


01

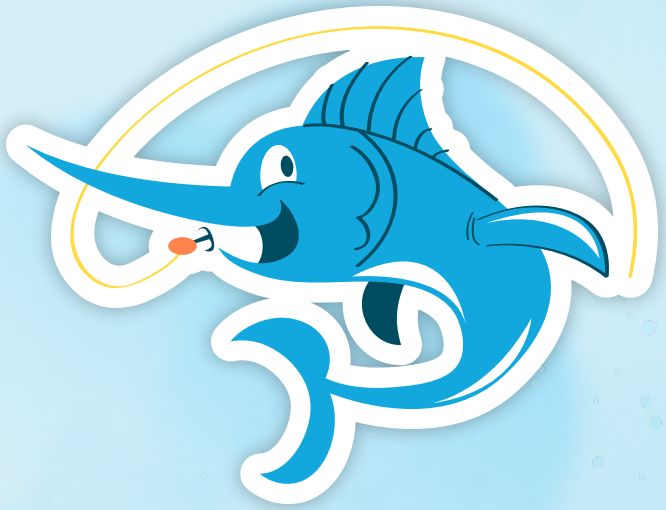
INTRODUCTION

ROV

- ROV stands for Remotely Operated Vehicle.
- An ROV is an unoccupied underwater robot that is connected to a ship by a series of cables.
- These allows the operator to transmit command and control signals to the ROV, allowing remote navigation of the vehicle.
- Used when working in deep water where diving is impractical or to investigate submerged hazards.

Research Background

- ROVs were invented to explore and operate in environments that are dangerous and inaccessible for divers or manned submersibles.
- Back in mid-20th century, the US Navy and other military organizations develop an unmanned underwater vehicles for reconnaissance and mine countermeasures.
- Currently, ROVs are widely used for research and exploration purpose including studying marine biology, oceanography, geology and more.
- Aside that, It is also used for commercial applications such as underwater construction, oil and gas exploration and pipeline maintenance.



02

HISTORY & APPLICATIONS

HISTORY (CURV)

RECOVERY VEHICLE — NOTS Pasadena Laboratory's new Controlled Underwater Research Vehicle (CURV) is shown in actual operation off Long Beach. Vehicle's large claw enables it to retrieve expensive ordnance items from sea floor for reuse.

- The first ROV “Cable-controlled Underwater Recovery Vehicle” (CURV), was developed in 1960s where it was funded by US Navy.
- It was developed by the Woods Hole Oceanographic Institution in Massachusetts, USA.
- The purpose of it is to recover lost objects from the ocean floor and it had a depth rating of 2000ft.

HISTORY (SEA OWL)

he Sea Owl observation class ROV with tether management system.

- The first commercial ROV was named “Sea Owl” and was built by Oceaneering International in 1973.
- It was designed to operate in water depths of up to 600 ft and has a maximum speed of 2 knots.
- Controlled by an operator on a support vessel using joystick and video monitor, with a cable tethered to the vessel.
- Equipped with black and white camera, sonar system and manipulator arm to retrieve samples and cutting cables.

APPLICATION

Scientific Research

- For exploring and studying the ocean, lakes and rivers.
- It provide a platform for marine biologist, oceanographers and scientists to observe and document marine life, geologic formation and hydrothermal vents.
- Can be used as a sampling tools to collect water and sediment samples, measure temperature, salinity and other water parameters.
- For mapping the seafloor, creating 3D maps and exploring deep sea ecosystems.

Commercial Industries

- Essential for offshore oil and gas exploration, pipeline inspection and underwater construction.
- Can perform visual inspections, monitor pipeline conditions and repair pipeline damage.
- Can be used for offshore drilling operations, monitor wellhead, collect soil and sediment samples and perform maintenance tasks.

APPLICATION

Military

- Used for reconnaissance, mine countermeasures and underwater surveillance.
- Equipped with cameras and sensors to gather intelligence, search for and neutralize underwater mines.
- Perform underwater search and rescue operations.

Environmental Monitoring

- To monitor lakes, rivers and oceans.
- Can be used to monitor coral reefs, seagrass beds, and other sensitive ecosystems.
- Equipped with water quality sensor to monitor water quality and identify source of pollution to protect marine life and human health.

Archaeology

- Used in marine archaeology to explore and document shipwrecks, sunken cities, and other underwater archaeological sites.
- Equipped with high-resolution cameras and manipulator arms to collect artifacts, take measurements and create detailed maps of the sites.

03 MAIN COMPONENTS OF ROV

I. Frame & Hull Design

II. Propulsion System

III. Navigation & Control System

IV. Data Collection

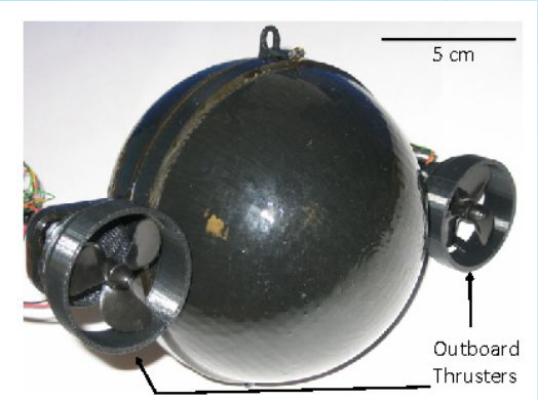
V. Data Transmission

VI. Power Management

I. Frame & Hull Design

- The frame and hull of an ROV give the structural support and protection needed to withstand underwater environment such as pressure when diving deep into the water.
- The frame is typically made of an aluminium or steel.
- The hull is made of a durable plastic or fiberglass material.
- Both the frame and the hull need to be designed to be hydrodynamic so that the ROV will be able to move through the water with minimal resistance.

SPHERICAL HULL



- Provides excellent hydrodynamic stability and allows the ROV to withstand high pressures at depth.

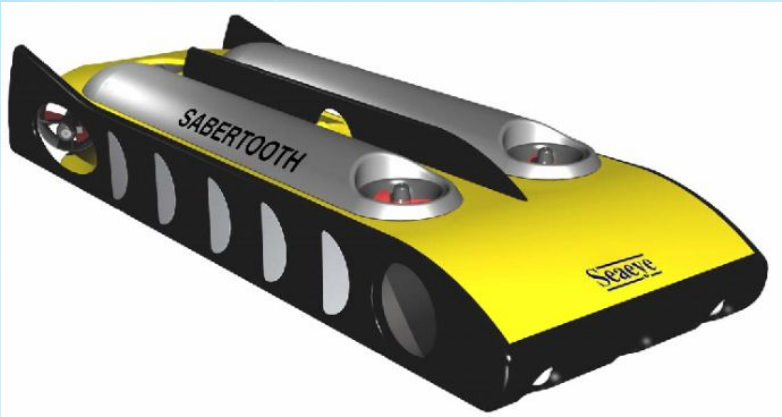
CYLINDRICAL HULL

- Common design used for inspection and maintenance tasks.
- Provides a streamlined shaped that reduce drag and allows the ROV to move more efficiently.

BOX HULL

- Common design used to carry heavy equipment or perform complex tasks.
- Provides a large internal volume that can be used to store equipment and sensor.

HYBRID HULL



- A combination of 2 or more hull designs. Allows the ROV to have multiple capabilities and operate in different environments.

TORPEDO HULL

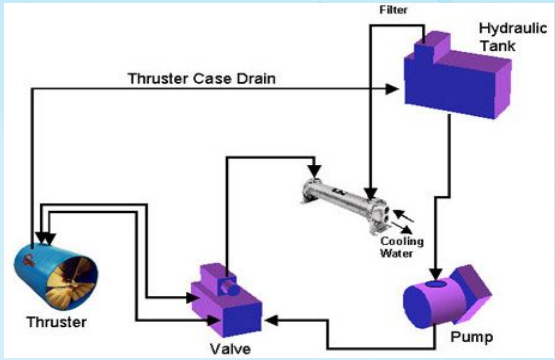
- A streamlined hull design commonly used to move quickly through the water.
- Often used for military applications and for ROVs that need to cover long distances quickly.

II. Propulsion System

Electric Thruster

- Provide precise control over speed and direction.
- Quiet and does not produce emissions.
- Powered by batteries located on the surface or ROV itself.

Hydraulic Thruster



- Used in larger ROVs due to high level of thrust and capable to operate at greater depths.
- Powered by hydraulic pump that is located on the surface.

Water Jets

- Use high pressure water to propel the ROV through the water.
- Used in shallow water or around delicate marine environments where propellers cannot be used.

Fin Propulsion

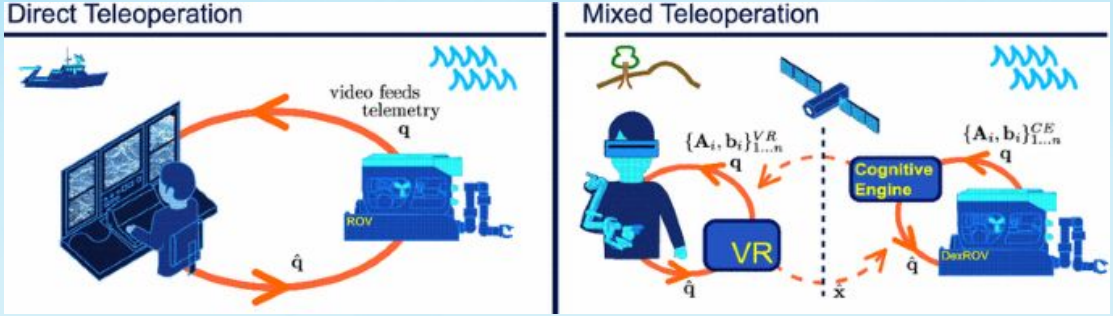
- Controlled by a set of hydraulic or electric motors that allow the ROV to maneuver through water.

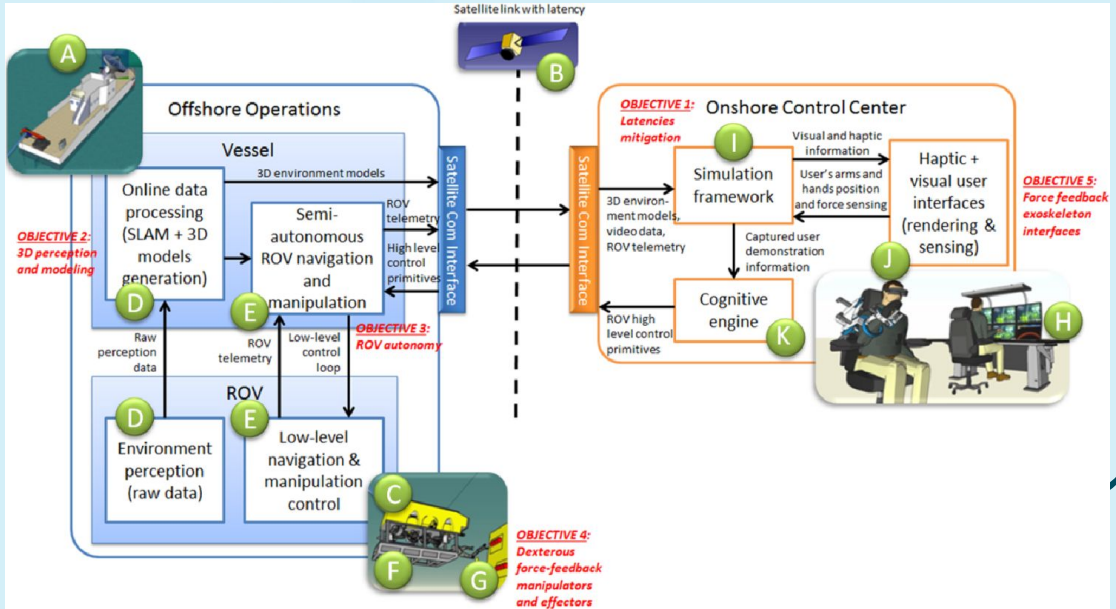
III. Navigation & Control System

Manual Control:

- The most basic type of navigation and control system used in ROVs.
- Operated by operator by using joystick or other control devices to manually control the thrusters and other components.

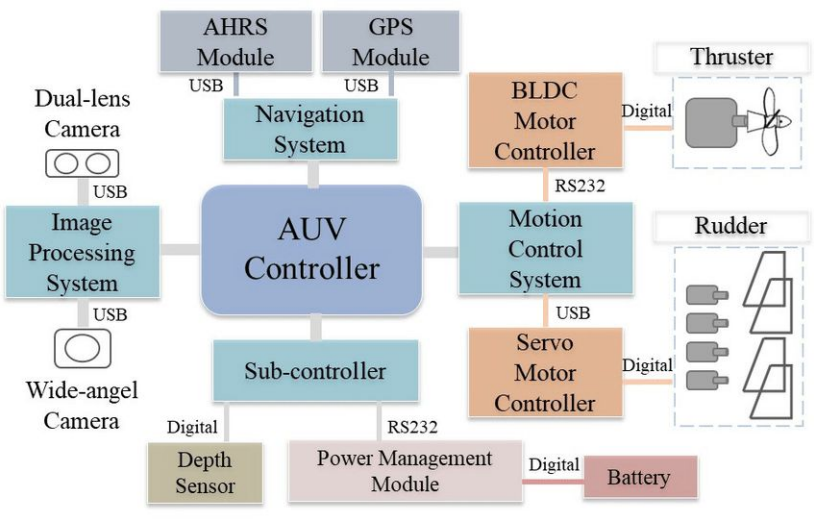
Semi-Autonomous Control

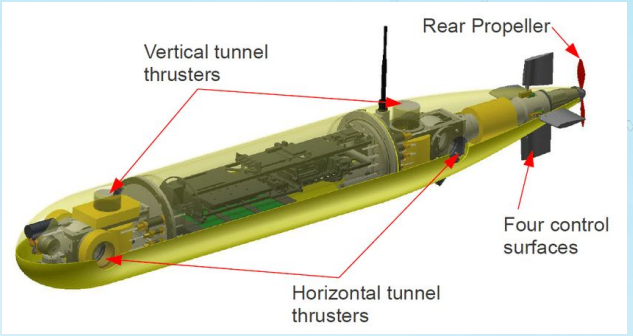




- Use a pre-programmed instructions to control the ROV.
- Particular task can be specified by the operator so that the ROV can navigate to the target location.

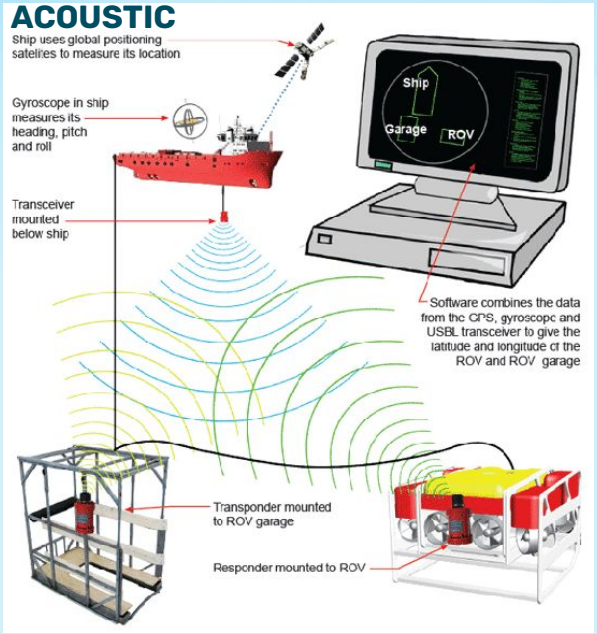
Autonomous Control

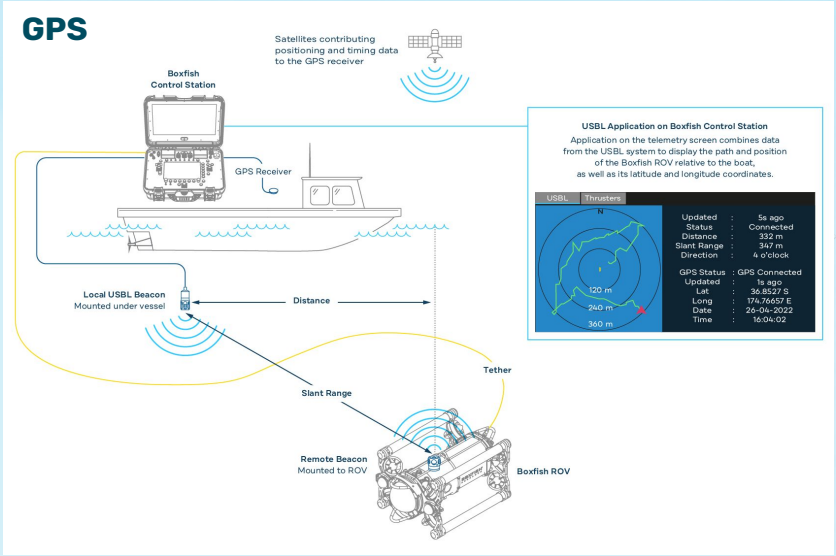




- An ROV with autonomous control is called Autonomous Underwater Vehicle (AUV)
- Artificial Intelligence (AI) and machine learning algorithms are used to control it.
- It can learn from past experiences and make decisions based on real-time data from sensors and cameras.

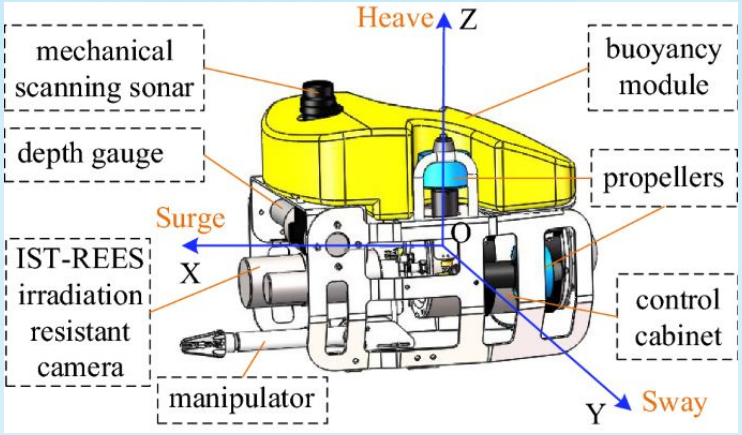
Positioning Systems

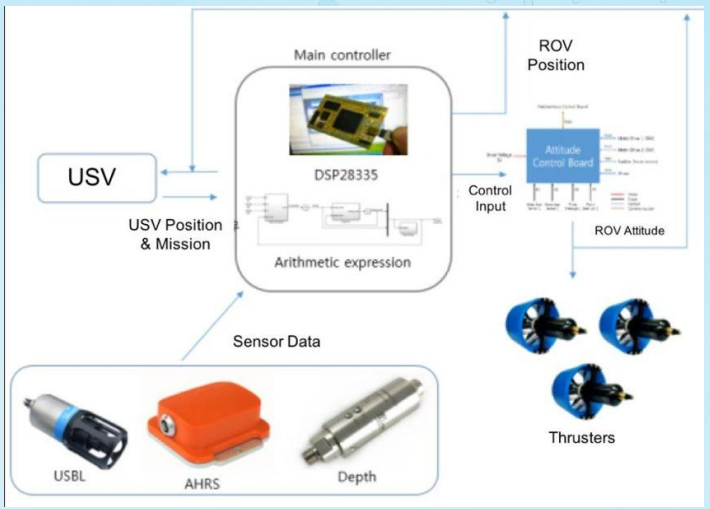




- Used to determine the location of the ROV underwater.
- GPS, Acoustic Positioning and Inertial Navigation Systems (INS).

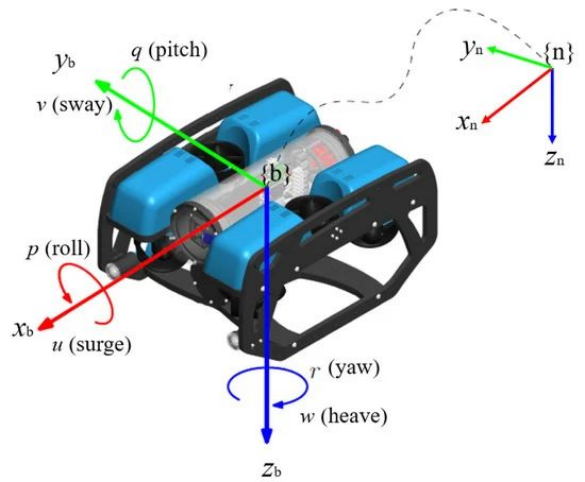
Depth Control Systems





- Used to maintain ROV at specific depth.
- Pressure sensors and depth gauges are used to maintain the ROV at a constant depth.

Stability Control Systems



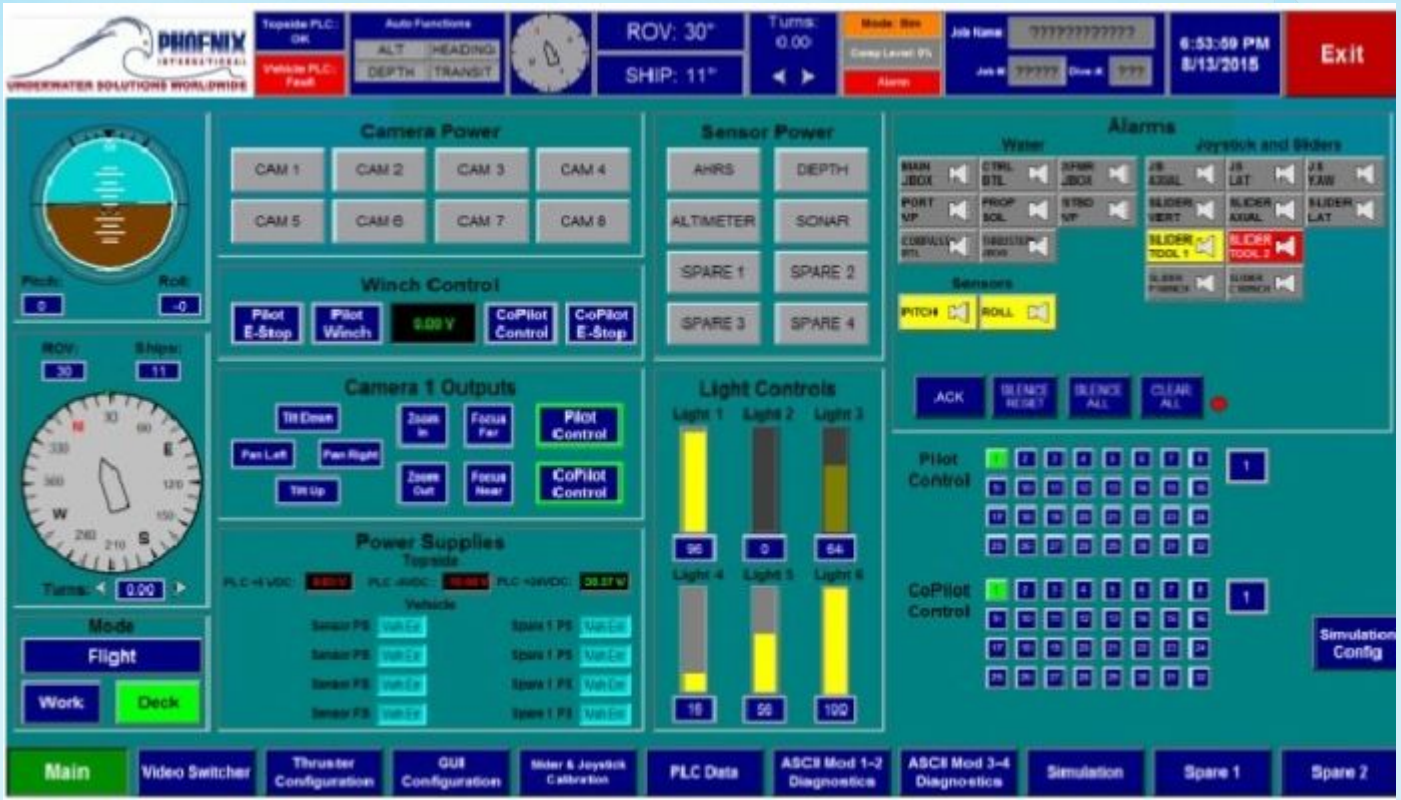
Subsonus

Subsonus is a next-generation USBL/Modem that provides high accuracy position, velocity and heading at depths of up to 1,000 metres.

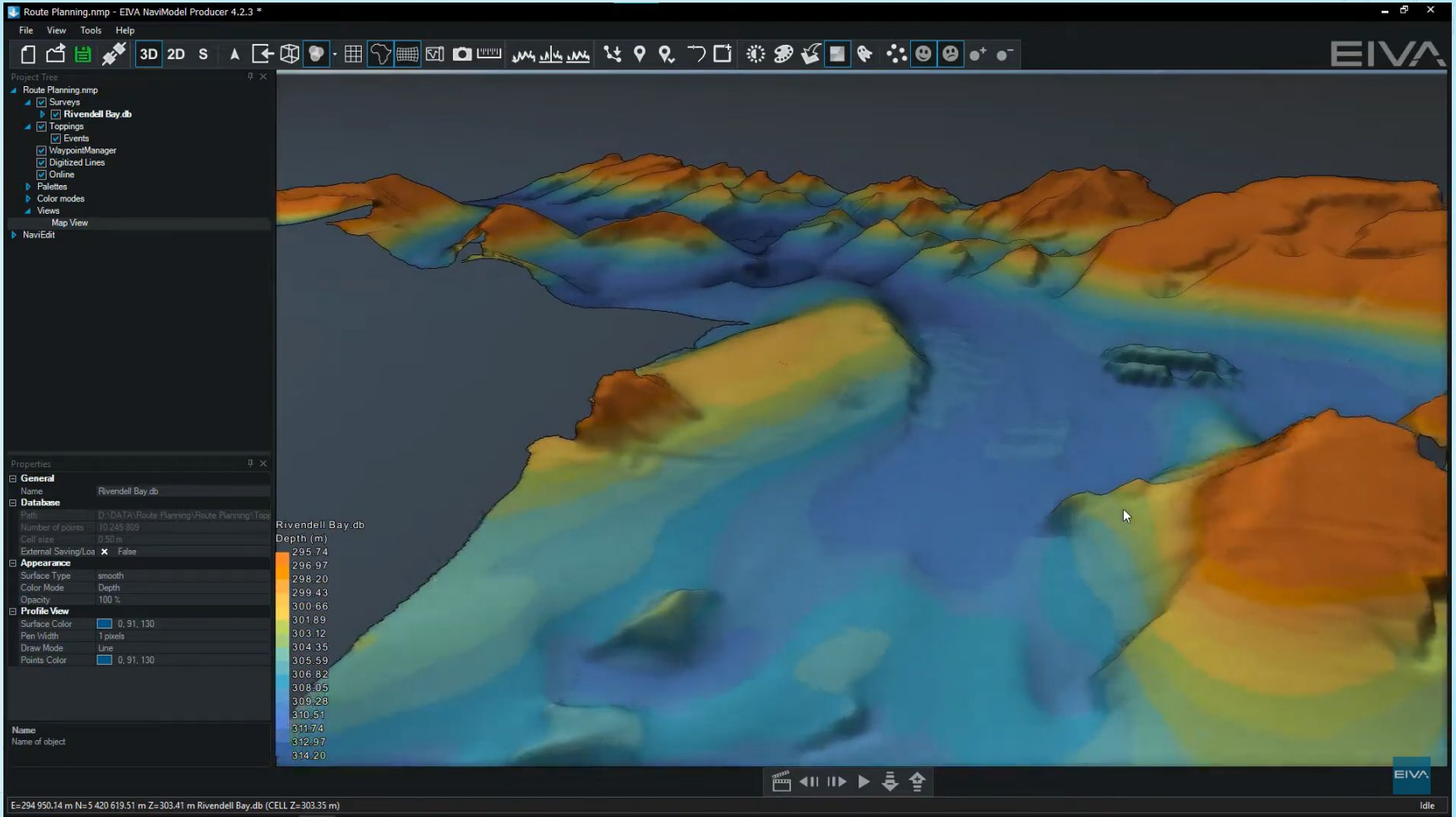
Position Accuracy	0.1 m
Roll & Pitch	0.1 °
Acoustic Heading	0.3 °
Range & Depth	1,000 m

- Used to maintain the orientation and stability of the ROV.
- Accelerometers, gyroscopes and more are used to monitor the motion of the ROV.
- Adjustments of the ROV are made by controlling the thrusters as required.

Navigation Software



Navigation Software (NaviSuite)



IV. Data Collection

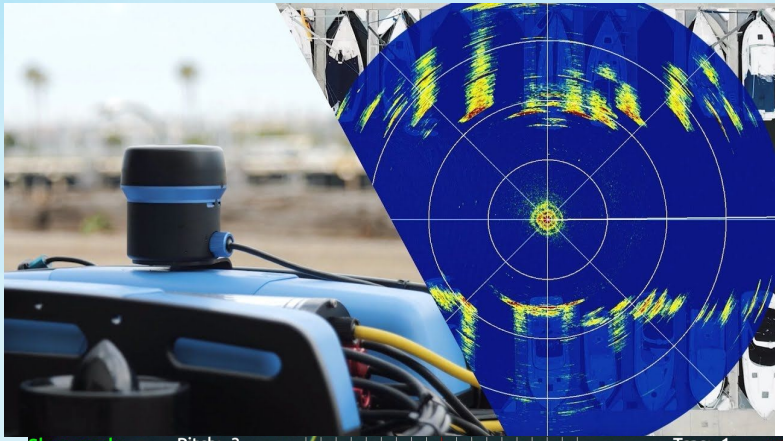
SENSORS

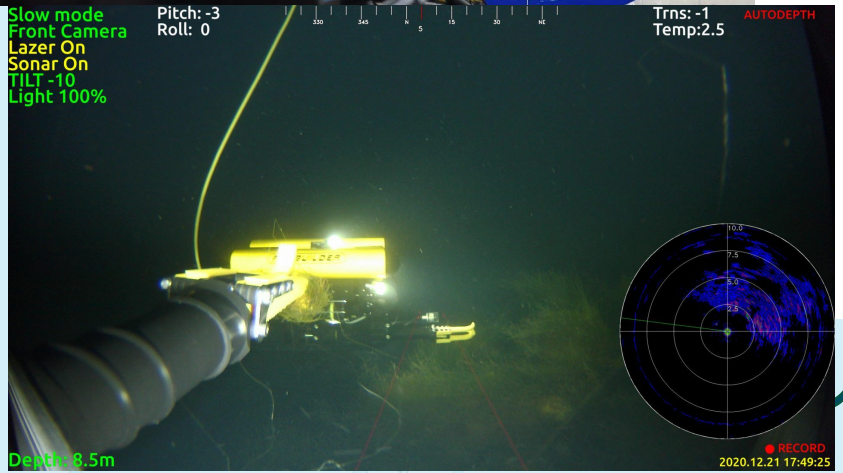
1. **Sonar**
   - Side-scan sonar, forward-looking sonar, multibeam sonar
2. **Cameras**
3. **Environmental sensors**
   - Water temperature, salinity and pressure sensor.
4. **Magnetometers**
5. **Hydrophones**
6. **Laser Scanner**

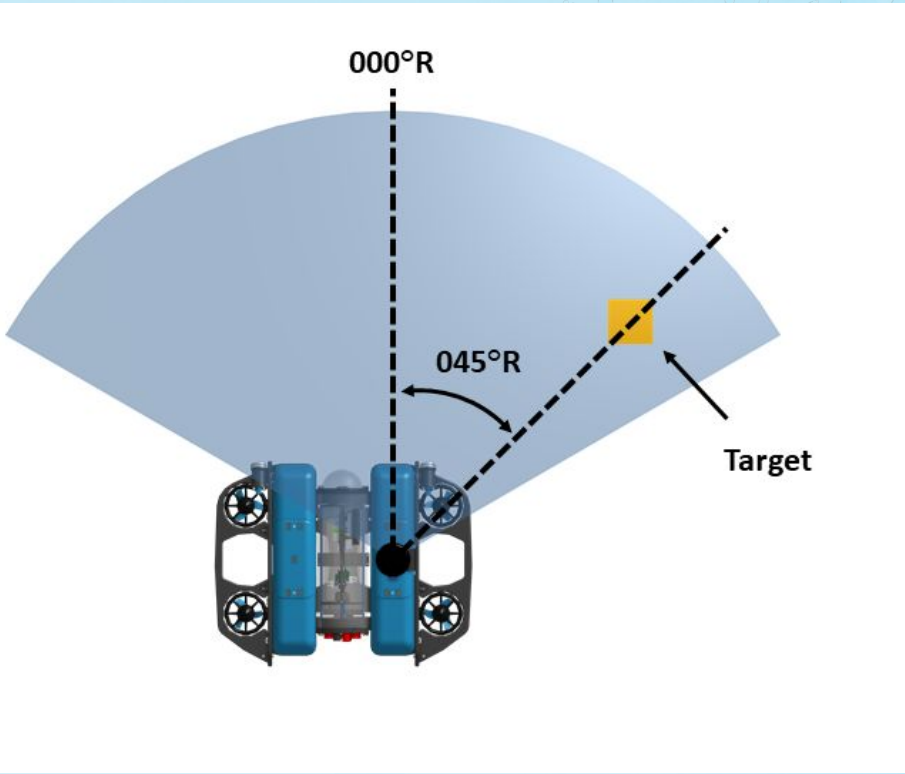
ACTUATORS

1. **Sampling tools**
   - Grab samplers, corers and suction samplers.
2. **Manipulator Arms**

Sonar:




Slow mode
Front Camera
Lazer On
Sonar On
TILT -10
Light 100%
Pitch: -3
Roll: 0
Trns: -1
Temp:2.5
AUTODEPTH
Depth: 8.5m
RECORD
2020.12.21 17:49:25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Target

Cameras:

Environmental sensors:

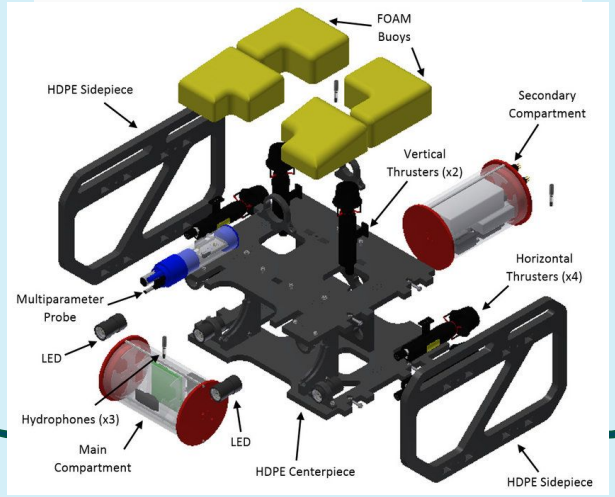
Water Temperature

Salinity Sensor

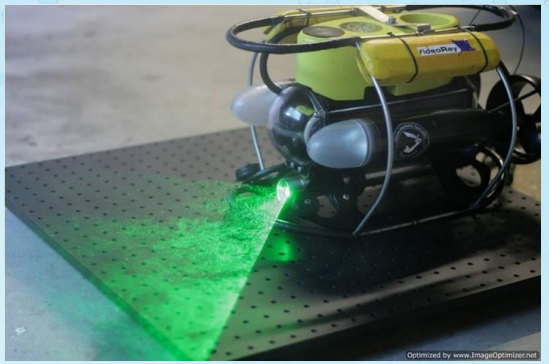
Pressure Sensor

Magnetometers:

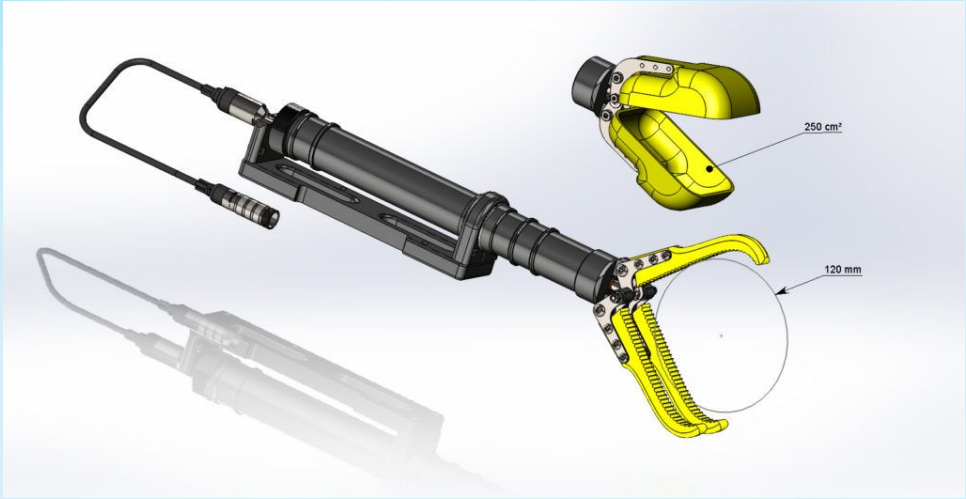
Hydrophones:



Laser Scanner:



Grab Sampler:



Suction Sampler:

Corer Sampler:

DATA ACQUISITION SOFTWARE

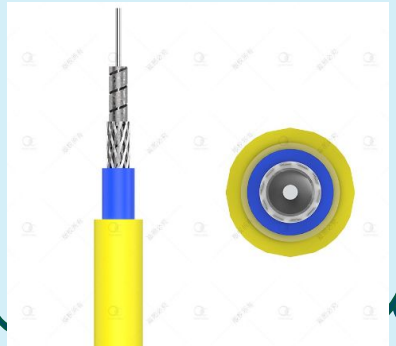
V. Data Transmission

Tether:

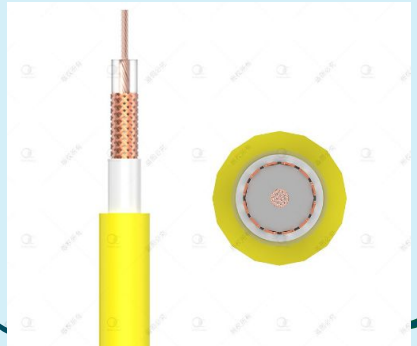
Fiber optic hybrid cable MM Optic fiber +10x0.34mm2 power cable

Video Hybrid Cable Coaxial+2x16AWG Power Cable+2X24AWG Twisted Pairs

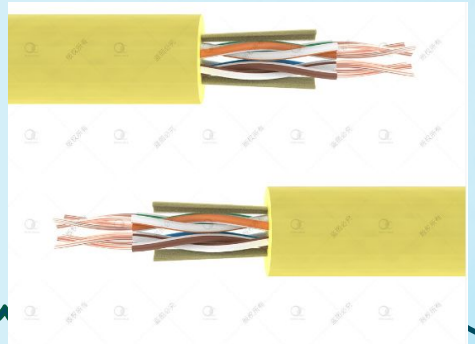
Hybrid Communication Cable 2X18AWG Power cable+1X(2X24AWG) Twisted Pairs



SM Fiber Optic Waterblocking Fathom ROV Remotely Operated Cable



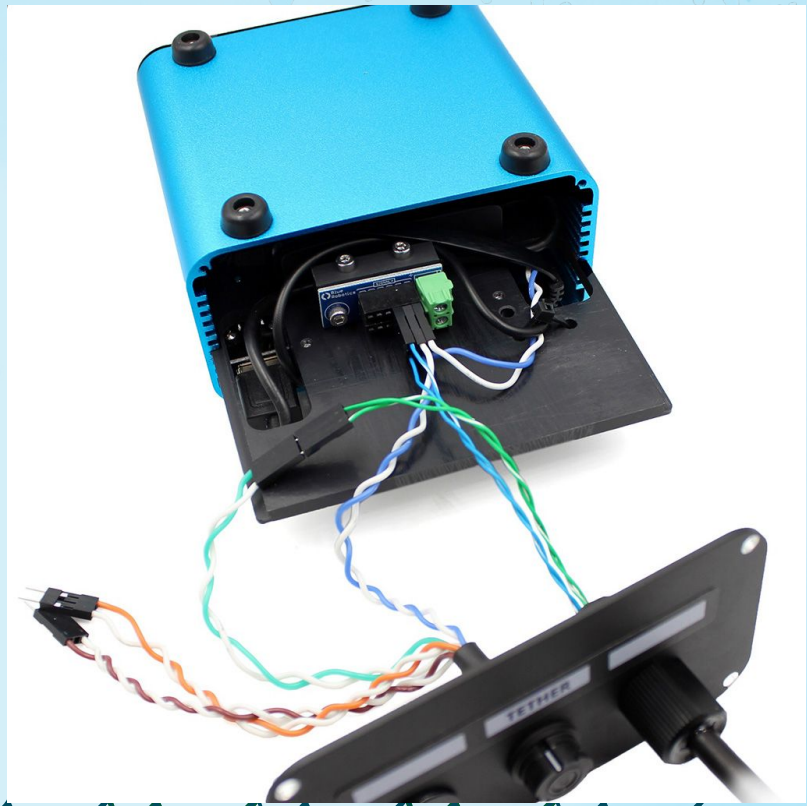
RG6 Coaxial Cable Rov Umbilical Kevlar Reinforced Cable



Yellow Zero Buoyancy Foam Underwater Rov Tether Cable

Ethernet Converter:

Fathom-X Tether Interface:



GPS:

SEASAM
NAVIGATOR
by notilo plus

VI. Power Management

Power Distribution System

- Power control board is used to distribute power to various components on ROV.
- The power supplied will be regulated to each component to ensure they receive the right amount of voltage and current.

Power Generator

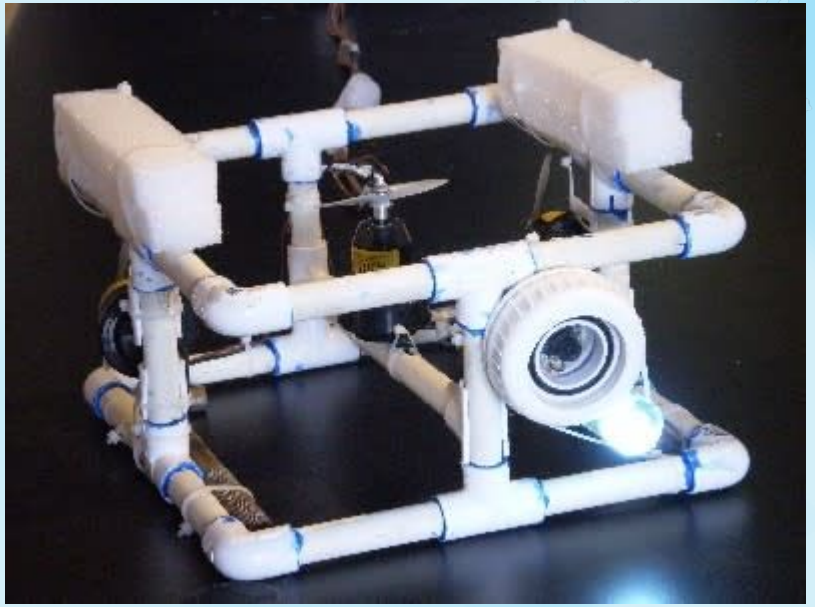
- Provide continuous source of power.
- Fueled by diesel of other fossil fuels.
- Used to extend the operating hours of an ROV.

Batteries

- Rechargeable and can provide power for several hours of operation.
- Often located within ROV's hull and connected to power distribution system.

Power Management Software

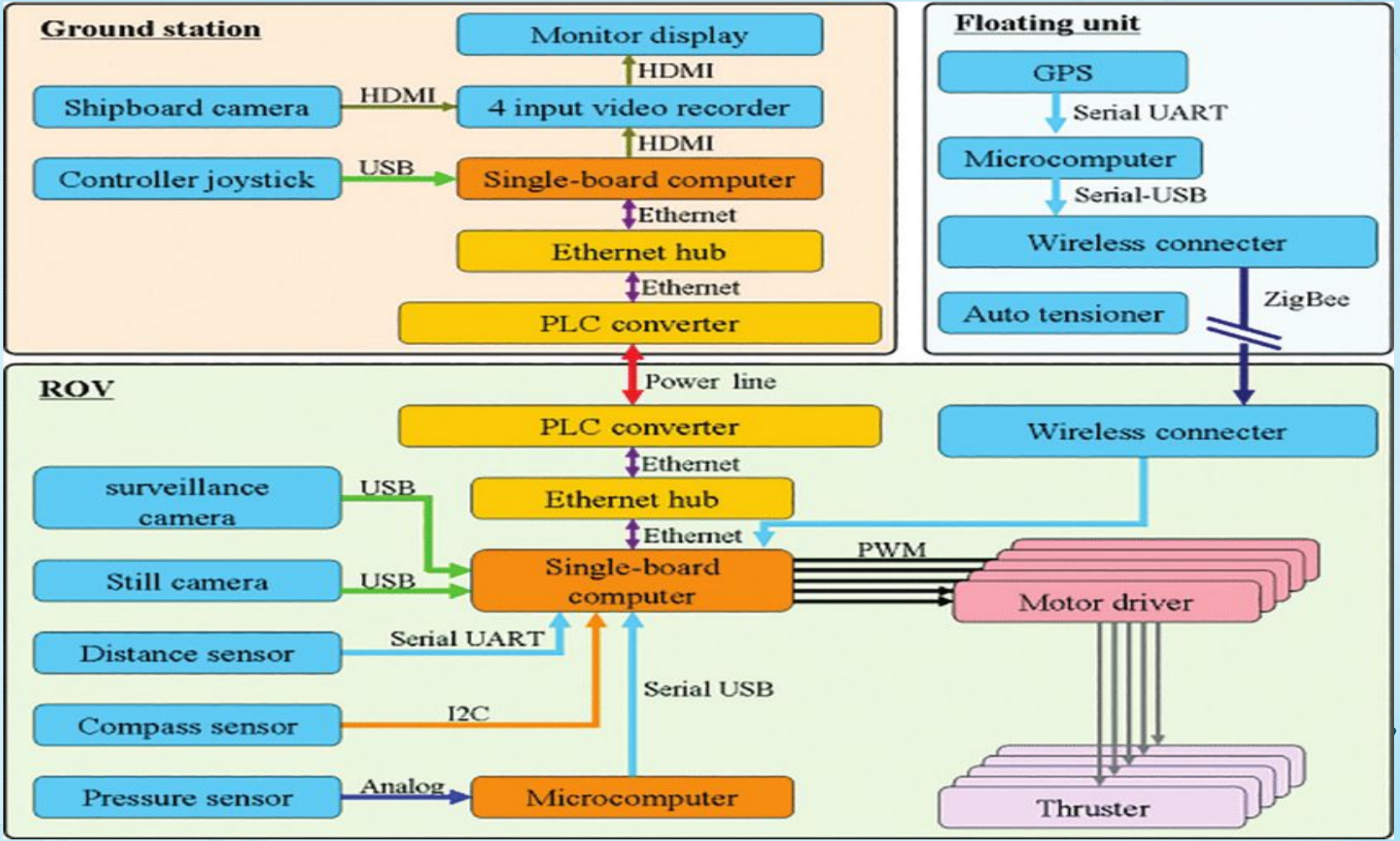
- Used to monitor ROV's power usage and ensure that power is supplied efficiently.
- Provide real-time data on power usage.
- Can notify the operators if any components are drawing too much power or when the battery is low.



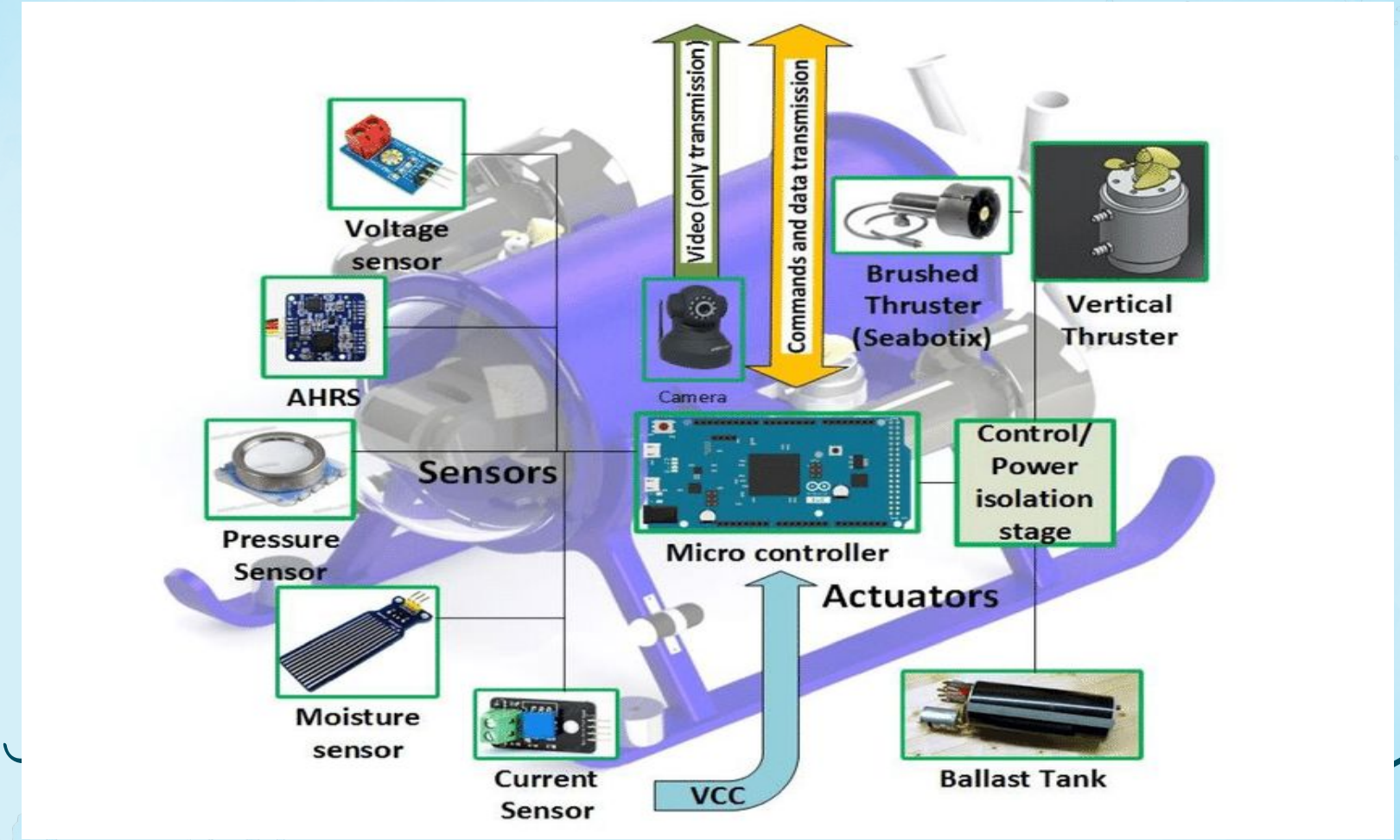
04

BUILDING YOUR OWN

Complete ROV's System Architecture



Hands On Session



ARE YOU READY FOR

THE IET/MATE HONG KONG REGIONAL - UNDERWATER ROBOT CHALLENGE 2023

Dates: 29 & 30 April 2023

Venue: Tseung Kwan O Swimming Pool

TAKE BLUETECH TO NEW DEPTHS

FREE STARTUP KIT (Programmable Controller + Waterproof Motors) FOR ALL NEW CONTESTERS

NEW AWARDS FOR THE BEST NEW CONTESTERS

The best new contester awards detials are in the event briefing sections

THE MATE ROV COMPETITION


“This is the way STEM should happen and how you bring students into the field – with application and engagement. MATE has their priorities straight.”

05 MALAYSIA MARKET

Current Trend

Manual sampling,
in-situ measurement,
manual maintenance by
using divers.

Potential Applications

Seafloor mapping,
natural gas detection,
biomarine,
water inspection,
pipeline maintenance
rescue mission,
and more.

Price Range

Based on area <RM100K

05 MALAYSIA MARKET

Market Player

1. Ocean Master Engineering Sdn. Bhd.
2. Alumac Industries Sdn. Bhd.
3. EONMARINE
4. MIBS ROV Sdn. Bhd.

Who can use this?

Jabatan Laut, Jabatan Alam Sekitar, Tentera Laut Diraja Malaysia, Nahrim JPS, Marine Scienties, Jabatan Taman Laut and more.

OBSTACLES

High Cost

ROVs are sophisticated, therefore require significant investment to design, build and maintain.

Lack of Awareness

Lack of awareness among Malaysian might exists on the benefits of using ROV.

Limited Infrastructure

Lack of adequate port facilities or ground station to launch and recover ROVs. Lack skillful individual to conduct training and support for ROV operators.

Regulatory Challenges

There are various regulations that need to be followed for an ROVs to be operated and permitted to operate in Malaysian water.

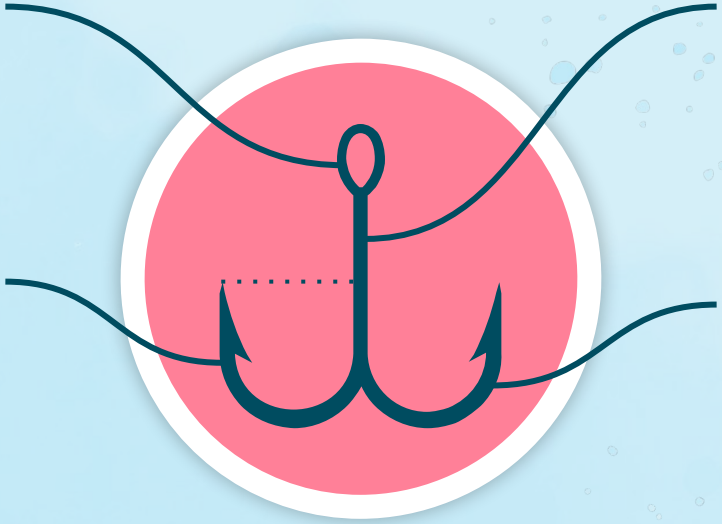
Top Things To Remember When Operating ROV

Electrical Shock

Take precautions to avoid electric shock. Ensure all electrical connections are properly insulated and connected.

Entanglement

Tethered cables and other equipment can become entangled with underwater structures or marine life.

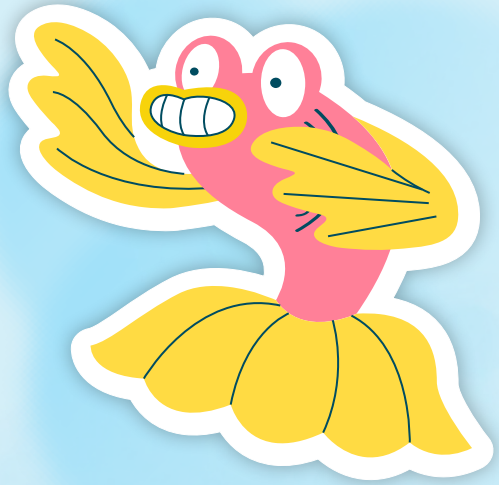


Pressure

Deep water environments has high pressure. This can cause pressure-related injuries to the operator and the ROV itself.

Communication Failure

Operator may lose control of the ROV if failure in communication happen since ROVs are controlled remotely.



06 CONCLUSION

In conclusion, ROVs have revolutionized the way we gather data and perform tasks underwater. The ability to navigate in hazardous and impossible-to-reach locations have now become possible due to ROV. The use of ROVs for underwater data collection has opened up new avenues for exploration and scientific research along with industrial applications. Nevertheless, the right action must be taken to ensure that the technologies will not be misleading so that our world and our way of life can be improved.