Development of ROV

By: Muhammad Syahmi Bin A Rahim (1916437)

Table of contents

01

Introduction

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ROV

- **R**emotely **O**perated **U**nderwater **V**ehicle (technically ROUV or just ROV) is a wired underwater mobile device a.k.a an underwater robot.
- ROVs are unoccupied, usually highly maneuverable, and operated by a crew either aboard a vessel/floating platform or on proximate land.
- They are common in deepwater industries such as offshore hydrocarbon extraction.
- These underwater machines are controlled by a person typically on a surface vessel, using a joystick in a similar way that you would play a video game. A group of cables, or tether, connects the ROV to the ship, sending electrical signals back and forth between the operator and the vehicle.
- ROVs are used when diving is impractical and dangerous for humans while working or investigating submerged hazards in the deep water. ROVs carry video cameras, lights, and robotic arms to grab things. ROVs help humans safely study the ocean by going to places where humans cannot go

History of ROV

1950s

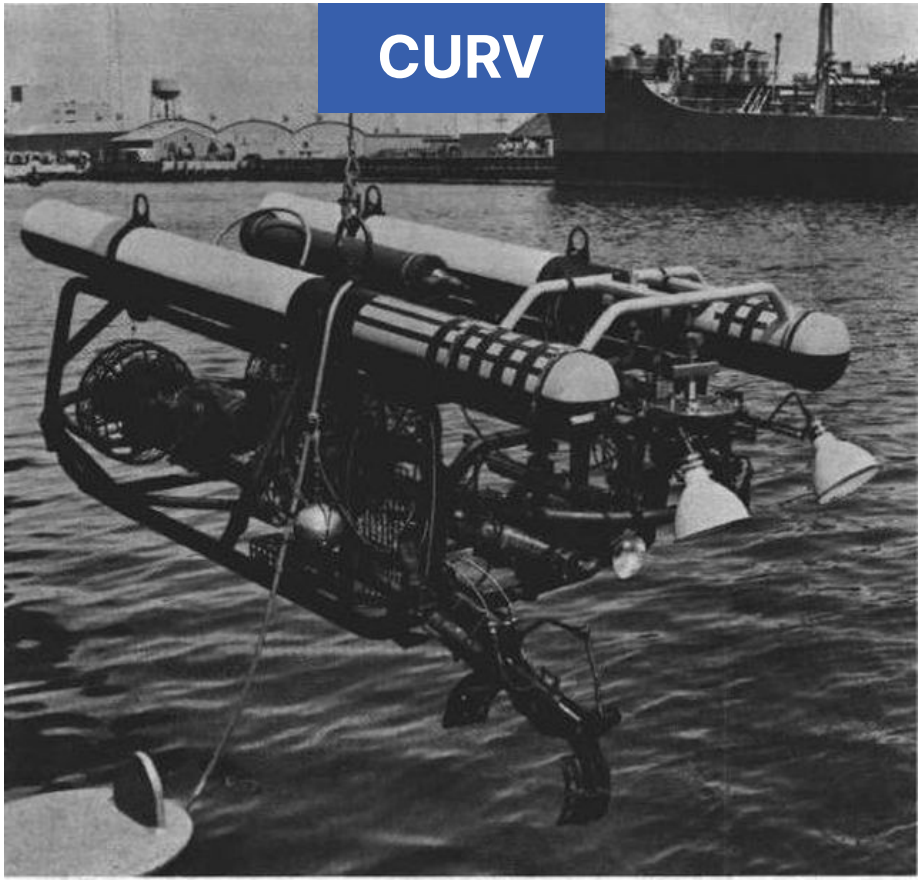
- early 1950s : US Navy began experimenting with remotely controlled submersibles for underwater reconnaissance.

- The first successful ROV was developed in 1953 by the French inventor Dimitri Rebikoff. Rebikoff's ROV used a tether and an on-board camera to explore the depths of the ocean.

A Royal Navy ROV (Cutlet) first used in the 1950s to retrieve practice torpedoes and mines

1960s

- The U.S. Navy funded most of the early ROV technology development in the 1960s into what was then named a "Cable-Controlled Underwater Recovery Vehicle" (CURV)
- 1966: CURV-I was used to recover a hydrogen bomb from the floor of the Mediterranean Sea



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.

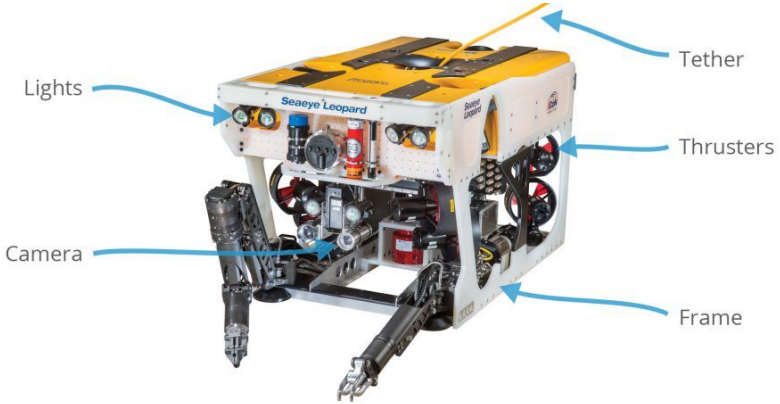
1970s

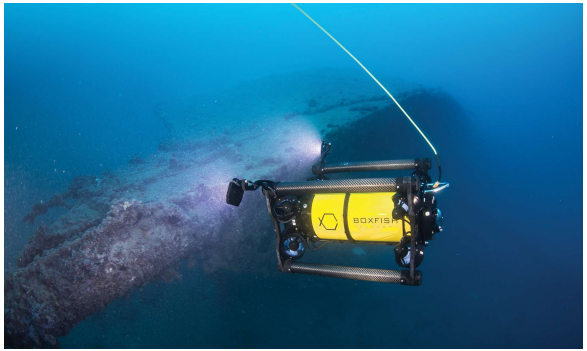
- 1973: CURV-III performed underwater rescue in submersible Pisces III incident.
- 1976: Survey the wreck of the SS Edmund Fitzgerald.
- CURV-21 is the current generation that replaced CURV-III.

U.S. Navy CURV-III

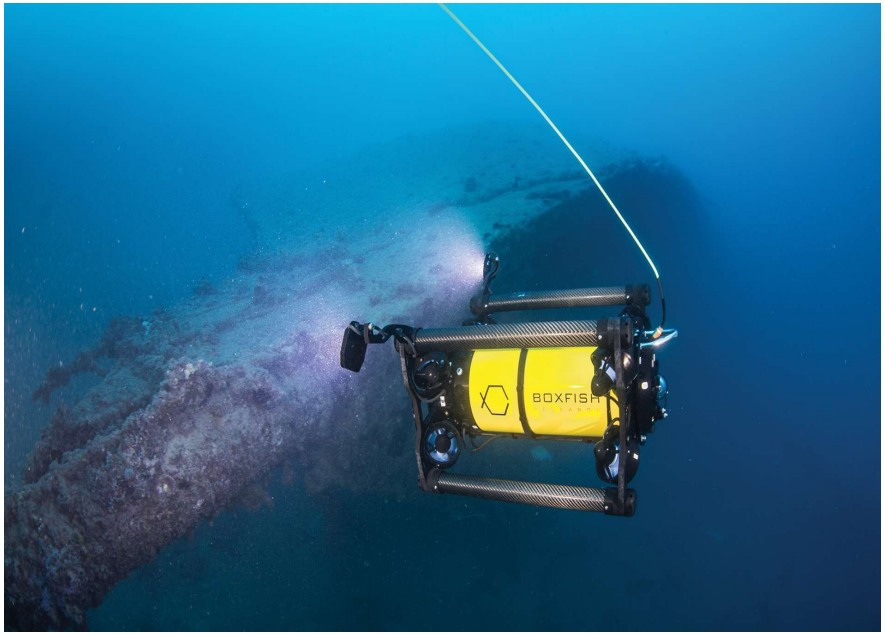
Today: Miniaturization, Advance sensors, Battery technology, etc…

- Improved sensors
- Autonomous navigation systems
- Increased communication capabilities.
- Expected to grow in the future as more areas of the ocean are explored and studied.





Ocean exploration

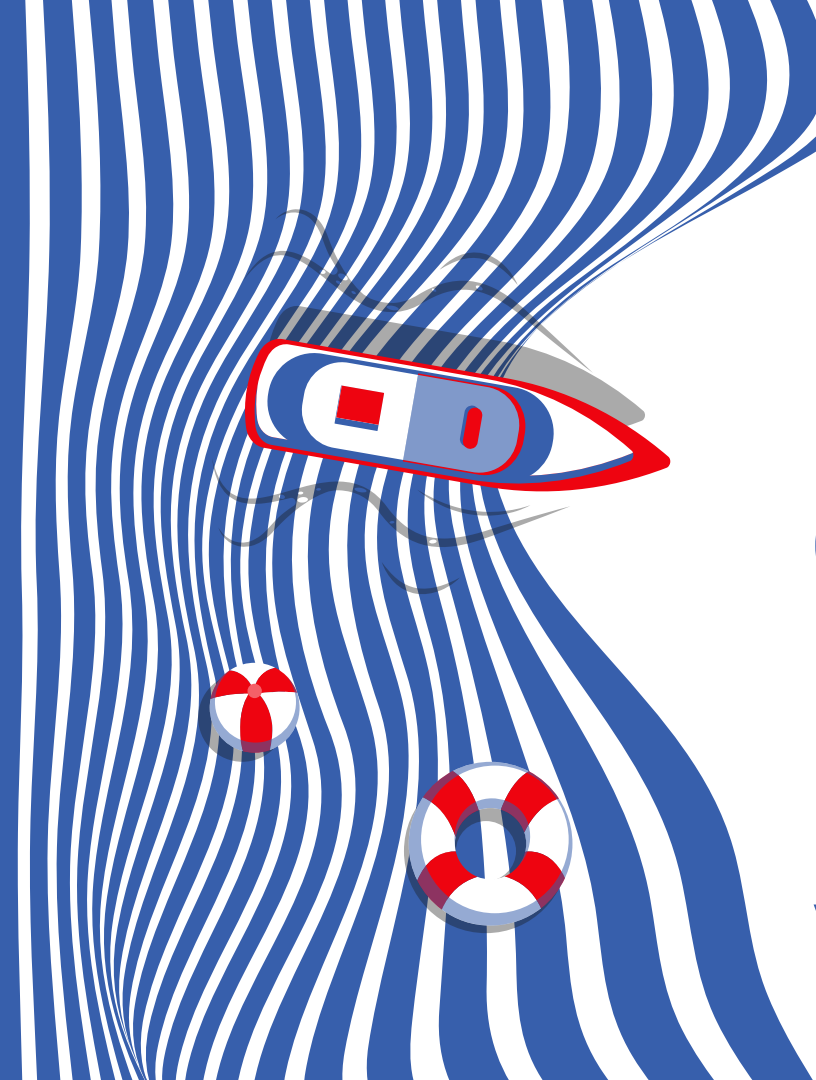


The remotely operated vehicle, Deep Discoverer, being recovered after completing 19 dives during the Windows to the Deep 2019 expedition. Image courtesy of Art Howard, Global Foundation for Ocean Exploration, Windows to the Deep 2019.

Applications

Their tasks range from simple inspection of subsea structures, pipelines, and platforms, to connecting pipelines and placing underwater manifolds. They are used extensively both in the initial construction of a sub-sea development and the subsequent repair and maintenance.

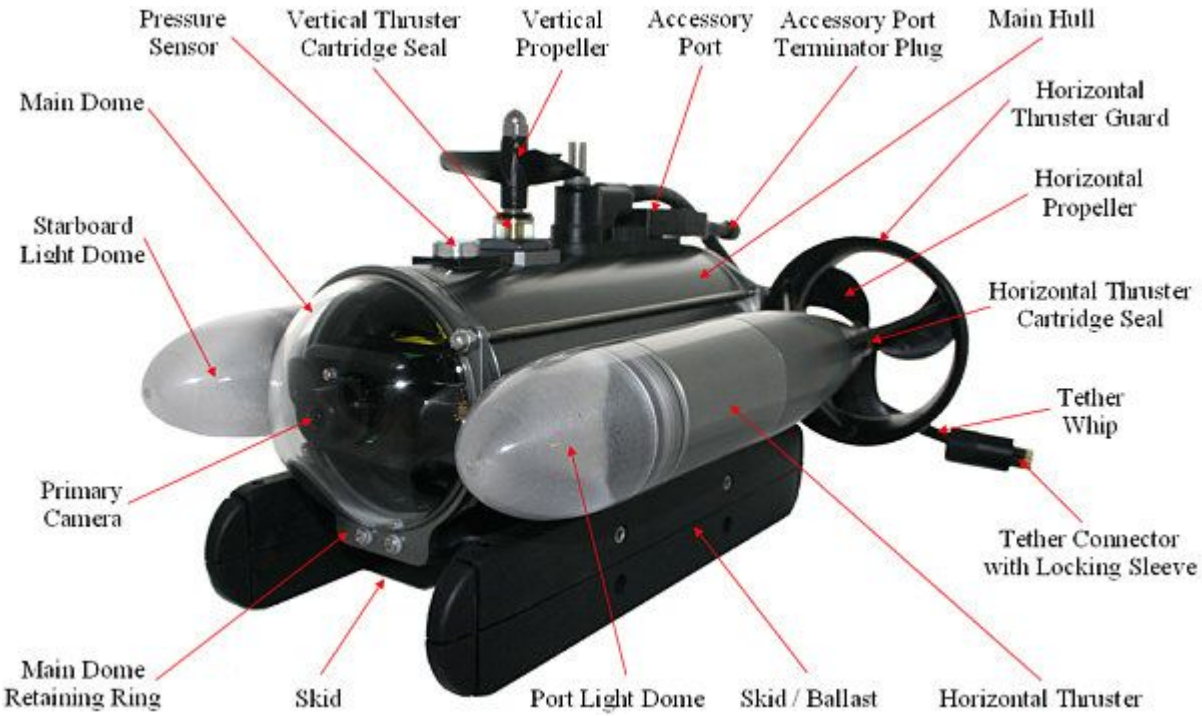
- Offshore oil and gas exploration
- Underwater construction
- Scientific research
- Military operations
- Oceanography.
- Exploring and studying the deep ocean, including the Titanic wreckage, hydrothermal vents, and other deep-sea habitats.

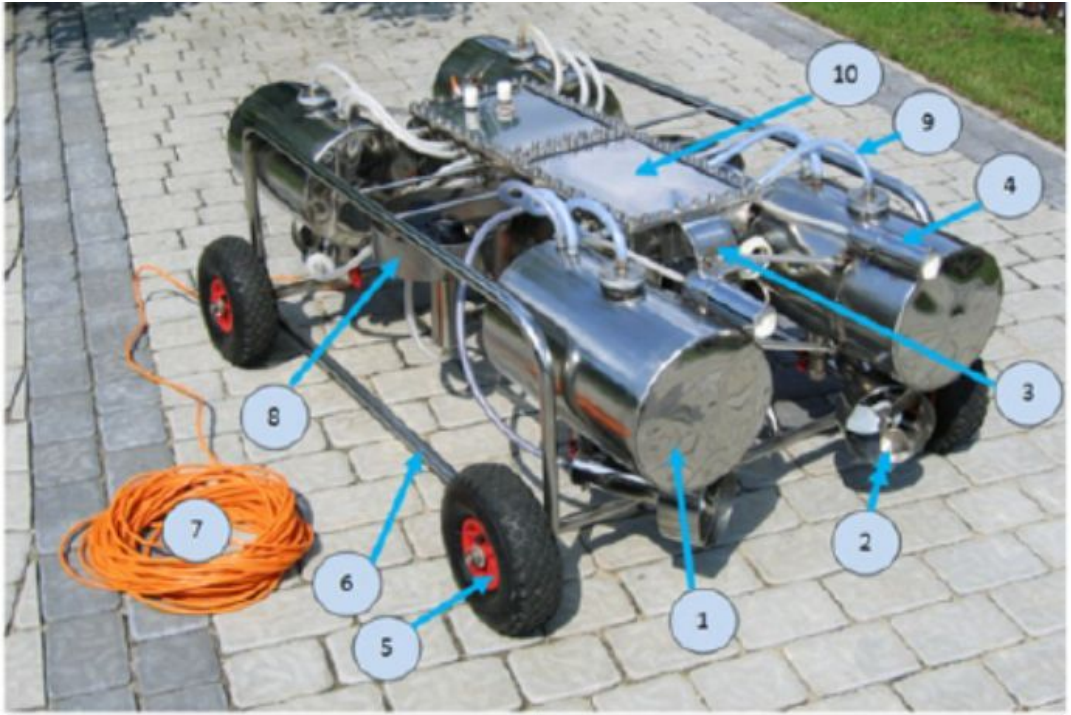


Main Components of the vehicle

Main components of the vehicle

1. Hull Design
2. Propulsion System & Ballast system
3. Navigation System & Control
4. Data collection & Manipulators
5. Data Transmission
6. Power Management


Pressure Sensor
Vertical Thruster Cartridge Seal
Vertical Propeller
Accessory Port
Accessory Port Terminator Plug
Main Hull
Main Dome
Horizontal Thruster Guard
Horizontal Propeller
Starboard Light Dome
Horizontal Thruster Cartridge Seal
Tether Whip
Primary Camera
Tether Connector with Locking Sleeve
Main Dome Retaining Ring
Skid
Port Light Dome
Skid / Ballast
Horizontal Thruster



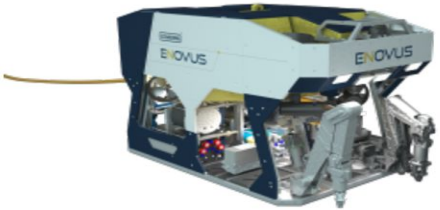
1) ballast tank
2) propeller horizontal motion
3) camera body drive
4) launcher buoys
5) wheel for transport
6) frame
7) communication cable
8) propeller vertical movement
9) tube with air
10) main hull

1. Hull Design

Frame: The frame is the main structural component of the ROV and provides support for all the other components. It can be made of various materials such as PVC pipes, aluminum, or carbon fiber.

ROV, TEMASEK Hidrokinetik

Torpedo design, YUCO by Seaber

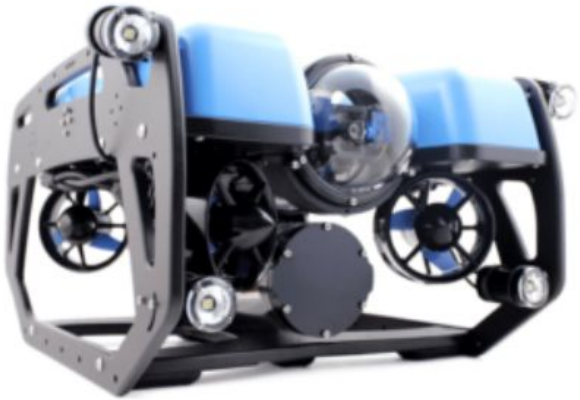
	Hull with Open frame	Frameless hull (close hull)
Structure type	 Seaeye Falcon[19]  Enovus ROV[20] ROV structure with open frame design	 SAAB Double Eagle SAROV[21]  Deep trekker DTG2[22] Frameless ROV design
Advantage	• Well known structure adopted on most ROV. • Stable 3DOF translational motions based on large metacentre. • Larger payloads and can carry object. • Easier to attach tools and equipment.	• Greater mobility/highly manoeuvre • Typically lightweight and portable • More energy efficient
Disadvantage	• These types of ROV have difficulties with motions requiring more than 3DOFs.	• Smaller payload • Not convenient for attaching tool or equipment

https://www.semanticscholar.org/paper/Hull-Design-for-ROV-with-Four-Thrusters-(X4-ROV)-Ashraff-Zainah/a869b5c4876bc4a1d567f800ca005e776011fd60

2. Propulsion System

Motors: The motors are responsible for propelling the ROV and controlling its movement. Brushless DC motors are commonly used for their high efficiency and reliability.

Propellers: The propellers are attached to the motors and generate thrust to move the ROV through the water.

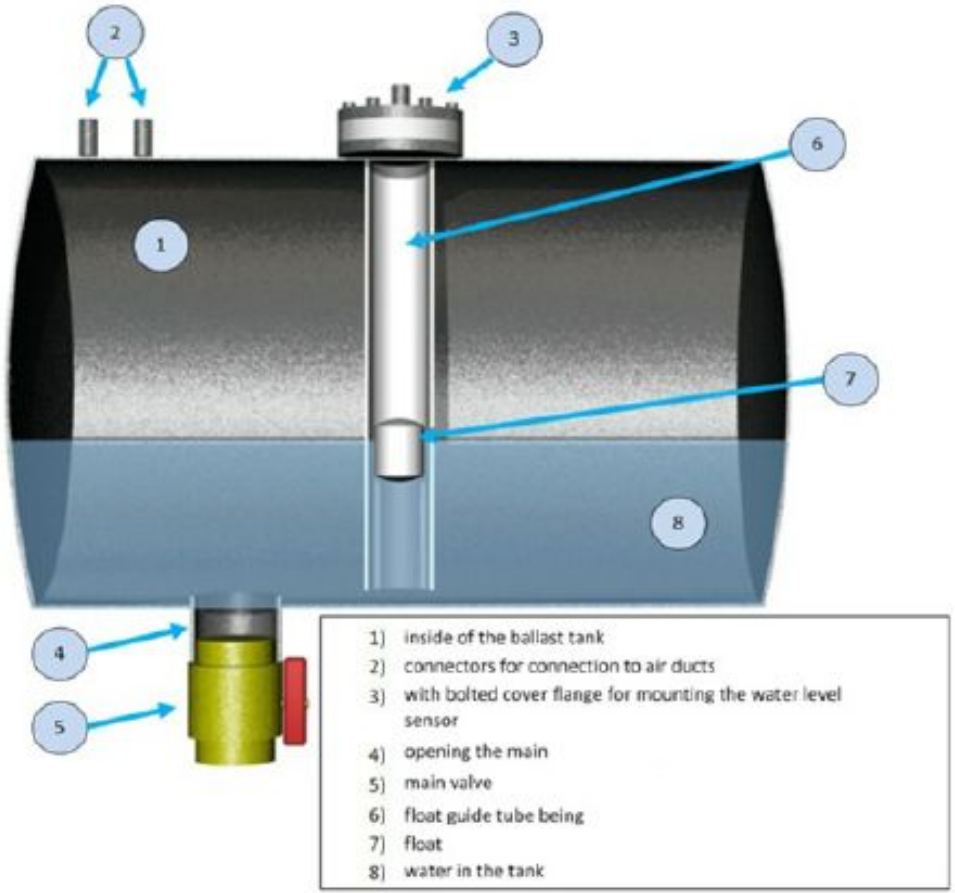


BlueROV2 featuring Blue Robotics T200 ROV thrusters

Blue Robotics' T200 ROV thruster

Ballast System

Ballast System: The ballast system controls the ROV's buoyancy and allows it to move up and down in the water. It can include adjustable weights, pumps, or inflatable bladders.



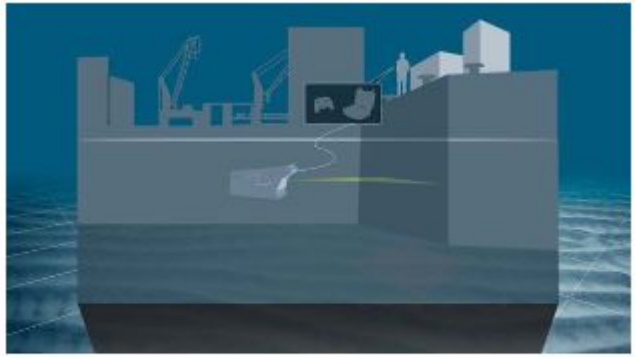
https://www.researchgate.net/figure/ehicle-ROV-Cross-ballast-tank_fig8_261643127

3. Navigation System & Control

Control System: The control system includes a microcontroller or a computer that receives input from the operator and sends commands to the motors and other subsystems. The control system also includes sensors that provide feedback on the ROV's orientation, depth, and other parameters.

Scanning sonar, Ping360

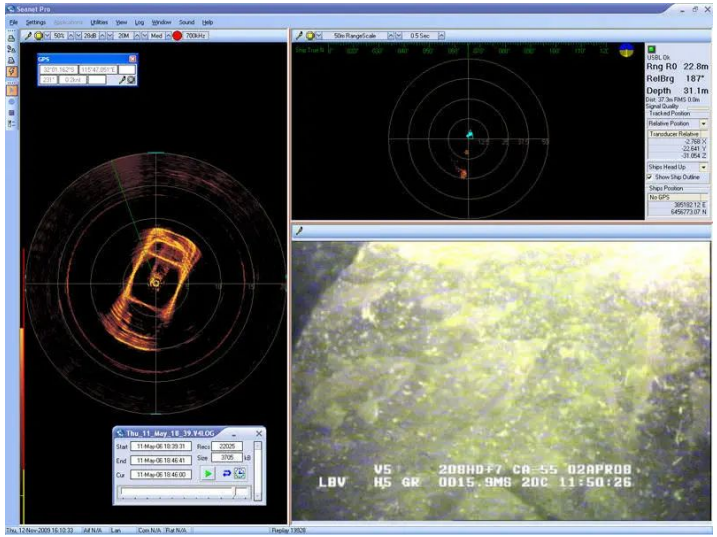
Control



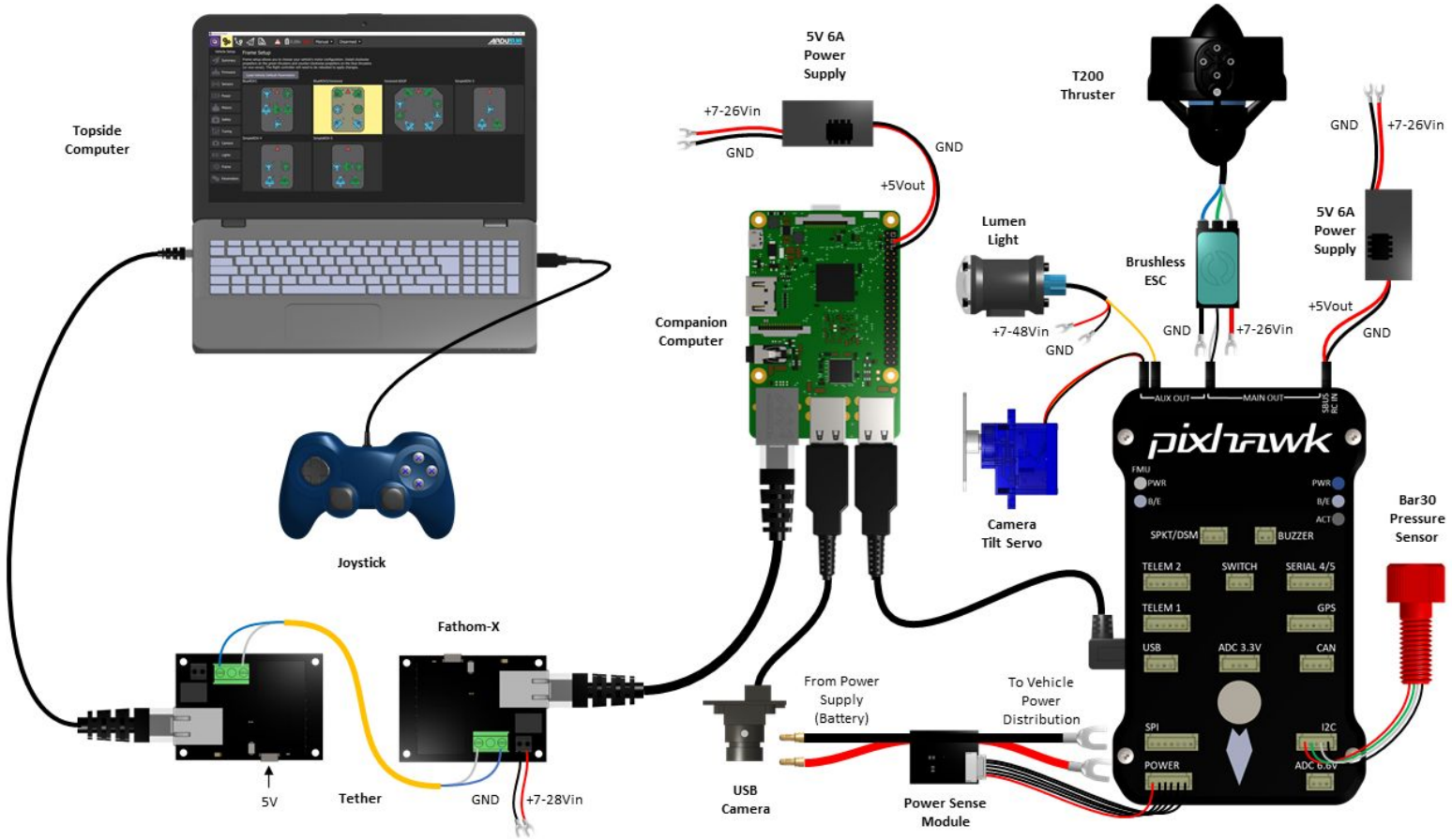
NaviSuite Mobula Sonar (VideoRay)

- High-speed 3D software, providing data fusion/georeferencing for all sensor data, with multiple 3D views with map and satellite image backgrounds
- Joystick steering of ROV in six degrees of freedom
- Assisted steering, lock depth, lock heading features
- Automated inspections modes such as scan harbour wall and orbit object
- Video and still imagery, multi-camera recording and playback synchronised with ROV track
- Near real-time ROV camera display
- Forward-looking sonar live image and mosaic
- Multi-beam, subsea laser/LiDAR, pipe tracker – all supported in the Sonar and Pro variants
- Observation registration and logging on 3D visualisation
- Connect remote displays over the internet so others can follow your operation anywhere
- Deliver your inspection in a NaviModel project so anyone with NaviModel Free Viewer can fly through the data

Integrated Navigation Control Console



ROV control console INC



Source : https://www.ardusub.com/introduction/hardware-options/connection-diagrams.html

4. Data Collection & Manipulators

Sensors: The sensors provide feedback on the ROV's environment and can include:

- Cameras
- Sonar
- Pressure sensors
- Temperature sensors and other types of sensors.

Manipulators and other specialized tools: Depending on the intended use of the ROV, it may require manipulators:

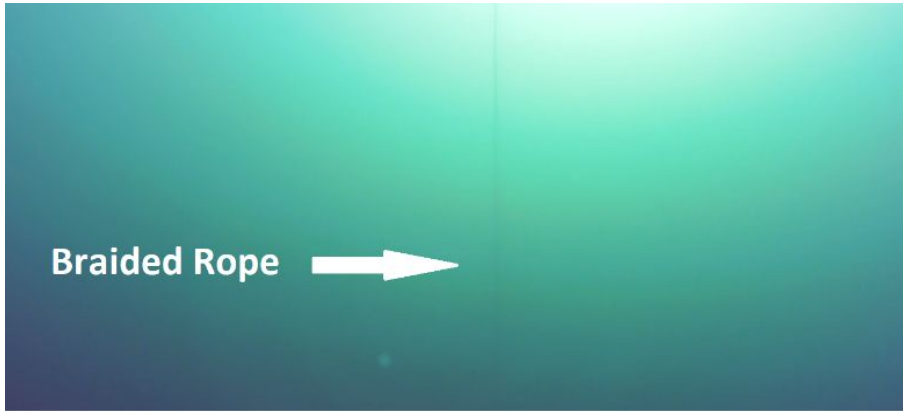
- Cutting tools
- Sampling tools, or other specialized equipment to perform specific tasks.

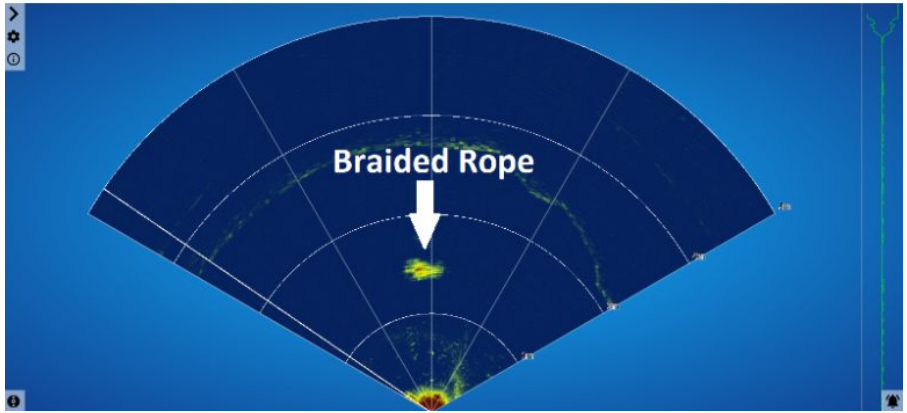
Sensors

Gyro compass

Intelligent pressure sensor (IPS)

Scanning sonar





Camera

The main ROV camera with tilt-function – the DTR-100Z from Bowtech

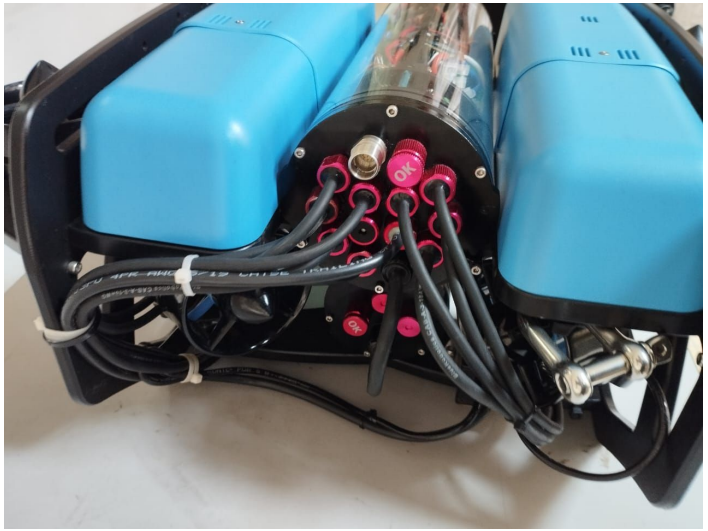
An image from the forward-looking camera on the ROV SuBastian of the Schmidt Ocean Institute.

Manipulators

5. Data Transmission

Communication System: The communication system allows the operator to control the ROV and receive data from the sensors. It can include a tethered cable, a wireless link, or a combination of both.

Tether cable



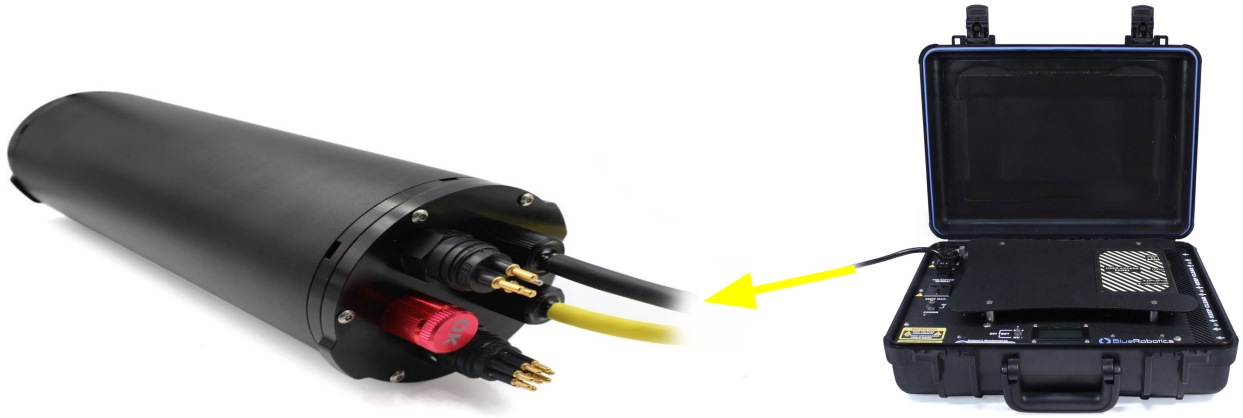
Multiplexers are designed to provide reliable fiber optic transmission of video and data signals in the demanding subsea applications of ROV.

Multiplexer

FXTI module, for interfacing on surface control station.

6. Power Management

Power Supply: The power supply provides electrical power to the motors, control system, and other subsystems. The power supply can be a battery pack or a tethered cable that supplies power from the surface.



ROV Enclosure

Topside Power Supply Unit