Remotely Operated Vehicle (ROV)

Robotic Hardware Systems

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Definition

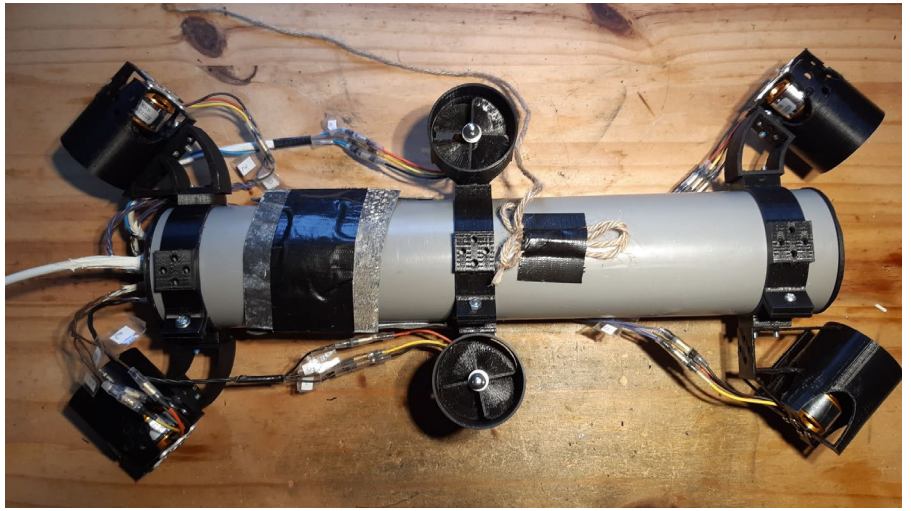
- A Remotely Operated Underwater Vehicle (or ROV) is a remotely controlled (usually wire-guided) underwater robot, unlike the Autonomous Underwater Vehicle (AUV). Like their aerial counterparts, these drones allow rapid and secure acquisition of global or precise, physicochemical and visual information (in digital form in particular), quickly enough, at a distance from the operator and sometimes massively. Some have a platform function that can be equipped on request with samplers or various sensors. Many prospectivists believe that their civilian use, still emerging, is a potential source of scientific and operational progress.
- ROVs can descend to around 6,000 meters below the water surface (ROV Victor, Ifremer), and withstand pressures of up to 600 bars.

An ROV (Subastian) aboard a research vessel used to explore and film the ocean depths.

Definition

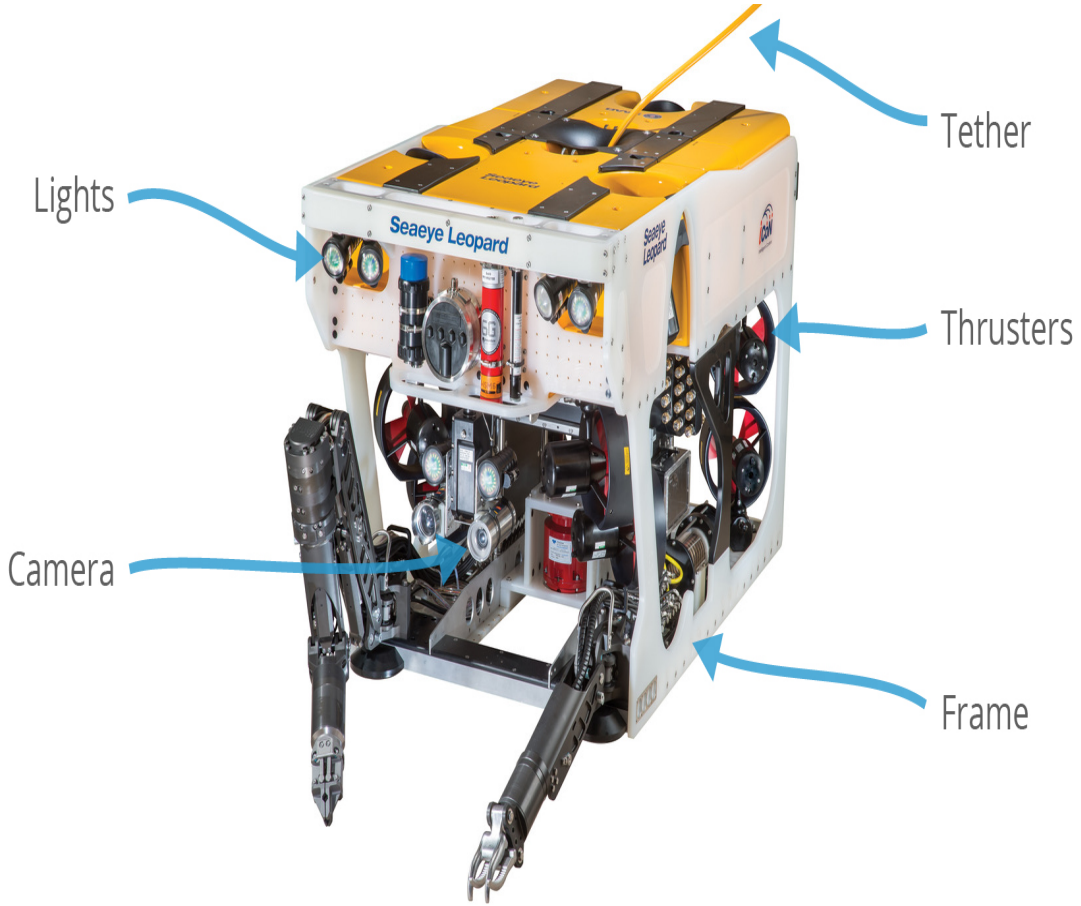
There are two categories of ROV depending on the job to be done:

- Observation ROVs or OBSROVs are machines used for observation purposes, for example to check the condition of pipelines or the foundations of oil platforms or to carry out various measurements (salinity, turbidity, magnetic field, etc.)
- Workclass ROVs are machines equipped with hydraulic or electric arms and tools allowing the accomplishment of specific work such as cutting or detecting gas. Typical examples are the handling of valves or the maintenance of petroleum installations.



Physical Design for various applications

- ROVs come in all shapes and sizes to address different needs, but they generally have some common elements.
- There are many other possible components on ROVs including sensors, robotic arms, sampling devices, actuators, tools, and sonars, but nearly every ROV has these core components.



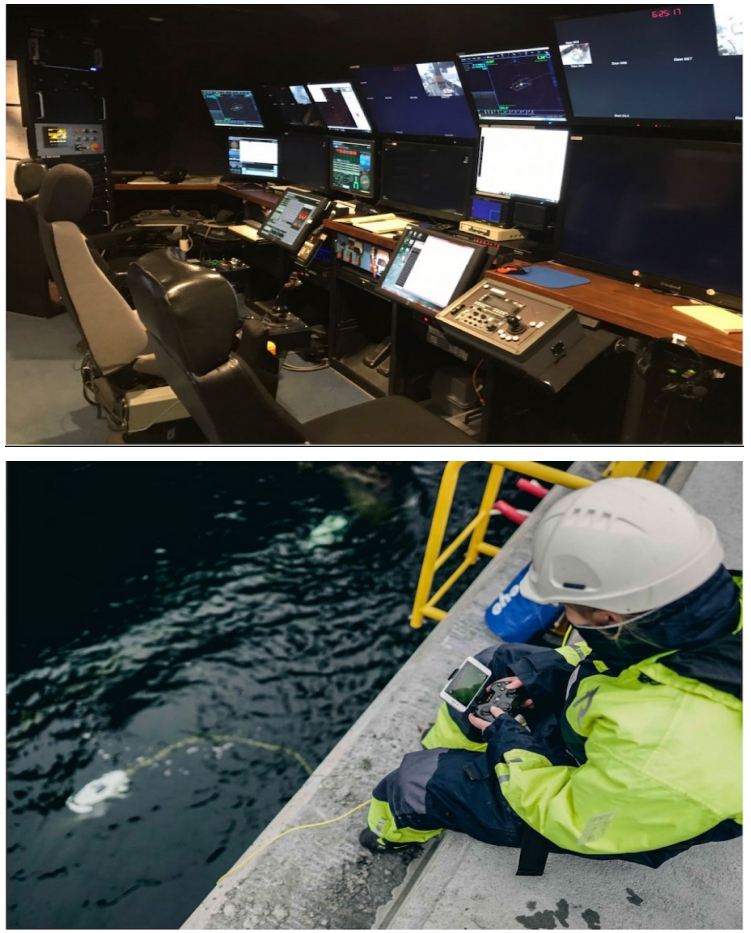
Locomotion System & Actuators

- **Thrusters.** The thrusters are electrically or hydraulically powered propellers used to maneuver the vehicle. There are almost always multiple thrusters to provide movement in multiple directions.
- Underwater electrical thrusters are composed of the following major components:
  - Power source
  - Electric motor
  - Motor controller (this may be part of the internal thruster electronics or may be part of a driver board in a separate pressure housing)
  - Thruster housing and attachment to vehicle frame
  - Gearing mechanism (if thruster is geared)
  - Drive shafts, seals, and couplings
  - Propeller
  - Kort nozzle and stators

ROV thruster

Navigation System (Sensors) & Control

- **Camera.** Since the vehicle travels deep underwater, the only view that the pilot has is through the onboard camera, which must be able to provide an image with low-latency.
- **Pilot Controls.** The surface controls can range from something that looks like the control room for a spaceship to something as simple as a smartphone. In any case, the surface controls provide a physical interface for the pilot to control the vehicle and a display of feedback from the vehicle including the camera view.
- **Tether.** Nearly all ROVs have a tether that carries electrical power and/or signals to the surface so that the pilot can control the vehicle and see the camera. Radio waves don't travel far through water, so it's not possible to operate an ROV with modern wireless technology. There are acoustic and optical modem technologies that may someday enable wireless operation.
- **Lights.** The lights provide illumination for the camera underwater. Sunlight disappears rapidly underwater and many ROV missions occur at depths that are normally in complete darkness.



The control room for a large science ROV, the Ventana (TOP), and the mobile control system for a small, portable ROV, the Blueye Pioneer (Credit: Blueye Robotics).

Data Collection and Transmission

- Camera and sensors provide critical data and visual information to be relayed back to the rig personnel to observe seabed and operating subsea, well, drilling-related tools, equipment, and surroundings. Sensors provide feedback on water depth, temperatures, currents, and ROV orientation
- The tether provides both the electrical power and allows the transfer of data between the vessel and ROV to be transmitted.
- ROV-mounted sensors communicate with the surface through four separate modes:
    1. Communication through the vehicle's tether and telemetry system
    2. Communication through the vehicle's tether but bypassing the telemetry system, for example, with a separate fiber breakout within the junction box routed to a survey pod (or directly to the sensor)
    3. Communication outside of yet attached to the vehicle, for example, physically attaching (via plastic or fiber wraps) a separate communication line to the tether
    4. Communication separate and apart from the vehicle, that is, with a separate down line from the vehicle and tether

Power Management

- The challenge with powering any ROV from the surface is the electrical power loss through the tether. A long tether with small wires, like that used on most ROVs, has an electrical resistance that causes a voltage drop proportional to the amount of electrical current passing through the wires. The best way to overcome this challenge is to transfer the power at a high voltage and low current, minimizing power losses.

The Outland Technology Power Supply (OTPS):

The inside of the topside power supply unit highlighting the (1) ground wire connection, (2) tether connection, (3) power cable input, (4) laptop charger outlet, (5) power switch, (6) LIM/GFI test switch, (7) status display, (8) laptop tray, (9) user access panel, (10) USB-B FXTI connection, (11) External FXTI connection, and (12) Fathom-X LINK and POWER indicators.