REMOTE OPERATED VEHICLE (ROV)

MCTE 4362 (ROBOTICS HARDWARE SYSTEM)

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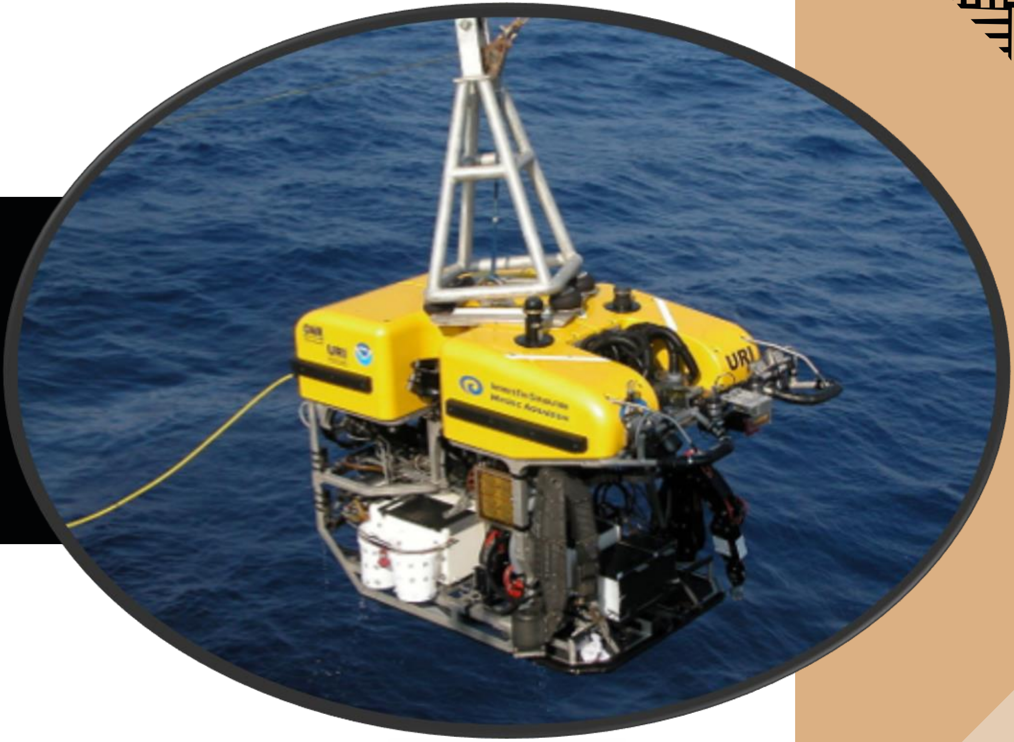
Introduction

- A Remote Operated Vehicle (ROV) is a type of crewless submersible vehicle that is tethered to a surface-based vessel by a cable
- Features a camera, lighting, thrusters that allow for three-dimensional agility, depth sensors, a wide range of manipulative and acoustic devices, plus specialized equipment to carry out operations
- Can take pictures underwater and carry out diverse underwater jobs
- ROV is an undersea vehicle that needs direct control by human through a remote control from above the water
- ROV is powered by electrical and controlled through control system, can maneuver according to human orders with thrust or electric booster

History & Applications



"Exactly who to credit with developing the first ROV will probably remain clouded, however, there are two who deserve credit. The PUV (Programmed Underwater Vehicle) was a torpedo developed by Luppis-Whitehead Automobile in Austria in 1864, however, the first tethered ROV, named POODLE, was developed by Dimitri Rebikoff in 1953."

– The Remotely Operated Vehicle Committee of the Marine Technology Society

History

1 2 3 4 5

1960

US Navy funded ROV technology development named "Cable-Controlled Underwater Recovery Vehicle" (CURV) that capable to perform deep-sea rescue operation and recover objects from ocean floor. Eg: nuclear bomb lost in the Mediterranean Sea after the 1966 Palomares B-52 crash

1970

Royal Navy used "Cutlet", a remotely operated submersible, to recover practice torpedoes and mines

1980

Development of offshore oil & gas industry fields using ROVs

Mid 1980

ROV development increased rapidly due to marine ROV industry suffered from serious stagnation in technological development caused in part by a drop in the price of oil and a global economic recession

Recent

ROVs are used in all manner of exploration and applications. Eg: dam and water-tank inspections to evidence recovery, pipeline maintenance, aquaculture and drowning-victim recovery

Applications

Military Use

October 2008 - The U.S. Navy improve its locally piloted rescue systems, based on the Mystic DSRV and support craft, with a modular system, the SRDRS, based on a tethered, manned ROV called a pressurized rescue module (PRM)

Science Use

Involves the construction of small ROVs that are made of PVC piping and can dive to depths between 50 and 100 feet. It has led to many organizing competitions. Eg: Marine Advanced Technology Education (MATE), National Underwater Robotics Challenge (NURC)

Applications

Broadcast Use

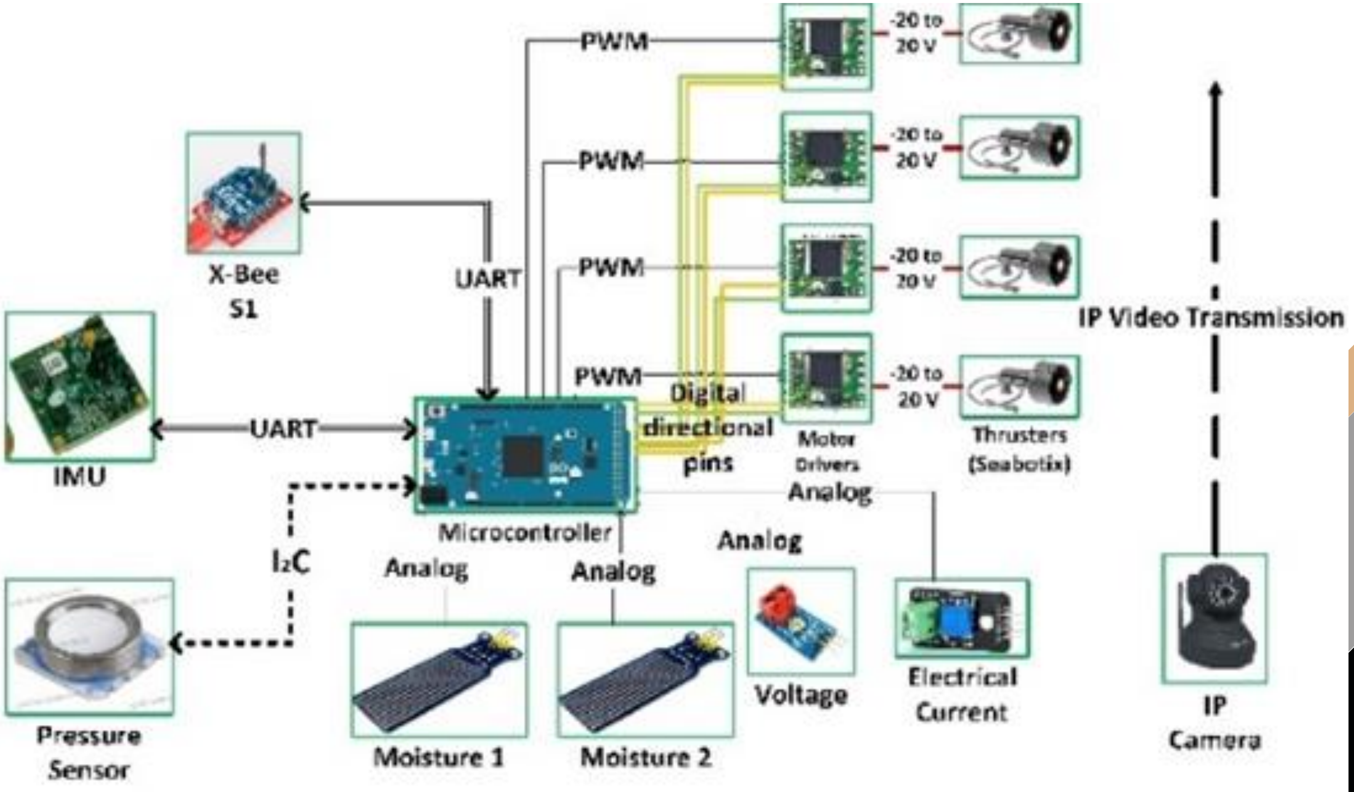
Used for documentary filmmakers due to their ability to access deep, dangerous, and confined areas unattainable by divers. ROV can be submerged and capturing footage, which allows for previously unseen perspectives to be gained. Eg: National Geographic Shark's Men

Hobby Use

To study the number of deep sea animals and plants in the ocean through the use of ROVs. Eg: Underwater archeology named Mardi Gras Shipwreck Project in the Gulf of Mexico

Main Components of The Vehicle

ROV Electronic System Architecture



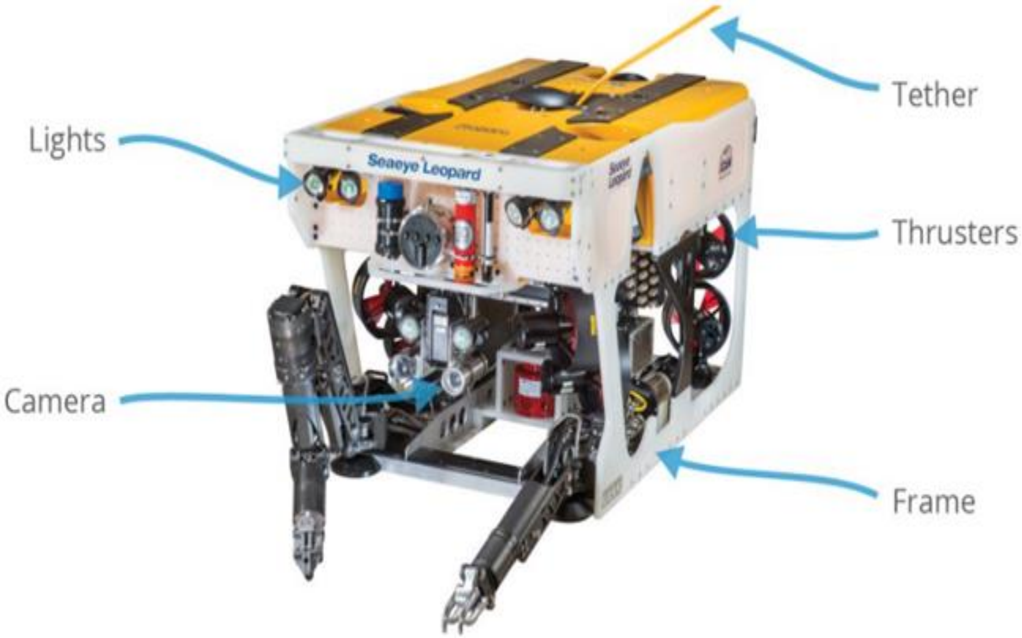
Main Components of ROV

1. Hull design
2. Propulsion System
3. Navigation System & Control
4. Data Collection
5. Data Transmission
6. Power Management

1. Hull Design

Basic features on a ROV includes:

1. **Thrusters**: Propellers used to maneuver the vehicle
2. **Camera**: Provide an image with low-latency under deep sea level
3. **Lights**: Provide illumination for the camera underwater
4. **Tether**: Carries electrical power and/or signals to the surface
5. **Frame**: Provides a structure to attach the thrusters, camera, lights, tether, and other components of the ROV
6. **Pilot Controls**: Provide a physical interface for the pilot to control the vehicle and a display of feedback from the vehicle including the camera view



ROV structures are divided into two main categories:

1. Hull with Open frame

Seaeye Falcon

Enovus ROV

2. Frameless hull (close hull)

SAAB Double Eagle SAROV

Deep trekker DTG2

	Hull with Open frame	Frameless hull (close hull)
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

2. Propulsion System (Locomotion)

Fixed thruster

- Lightweight design
- Integral drive electronics
- Various connectors and voltage options
- Magnetically coupled brushless DC motor

Azimuth thruster

- Made of aluminium and plastic
- Generate high bollard pulls for working applications and high vehicle speeds for efficient survey work rates
- Have high thrust levels that able to adapt in high current environments

Rudder thruster

- Lightweight ceramic shaft sealing system
- Efficiency near equal forward/reverse within a 5% band
- Can fit any motor displacement size due to the common, one-size motor/thruster interface

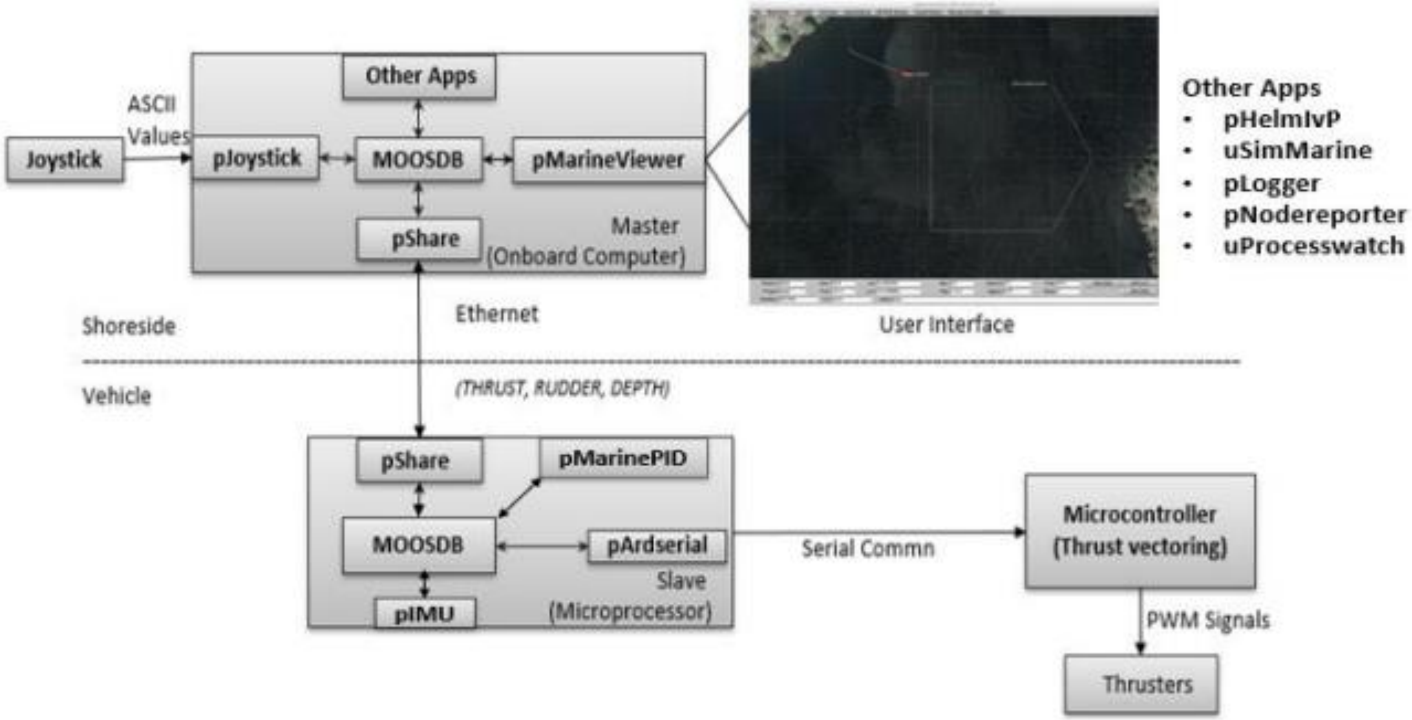
3. Navigation System & Control

Eg: A ROV named ORCA with integrated navigation system

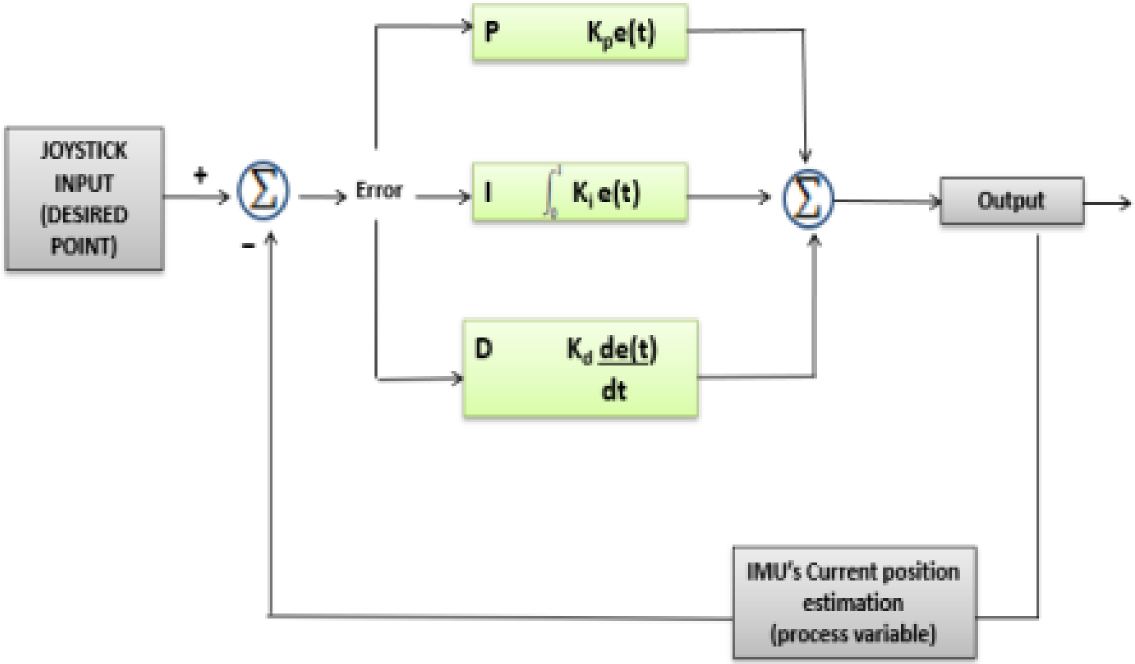
→ Using the **Mission Oriented Operating Suite-Interval Programming (MOOS-IvP),** a set of C++ open-source modules has been incorporated in this ROV as the major tool for navigation system and control

Joystick

- ROV operations a joystick command console is used for positioning control
- It controls the propeller speed of each thruster. A thrust allocation may be used for manual control in surge, sway, heave and yaw
- These allow the operator to manipulate objects with the ROV



The architecture of ORCA navigation and control system using MOOS-IvP



Block representation of closed-loop PID controller system used in ORCA

- A closed-loop PID control system was implemented to minimize the positional errors and drift of the vehicle thus inducing stability in its movement
- The application pMarinePID has basic PID controllers operating to control heading speed and depth based on incoming desired heading, speed, and depth objectives

4. Data Collection

Data Collection

Sensor

Give data on the orientation and position of the ROV

Camera

Provide an image with low-latency under deep sea level

Light

Provide illumination for the camera underwater

Sonar

Enables ROV to effectively and securely survey enormous water regions

Sensors

Pressure sensor

To monitor the temperature underwater for any alarming temperature variations

SOS leak sensor

A safety sensor that helps in monitoring for any water going into the electronic enclosure to prevent any electrical catastrophe due to leakage

HG1120 IMU

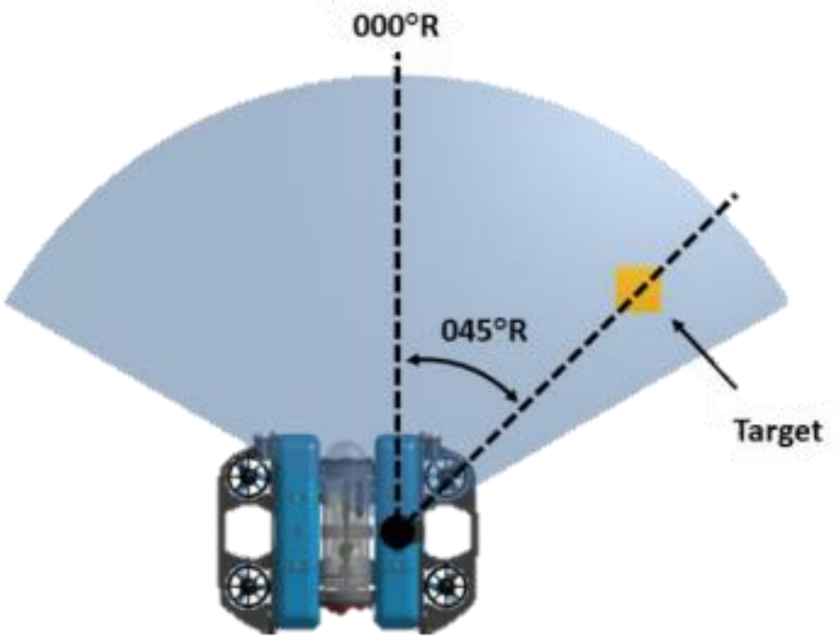
Provide compensated incremental angle and velocity data for navigation and angular rates, linear accelerations, and magnetic fields for control through a digital serial interface bus

Camera

Lowlight HD USB camera

- Mounted at the front end of the acrylic housing to provide continuous live video footage to the user and to help in smooth navigation underwater
- Offers a field of view of 80 degrees horizontally and 64 degrees vertically.
- The tilt system was PWM controlled by the controller for 180-degree movement.

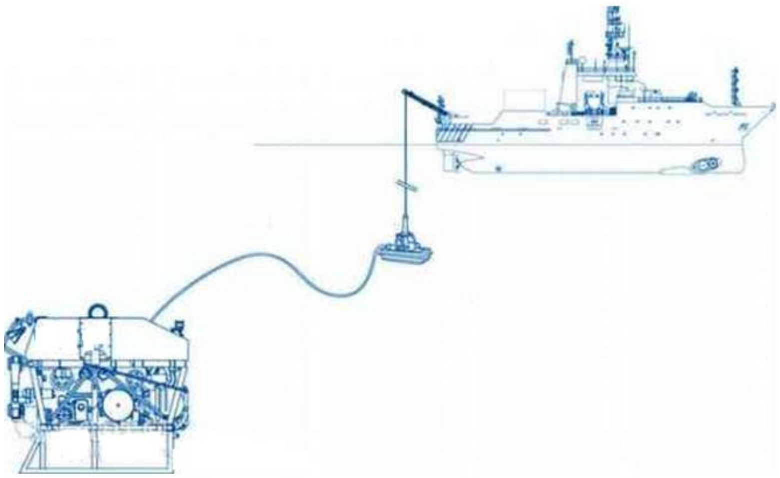
Sonar



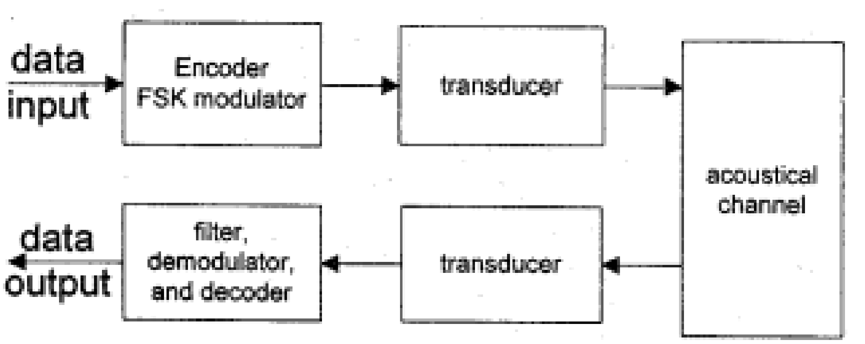
Scanning Sonar

- The scanning sonar will explain on the interpret sonar pictures produced and provide some best practices and procedures for using sonar when it is placed aboard ROVs.

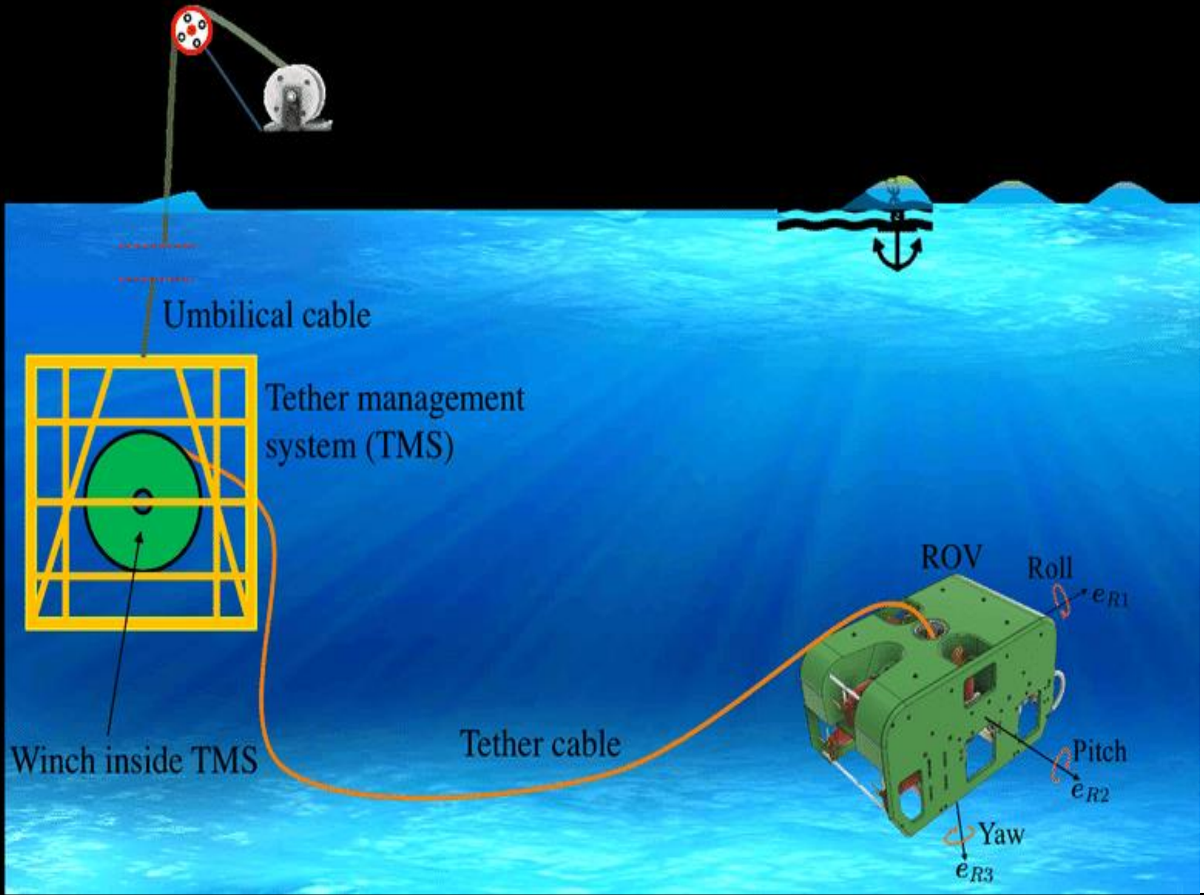
5. Data Transmission



ROV auxiliary transmitter using tether cable



General block diagram of ROV communication system



- Data transmission between the boat and the ROV is made possible by the tether, which supplies electrical powe
- A distance of at least 500 feet (150 m) from the point of the cluster weight may be covered by the ROV's excursions at depth using the tether cable

6. Power Management

Power Distribution

- 225 kVA Transformer for vehicle hydraulics
- 8..5 kVA Transformer for vehicle electronics
- 15kVA Transformer for TMS-HPU
- 1.5 kVA Transformer for TMS electronics
- Ground fault detection circuits
- Deck cable interface

Heavy Duty Work Class ROV

- Depth rating: 3000 or 4000 msw
- Power: 200 hp shaft
- Through frame lift: 3000 kg
- Payload capacity: 300-25 kg

Perry XLX EVO

Saipem's Hydrone-R

Heavy Duty Work Class ROV

- Have long endurance
- Ensure remote access in all weather conditions at al time (24 hours operating for the whole year)

Thank you ☺