PROPOSAL FOR SOMETHING CLEANING ROBOT SOMETHING

Submitted to

------, Project Co-Ordinator

by

Arfaz Hussain

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Proposal Background

Ocean Networks Canada (ONC) is seeking proposals for the development of an autonomous underwater robot capable of cleaning and positioning objects on underwater cameras and sensors. As part of the observatories, ONC operates world-leading ocean monitoring systems that collect a wide range of data, including water quality, biodiversity, and marine environment information, and provide live video feeds of conditions related to the ocean floor, seismology, and biology. However, the observatories' cameras and sensors can be obscured by biofouling, sedimentation, and falling debris, impacting data collection and monitoring. To address this issue, ONC is inviting external proposals for the research, design, construction, development and testing of a prototype robot that can locate an object emitting a specific IR signal, within a constrained search area, position a simulated cleaning device on top of it, and signal the completion of the task. [1]

The prototype robot must be environmentally sensitive and capable of maneuvering without causing damage to the surrounding objects. According to Ocean Networks Canada, the automated systems should include designs for small-scale models that can simulate the prototype's function in a dry lab environment.[1] The robot's onboard sensors and cameras should be capable of collecting and transmitting data on the robot's movements, the target's location, and other environmental variables. The proposed design should factor in the underwater environment's unique challenges, including light absorption, pressure, and temperature.

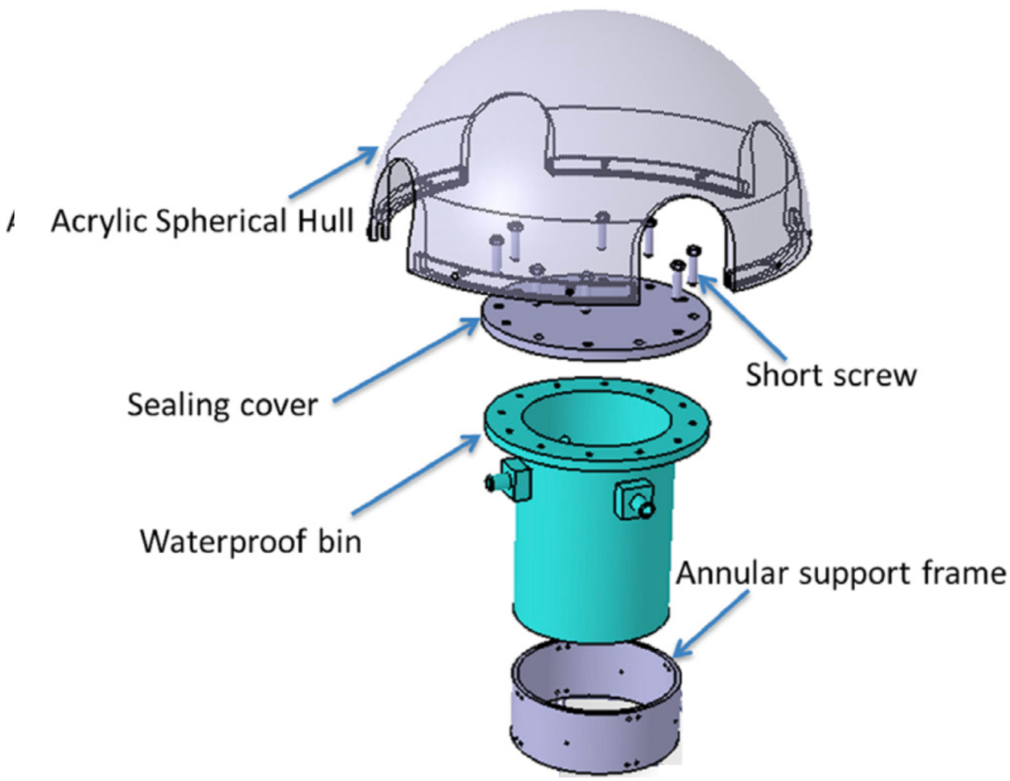
Design Proposal for the Prototype Robot

Our initial design for the robot features a legged, multi-vectored spherical design with a six-axis torque sensor at its center. The torque sensor, like those used in our previous autonomous systems, allows for precise maneuvering of the robot through controlling its longitudinal and lateral motion, rotatory motion, sinking and floating motion, as well as cruising motion. This design ensures safe maneuverability in the sensitive ecology of the underwater environment. We have incorporated a sensor integrated control system that allows for remote operations and monitoring in case of any accidents or emergencies, ensuring safety and flexibility during underwater missions. Our design is also equipped with a set of external Infrared sensors in the front, allowing it to detect and avoid obstacles in real-time while navigating through the water, our robot is equipped with a robust power supply system, featuring a central waterproof compartment that houses a set of rechargeable batteries. This design ensures long-lasting and sustainable operation of the robot during extended missions, without the need for frequent recharging or replacement of batteries.

Omni-Directional Axial Design

The main key design feature of our robot is the axial design, which consists of six peripheral modules and a central waterproof cylinder. The peripheral compartments also provide additional space for specific sensors, wirings and equipments tailored for the surface cleaning mechanism. This integrated sensor and wiring settings can be customized for a wide variety of underwater operations, but the current setting is specifically designed for this proposal. The waterproof cylinder (central bin), which is surrounded by an annular support frame, is suspended from the top of the shell by several 140-mm screws, ensuring even distribution of weight. The annular support frame is designed to provide additional stability and support, with the four long screws on top of the support frame.

The central waterproof bin is a crucial element of the robot's design, housing the batteries, control boards, and other electronic components. A sealing cover on top of the bin provides easy access to these components before and after missions. The bin is also equipped with a robust power supply system, which utilizes a combination of rechargeable batteries and solar panels to ensure long-lasting and sustainable operation of the robot. The six-legged design allows the robot to move in six different directions along the center axis, providing stability and safer maneuverability in challenging terrain. Overall, the combination of the axial and six-legged designs, along with the central waterproof bin and annular support frame, make for a versatile and reliable robot that is well-suited to a wide range of underwater missions. This modular design approach enables reusability and sustainability, allowing the robot to be repurposed for different tasks simply by swapping out specific sets of equipment in the six peripheral compartments.



1A: The Central Waterproof Compartment

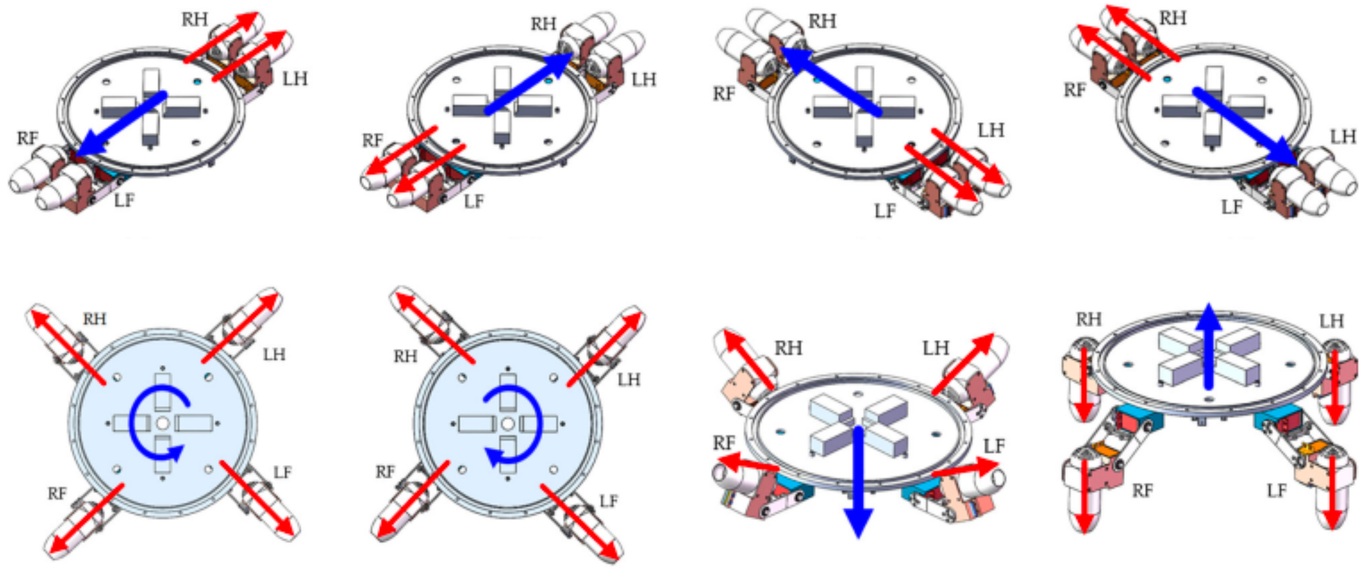
Figure:

Sensor Integrated Control System

The control system is a critical component of our underwater robot, providing safety, flexibility, and precise remote control when in operation. Our control system is integrated with many different types of sensors, mainly infrared, imaging, motion, depth, and proximity sensor to help enable remote operation and monitoring. This allows operators to safely monitor its coordinates, depth, propulsion rate among other operation modules when in underwater. One of the key features of the integrated sensor system is the integrated torque sensor, which allows for precise control of the robot's movement. This sensor measures the force and torque of each of the robot's propellers, providing real-time feedback to the operators about the robot's speed, direction, and orientation. With the torque sensor, operators can control the robot with great precision, enabling it to perform complex movements and navigate through narrow spaces in such a way that does not harm the surrounding ecology.

The integrated system is composed of several subsystems, which mainly includes the electrical (sensor) system, mechanical, and propulsion systems:

	Electrical System	Mechanical System	Propulsion System
1	The electrical system is a critical component of the robot's control subsystem and includes the control unit, sensors, communication unit, and execution unit.	The axial design of the robot, with six peripheral modules and a central waterproof cylinder, provides stability and flexibility for a wide range of underwater missions.	The propulsion system is a unique feature of our robot, which uses only four propellers. Each propeller is connected with the central plate at the bottom of our central compartment (waterproof bin).
2	The use of sensors, such as the torque sensor, allows for precise control of the robot's movements, making it well-suited for underwater operations.	The waterproof cylinder houses the batteries, control boards, and other electronic components and is designed for easy access and maintenance.	The electrical and mechanical system of our robot enables each of the four propellers to move rightward and leftward to a degree along the central (middle) plate, allowing it to navigate underwater.
3	The sensor integrated architecture of our system allows for precise movement and operation of the robot.	The annular support frame surrounding the waterproof cylinder provides additional stability and support for the robot.	The system also provides stabilization of the robot's attitude, high flexibility and mobility, rotation with zero-radius, and accurate position control.



1B: Degrees of Complex Locomotions throughout the Central Plate with the help of 4 Propellers

Surface Cleaning Mechanism

Our robot is equipped with three different types of sensors: infrared, imaging and proximity sensor. Infrared and imaging sensor will help us guild our robot from remote systems to our target location, whereas our proximity sensor will help us with the co-ordinates and with our cleaning mechanism. Once the target is located, the robot will get close to the object and activate its surface cleaning mechanism. The vectored propulsion system will provide the necessary mobility and flexibility to navigate around the target object and clean its surface. Once the cleaning is complete, the robot will signal the completion of the task.

Sustainability in the Design

The modular design of our robot is an essential element in achieving our sustainability goal. The modularity allows us to easily replace and upgrade the robot's components, minimizing the need for complete replacement and reducing waste. We are also planning to use environmentally friendly materials for our robot's construction, such as biodegradable and recyclable plastics, to reduce its ecological footprint.

The robot's electrical, integrated sensor and propulsion system is designed to minimize its impact on the surrounding environment and ecology. The multi-vectored propulsion system reduces the number of propellers needed for our axial design, which would significantly decrease the amount of turbulence generation and noise created.

In addition to the design features, the robot's integrated sensor system is optimized for energy efficiency. The control system is designed to consume low power, which prolongs the robot's operational time and reduces its energy consumption. This energy efficiency, coupled with the modularity and eco-friendly materials, allows our robot to meet our sustainability goals and minimize its impact on the environment.

Bills Of Materials and Timeline

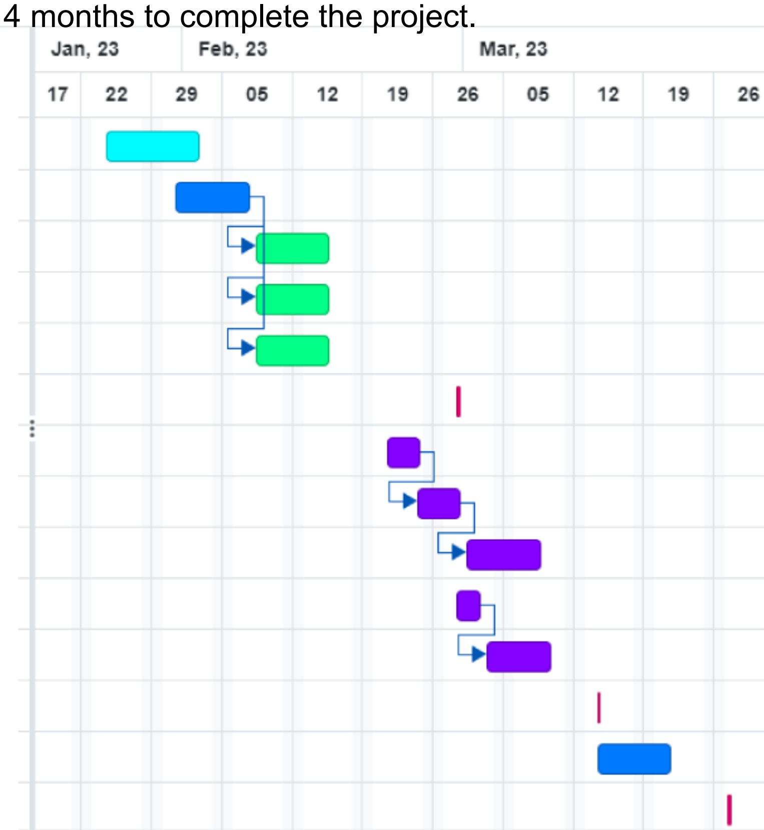
This is an estimated cost of making one robot, which includes all our prices, some elements we make by ourselves, and others we order and make from [ideal company name]. Our engineering team has estimated the cost and timeline required to complete the project.

Components	Quantity	Cost (CAD)
Waterproof Cylinder Bin	-	$5,200 - $7,500
Propulsion System with Central Plate	-	$1,000 - $3,500
Cleaning Unit	-	$3,500
Control unit	-	$1300 - $2400
Propellers	4	$100 - $200
Infrared Sensors	5	$300 - $400
Proximity and Motion Sensors	5	$500 - $600

Imaging Sensors	1	$200
Torque Sensor	1	$1,000 - $1,200
Central Frames	13	$800
Rechargeable Batteries	12	$400 - $500
Miscellaneous	-	$12,000
Total Cost (CAD)	-	$25,000 - $31,500

We estimated that it will take approximately 4 months to complete the project.

Timeline	Teams Designated
Concept Sketches	Design Team
Robot Built	Mechanical Engineering Team
Robot Movement (run 1 meter)	Structural and Mechanical Team
Robot movement (turn)	Software Testing and QA
Robot mechanics (ball dropping)	Software Engineering Team
Milestone 1 - Mechanical testing	All Teams
sensing distance	Structural Engineering Team
Reporting Distance	Software Engineering Team
moving to destination	Software Engineering Team
Sensing wall	Mechanical and Software
avoiding wall	Software
Milestone 2	All Teams
Speed improvement	Mechanical Engineering Team
Final Demo	All Teams



FINAL CONSIDERATION

We recognize the significance of sustainability and thus demonstrating our commitment to it through integrating energy-saving features and utilizing recyclable, materials in our design, will increase the likelihood of securing the contract. This will not only align with the values of Oceans Network but also demonstrate our capability as a responsible and innovative company.

REFERENCES:

Citations:

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2. Y. Li, S. Guo, and Y. Wang, "Design and characteristics evaluation of a novel spherical underwater robot," *Robotics and Autonomous Systems*, vol. 94, pp. 61–74, Aug. 2017 [Online] *doi.org/10.3390/mi13010025*

3. H. Xing, S. Guo, L. Shi, X. Hou, Y. Liu, and H. Liu, "Design, modeling and experimental evaluation of a legged, multi-vectored water-jet composite driving mechanism for an amphibious spherical robot," *Microsystem Technologies*, vol. 26, no. 2, pp. 475–487, Jul. 2019 [Online] doi.org/10.1007/s00542-019-04536-7

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