2024 MATE World Championship

epoxsea | HKUST Robotics Team | 香港科技大學 THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

WAHO

ABSTRACT

EPOXSEA, a diverse company based in Hong Kong consisting of 29 undergraduate students from business, science and engineering, with balanced mix of genders, has 13 years of experience in remotely operated vehicles (ROV) development. This year, we developed our latest model WAHOO.

WAHOO, designed for adaptability, reusability and safety, is a result of iterative design and extensive testing with tools like Gazebo Simulator, ROS2 control system and SolidWorks. Innovative features, 2 axis claw, mountable manipulators, temperature sensor, cameras and AI-based photogrammetry solution have proven high performance in relocating ocean assets, 3D Modeling, deploying undersea cables and saving species, to complete MATE ROV 2024 tasks.

The capabilities of WAHOO extend to addressing real-world challenges, such as the relocation of the Coastal Pioneer Array, the installation of SMART cables, and the 3D reconstruction of coral reef ecosystem areas. This poster showcases WAHOO's proficiency in addressing The United Nations' stipulated oceanic challenges. (149 words)

THEME

Remotely Operated Vehicles (ROVs) have become indispensable tools for organizations engaged in underwater operations across industrial, scientific and military. ROVs represent a cost-effective and safer approach to deep-sea exploration, enabling the addressal of global oceanic challenges. Furthermore, they play a crucial role in advancing the United Nations' Sustainable Development Goals (SDGs), Ocean Decade Challenges for collective impact (ODCCI) and promoting Environmental, Social, and Governance (ESG) principles.

ROVs are anticipated to augment the efficiency of future ecological research and surveillance, thereby facilitating the enlargement and repositioning of the oceanic observation system. The Coastal Pioneer Array, an oceanic observation system constructed and preserved by scientists and engineers, amasses physical, chemical, geological, and biological data accessible globally, the data collected provides valuable insights into life below water (SDGs#13). The ROV plays a pivotal role in the expansion of the Global Ocean Observing System (ODCCI#7), as it is utilized by scientists and engineers for the repair, deployment, and retrieval of the system's components [1].

In recent years, advances in ROV tooling have enabled effective subsea cable maintenance [2]. It is recommended by researchers to utilize the ROV for the incorporation of the Science Monitoring And Reliable Telecommunications (SMART) system into existing or replacement subsea cables. ROV helps to expand the SMART Cable system (ODCCI#7), which is a Global Ocean Observing System has the ability to gather and relay data pertaining to temperature, pressure, and seismic acceleration, thereby enhancing the efficiency of earthquake and tsunami early warning systems.

Beyond their role in passive oceanic surveillance, Remotely Operated Vehicles (ROVs) serve as instrumental tools in the preservation and rejuvenation of ecosystems and biodiversity (ODCCI#2). These devices equip scientists with intimate observations of coral reefs [3], facilitating the assessment of coral health and the encompassing ecosystem, which can be utilized in the implementation of Climate Action (SDGs#14) initiatives. They even have the capacity to construct 3D models of coral reef regions, a critical resource for future restoration efforts, such as the application of probiotics to treat afflicted corals.

In addition, the progression of Float technology contributes significantly to mitigating climate change and its effects (SDGs#13). The International Argo Program sustains a global network of approximately 3,800 floats [4], which monitor the pressure, temperature, and salinity of the ocean's upper 2,000 meters (1.2 miles). This data, available to the worldwide research community, facilitates the discovery of oceanic solutions to climate change (ODCCI#5).

In conclusion, the use of ROVs underscores the support provided to ESG considerations, is crucial for sustainable oceanic exploration. It enhances ecological research, improves societal safety, and adheres to international standards, aligning with global sustainability goals. This approach sets a model for responsible interaction with our natural world.

[1] Ocean Observatories Initiative. (2022, April 8). 10th Turn of the Pioneer Array in April. Ocean Observatories. https://oceanobservatories.org/2022/04/10th-turn-of-the-pioneer-array-in-april/
[2] Bonnon, I.D. (1998). Advances in ROV Tooling for Subsea Cable Repair and Maintenance. In SUBTECH '98. Advances in Underwater Technology, Ocean Science and Offshore Engineering. vol 27. Springer, Dordrecht. https://doi.org/10.1007/978-94-011-5043-3_14
[3] ROVs and auvs lead the charge in Coral Reef Revival. Oceanology International. (n.d.). https://www.oceanologyinternational.com/london/en-gb/about/media/industry-updates-press-releases/robots-restoring-coral-reefs.html
[4] National Oceanic and Atmospheric Administration. (2021, December 15). New ocean floats to boost global network essential for weather, climate research. Retrieved March 25, 2024, from https://www.noaa.gov/news-release/new-ocean-floats-to-boost-global-network-essential-for-weather-climate-research.


Figure 1. Moorings were retrived for the relocation of Pioneer Array.
Source: https://www.marinetechnologynews.com/news/pioneer-array-relocating-southern-628134


Figure 2. ROV fixing damaged subsea cables.
Source: https://qmind.com/how-robots-are-fixing-damaged-subsea-cables/


Figure 3. ROV spawning coral on the Great Barrier Reef.
Source: https://www.qut.edu.au/engage/giving/support-research/great-barrier-reef


Figure 4. An Argo float is deployed into the ocean
Source: https://www.theguardian.com/environment/climate-consensus-97-per-cent/2017/jun/26/new-study-confirms-the-oceans-are-warming-rapidly

SAFETY

EPOXSEA prioritizes safety above all, employing dedicated safety officers to oversee employee operations. It is imperative that all employees adhere to the safety guidelines established by EPOXSEA and MATE.
A secure work environment not only facilitates stress-free productivity among our employees but also safeguards the marine ecosystem and its wildlife. To uphold this secure environment, we enforce the following regulations:

- Safety goggles required for drilling and hammering.
- Junior engineers are required to complete safety training prior to commencing work.
- Engineers must operate under safety officer's supervision.
- Engineers follow Safety Checklist before using the ROV.


Figure 5. Employee Opearting With Safety Equipments
Credit: Wong Wing Him

Safety Design Standards

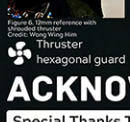
Figure 6. 10mm reference with shrouded thruster
Credit: Wong Wing Him


Figure 7. Rounded shape of the structure holder
Credit: Wong Wing Him


Figure 8. Waterproof Connectors
Credit: Wong Wing Him

Thruster hexagonal guard | No Sharp Edges | Waterproof

EPOXSEA's Remotely Operated Vehicle (ROV) is engineered in strict adherence to safety standards, with the goal of minimizing potential risks to humans and marine life. Hardware engineers follow electronic review protocol, checking power connections and voltage levels. Mechanical engineers, design motor system using motor with a hexagonal guard, with a diameter of less than 12 millimetres, prevent the intrusion of small marine organisms or objects into the motor. Software engineer employ rigorous unit testing to maintain control over the code and ensure its reliability and efficiency.

ACKNOWLEDGEMENT

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MATE II | IET The Institution of Engineering and Technology | MMM Materials, Design and Manufacturing Faculty (CWB) | School of Engineering | Milwaukee | RS | act Autodesk Construction Solutions

Financial Spport:

DESIGN RATIONALE

With a 13-year history in the research and development of ROV designs, EPOXSEA has introduc
compact. The design standard of WAHOO is not only aimed at flawless mission execution, but
for non-professional drivers.

Our design incorporates a versatile manipulator system capable of executing a variety of tasks,
to the previous year, it is easier to control and repair. WAHOO features a cubic frame design
precise and uniform movements across all axes at a steady speed. The dynamic movement ad
matrix movements during mission execution, it also incorporated an Inertial Measurement
Calculation System, as opposed to the previously used fixed matrix movement. Additionally,
ROS2, a move aimed at enhancing efficiency and reliability while reducing latency. The Flaw
camera view to any side for control, a departure from traditional ROVs that focus solely on the f

Furthermore, WAHOO employs an open structure design for electronic components, facilitatin
material for waterproofing due to its robust waterproofing capabilities and its ability to reinforc

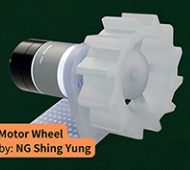


Figure 9. Motor Wheel
Designed by: NG Shing Yung

A DC motor drives the 3D-printed wheel. It is designed and fixed at the correct position to turn the valve and hence, activate the sprinkler system.

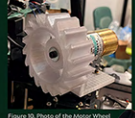
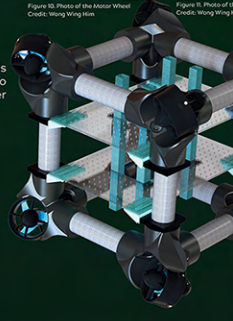


Figure 10. Photo of the Motor Wheel
Credit: Wong Wing Him


Figure 11. Photo of t
Credit: Wong Wing H



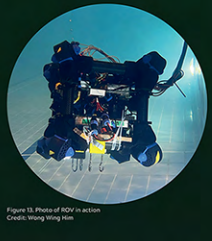


Figure 13. Photo of ROV in action
Credit: Wong Wing Him

Drived by a se
ADCP 2. AUV
repeater 5. Irr

MISSION SPECIFIC FEATURE


Figure 16. Illustration of Mission Execution
Credit: TANG Lok Hang

The Linear Gripper is designed with an extendable feature, enabling it to accommodate and secure large box-shaped objects by increasing its reach.

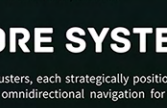


Figure 17. Illustration of Mission Execution
Credit: TANG Lok Hang

The Linear Gripper is also adept at securely handling cylindrical objects, ensuring stable manipulation.


Figure 18. Illustration of Missi
Credit: TANG Lok Hang

The 2-axis Claw
grasping objec
size, and can b
insert or releas

VEHICLE CORE SYSTEM

The WAHOO is outfitted with eight thrusters, each strategically positioned at a corner and a
degrees. This arrangement facilitates omnidirectional navigation for the ROV, maintaining
velocity.
Each thruster generates a thrust of 6.3kg at an operating voltage and current of 20V
respectively, with the thrust vector oriented 45 degrees from the z-axis. The vertical compo
force can be calculated as 6.3kg × sin(45°) = 4.45kg. By summing the contributions fro
thrusters, the ROV achieves a total vertical lift of 4.45kg × 8 = 35.64kg.

Drive Time	Build Time	Thruster Model	Weight	Max Speed	8 Thr
85 Hours	>1200 Hours	P75	17.95 Kg	2.32 m/s	

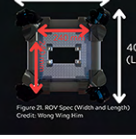


Figure 21. ROV Spec (Width and Length)
Credit: Wong Wing Him

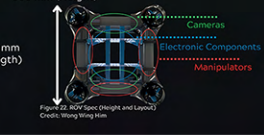


Figure 22. ROV Spec (Height and Layout)
Credit: Wong Wing Him

Marketing Display Winners

Explorer

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