

# 2024 MATE World Championship



香港科技大學  
THE HONG KONG UNIVERSITY OF  
SCIENCE AND TECHNOLOGY



WAHOO

## 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 cameras 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 (ODCC) 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 (ODCC#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 (ODCC#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 (ODCC#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 (ODCC#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 18). 18th Year of the Pioneer Array in April. Ocean Observatories. <https://oceanobservatories.org/2022/04/18th-year-of-the-pioneer-array-in-april/>  
[2] Research, N. (2023). Advances in ROV Tooling for Subsea Cable Repair and Maintenance. In 2023 IEEE 18th International Conference on Underwater Technology, Ocean Science and Offshore Engineering, vol. 32, Springer, Dordrecht, [https://doi.org/10.1007/978-94-001-3544-3\\_14](https://doi.org/10.1007/978-94-001-3544-3_14)  
[3] ROV and sea level rise: A Coral Reef Resilience. Oceanography International. (n.d.). <https://www.oceanographyinternational.com/index.php/about/media/industryupdates/petro-research/rovs-restoring-coral-reefs.html>  
[4] National Oceanic and Atmospheric Administration. (2020, December 15). New ocean floats to boost global network essential for weather, climate research. Retrieved March 25, 2024. From <https://www.noaa.gov/news/new-ocean-floats-to-boost-global-network-essential-for-weather-climate-research/>



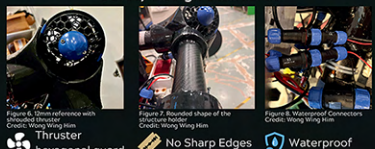
## SAFETY

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.



### Safety Design Standards



- hexagonal guard
- No Sharp Edges
- Waterproof

## ACKNOWLEDGEMENT

Special Thanks To:



Financial Support:



## DESIGN RATIONALE

With a 13-year history in the research and development of ROV designs, EPOXSEA has introduced 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 and matrix movements during mission execution, it also incorporated an Inertial Measurement Unit 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 Flow camera view to any side for control, a departure from traditional ROVs that focus solely on the front view.

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



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.

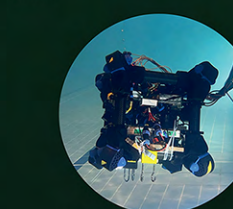


Figure 10: Photo of ROV in action. Credit: Wong Wing Him

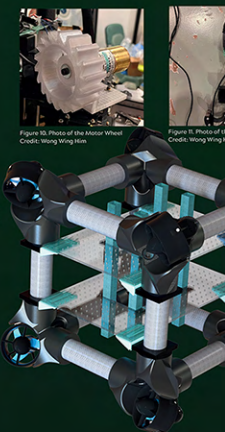


Figure 11: Photo of the Motor Wheel. Credit: Wong Wing Him

Figure 12: Photo of the Motor Wheel. Credit: Wong Wing Him

Figure 13: Photo of the Motor Wheel. Credit: Wong Wing Him

Driven by a se ADCP 2, AUV repeater 5, Irr

## MISSION SPECIFIC FEATURES

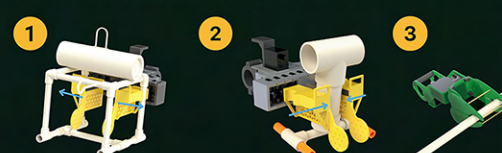


Figure 14: Illustration of Mission Execution. Credit: TANG Luk Hang

Figure 15: Illustration of Mission Execution. Credit: TANG Luk Hang

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

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

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

The 2-axis Claw grasping object size, and can be insert or release

## VEHICLE CORE SYSTEM

The WAHOO is outfitted with eight thrusters, each strategically positioned at a corner and angles. 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 component force can be calculated as  $6.3\text{kg} \times \sin(45^\circ) = 4.45\text{kg}$ . By summing the contributions from thrusters, the ROV achieves a total vertical lift of  $4.45\text{kg} \times 8 = 35.64\text{kg}$ .

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

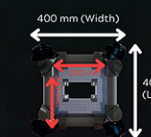


Figure 20: ROV Spec (Width and Length). Credit: Wong Wing Him

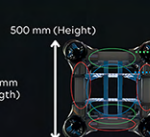


Figure 22: ROV Spec (Height and Layout). Credit: Wong Wing Him

# Marketing Display Winners

# Explorer

## COMPANY INFORMATION

Company Name: EPOXSEA  
Location: Hong Kong

School: The Hong Kong University of Science and Technology  
Tag Line: When in doubt, use EPOXSEA



Figure 24: Company Group Photo  
Credit: CHAN Ho

### Software Engineers

YIP Chi Ho (Leader, Year 2, COMP)  
CHAN Tak Ming (Year 3, COMP)  
CHI Ting-hsuan (Year 3, COMP + ELEC)  
TSAI Yiu Ki (Year 2, COMP)  
ZHANG Tin Yau (Year 2, COMP)

### Mechanical Engineers

HUI Kan Lap (Leader, Year 2, ISD)  
CHAN Ho (Year 3, ISD)  
KWOK Wing Lam (Year 3, MECH + AI)  
LAI Pui Yin (Year 1, Engineering)  
LAM Chun Ho (Year 3, MECH)  
MUI Jessye (Year 2, MECH)  
NG Shing Yung (Year 2, CIVL)  
WONG Chin Ching (Year 2, CIVL)  
YANG Shi Long (Year 2, ELEC)

### CEO

LI Chi Kin (Year 2, COMP)

### CFO

NG Hau Yi Chloe (Year 1, Engineering + AI)

### CTO

TANG Lok Hang (Year 1, Engineering + AI)

### Safety Officer

ZHENG Yiqi (Year 1, Engineering)

### Pilot

KHAIDAR, Orazkhan (Year 2, ELEC)

### Hardware Engineers

SONATA Joshua Elnathan (Leader, Year 3, ELEC)  
HONG Jiarong (Year 2, ELEC)  
JANIUS Erick (Year 2, MECH)  
KUO Chen-chieh (Year 3, ELEC + COSC)  
LEE Ka Hin (Year 1, CHEM)  
LEE Sze Chun Martin (Year 2, ELEC)

### Business

WONG Wing Him (Leader, Year 3, ELEC)  
CHEN Wai Yan Grace (Year 1, Engineering + AI)  
TAM Siu Ho (Year 2, ELEC)  
TANG Justin Kit Hang (Year 2, WBB)

### Supervised by

Dr. WOO Kam Tim  
LEUNG Chun Yin

## COMPANY EVALUATION

### COMMUNICATION

At EPOXSEA, we regard communication as the cornerstone of our operations, believing it to be the solution to any challenges that may arise in a company of 30 employees. To ensure clarity and mutual understanding, we promote the use of English as the primary language within the organization.

EPOXSEA conducts two major meetings each week, where all employees are mandated to present their weekly progress and ideas. This initiative is designed to enhance team communication, keep everyone abreast of ongoing developments, and foster a sense of involvement. Feedback is encouraged, fostering a supportive and collaborative environment. Additionally, we have established a company-wide knowledge base for employees to share their files and documents. This platform facilitates rapid communication and the exchange of ideas.



Figure 25: Group Meeting for Meeting  
Credit: WONG Wing Him



Figure 26: Group Meeting for Meeting  
Credit: WONG Wing Him

### CREATIVITY



Figure 27: 3D Print System  
Credit: WONG Wing Him

Creativity is the important in EPOXSEA. Unlike conventional organizations, we do not merely tolerate but actively welcome feedback and suggestions. We are particularly receptive to innovative solutions from new employees. For instance, a recently hired mechanical engineer identified a bottleneck in our 3D printing process. Previously, we had to manually insert an SD card and initiate the 3D printer for each job. The engineer proposed the development of an EPOXSEA 3D print pipeline web system in collaboration with our software engineers. Within a week, the system was operational, enabling all mechanical engineers to upload their 3D models. The system automatically processes the files and queues them for 3D printing. This enhancement has increased our 3D printing efficiency by 60%, enabling us to construct the ROV more rapidly.

### TEAMWORK/COLLABORATION

The collaborative environment at EPOXSEA is believed to surpass that of other organizations. The organizational structure of EPOXSEA comprises a CEO, CTO, CFO, Safety Officer, and four key departments: Software, Hardware, Mechanical, and Business. Each department is led by a department head who communicates strategic directions from the CEO and CTO to the team members. The senior staff members are responsible for guiding and mentoring the junior employees. This structure has received positive feedback as it fosters a learning environment and encourages inter-departmental collaboration. A practical example of this collaboration is evident when the Software department decided to develop a ROV simulator. All software engineers, along with mechanical engineers, contributed to the project. The mechanical engineers designed and built 3D models for use in the simulator. As a result, EPOXSEA successfully completed the simulator within a two-week timeframe. Furthermore, when the Business department necessitates data for the creation of ROV documents, members from all departments exhibit readiness to contribute their technical expertise and pertinent information.



Figure 28: ROV Simulator  
Credit: WONG Wing Him

### COMPANY'S GROWTH AND DEVELOPMENT

Leveraging the aforementioned employability skills, EPOXSEA reaps significant benefits. The robust synergy of teamwork, communication, and creativity empowers EPOXSEA to cultivate innovative concepts while fostering a secure and amicable work environment. Furthermore, EPOXSEA aspires to extend this ethos beyond its confines, prompting its employees to spearhead promotional activities through community service and mentoring outreach.



Figure 29: Participating in the MATE ROV Competition  
Credit: WONG Wing Him



Figure 30: Members of EPOXSEA presenting EPOXSEA to primary and secondary school students  
Credit: WONG Wing Him



Figure 31: ELEC mentoring MATE ROV to primary school students  
Credit: WONG Wing Him

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ed WAHOH this year, a model that is lighter, faster, and more also emphasizes ease of control, maintenance, and usability

reducing the number of manipulators from 12 to 3 compared equipped with eight cameras and eight thrusters, guarantees adjustment system, a new addition, enables real-time tuning of Unit (IMU), which facilitates stable movement via the Matrix EPOXSEA has transitioned its control framework from ROS to a less Switchable Core Control System can shift the primary front.

rapid repair and replacement. EPOXY remains the primary wires.



Figure 12: 2-axis Claw  
Designed by: CHAN Ho

The articulated front gripper has two axes of rotation alongside the gripping function, allowing pitch and roll control of the end manipulator. All axes are propelled by servo motors for angular control. It is for gripping 1. acoustic release pin 2. sprinkler system 3. recovery float 4. branching coral 5. brain coral 6. sediment sample



Figure 14: Photo of the Linear Gripper  
Credit: WONG Wing Him

Figure 15: Linear Gripper  
Designed by: KWOK Wing Lam

servo motor and the rack gear set, it is for gripping 1. docking station 3. Acoustic Receiver 4. Smart cable management system 6. Float

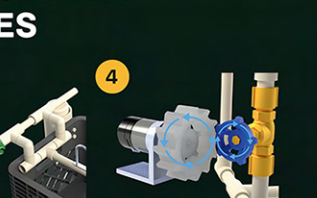


Figure 19: Illustration of Mission Execution  
Credit: TANG Lok Hang

The Motor Wheel is capable of executing torque-driven movements to facilitate the rotation of a stop valve.

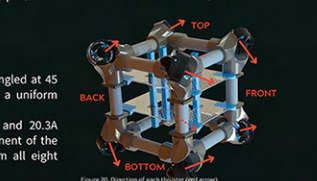


Figure 20: Direction of each thruster (dotted arrow)  
Credit: TANG Lok Hang

8 Cameras 3 Manipulators

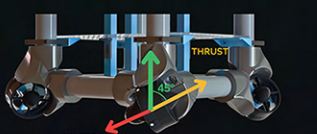


Figure 23: Thruster Direction and Water Flow  
Credit: WONG Wing Him

## TEAM NAME

### EXPOSEA

Hong Kong University of  
Science and Technology  
Hong Kong

## TEAM MEMBERS

|                    |                 |
|--------------------|-----------------|
| CHAN Ho            | NG Shing-Yung   |
| CHAN Tak-Ming      | SONATA Joshua   |
| CHEN Wai-Yan Grace | Elnathan        |
| HONG Jiarong       | TAM Siu-Ho      |
| JANIUS Erick       | TANG Lok-Hang   |
| KHAIDAR Orazkhan   | TSAI Yiu-Ki     |
| LAI Pui-Yin        | WONG Chin-Ching |
| LEE Ka-Hin         | WONG Wing-Him   |
| LEE Sze-Chun       | YANG Shi-Long   |
| LI Chi-Kin         | YIP Chi-Ho      |
| MUI Jessye         | ZHANG Tin-Yau   |
| NG Hau-Yi Chloe    | ZHENG Yiqi      |

## MENTORS

Dr. WOO Kam Tim  
LEUNG Chun Yin