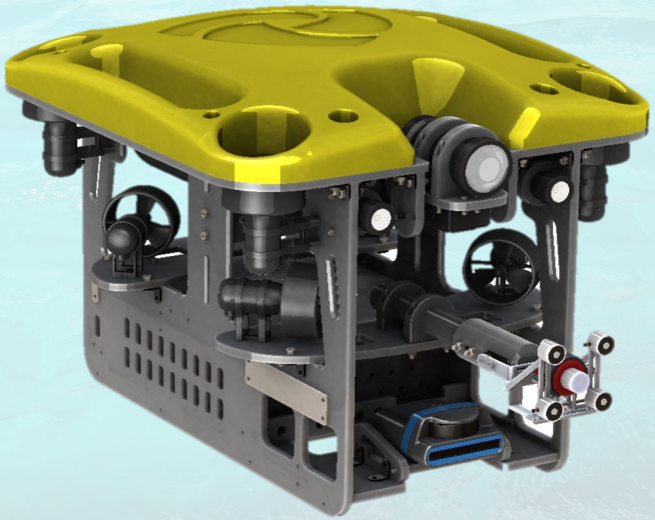
Mare Custos

2025

Final Year Internship Projects Book (PFE)



Get to know us

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Who we are

Mare Custos is a leader in underwater robotics, dedicated to advancing offshore inspection and marine exploration. With innovations like Seabot Y and Seabot X, we make underwater operations safer, more efficient, and environmentally responsible.

Our vision

We envision a future where underwater exploration and protection are seamless, powered by advanced robotics. Mare Custos is committed to setting industry standards in sustainable marine technology that benefits both people and the planet.

Our mission

Our mission is to provide reliable, eco-friendly underwater solutions that optimize offshore operations and contribute to ocean conservation. We strive to make a positive impact through technology that helps protect marine ecosystems.

Get to know us

Our team

Our team of engineers, scientists, and marine experts is united by a passion for innovation in marine technology. Together, we're dedicated to transforming underwater exploration and supporting sustainable practices across industries.

Our values

At Mare Custos, we are driven by values that prioritize innovation, integrity, and environmental responsibility. We believe in pushing boundaries to create technology that respects marine ecosystems and empowers our clients. Collaboration, sustainability, and excellence are at the core of every project we undertake, guiding our efforts to make the underwater world safer and more accessible for all.

Software Engineering

ROV Nexus Control System GUI

Summary: Develop a control system for an ROV using Electron, Python, and ROS2. The system will include a cross-platform user interface (UI) for controlling the ROV and integrating sensors, actuators, and camera feeds.

Required skills:

- Software development, Electron, Python, ROS2, gRPC, real-time systems, UI/UX design, and robotics.

Key tasks:

- Design and implement the UI in Electron.
- Use Python to handle backend communication with ROS2 topics, services, and actions.
- Implement real-time data updates via WebSockets between the frontend and backend.
- Integrate various subsystems such as movement control, sensor readings, and camera visualization.
- Ensure real-time performance and smooth interaction between software components.

ROV Database and Real-Time Monitoring System

Summary: Develop a centralized database management system to store and monitor real-time data from multiple ROVs. The system will support real-time data retrieval, historical data analysis, and multi-robot management.

Required skills:

- Database management, Python, ROS2, R, x-db, real-time systems, gRPC, data visualization, and multi-threading.

Key tasks:

- Design and implement a database schema to handle data from multiple ROVs, including sensor readings, operation logs, and mission data.
- Implement real-time data collection and monitoring dashboards using Python and ROS2.
- Ensure multi-robot support, enabling simultaneous tracking and management of multiple ROVs.
- Integrate data visualization for mission status, health indicators, and performance metrics.
- Develop a backend service for querying and updating the database in real-time.

Advanced ROV Fault Diagnosis and Predictive Maintenance System

Summary: Develop an advanced diagnostic and predictive maintenance system for an ROV that uses machine learning and AI to detect faults, predict failures, and optimize maintenance schedules based on real-time and historical data.

Required skills:

- Machine learning, Python, ROS2, real-time systems, predictive maintenance, data analysis, AI algorithms, and embedded systems.

Key tasks:

- Implement machine learning models to analyze sensor data and predict potential failures across various ROV subsystems (e.g., motors, battery, thrusters).
- Integrate real-time fault detection that uses data from ROS2 to detect anomalies as they happen.
- Develop a predictive maintenance algorithm that estimates the remaining useful life (RUL) of components and suggests proactive maintenance actions.
- Create an advanced diagnostic dashboard with visualizations for system health, predicted failures, and maintenance logs.
- Enable data logging and automated fault reporting for continuous learning and optimization of the diagnostic models.

Advanced Yocto-based ROV Operating System with Real-Time Custom BSP and Driver Development

Summary: Design and implement an advanced Yocto-based OS for an ROV, integrating a custom Board Support Package (BSP) and real-time drivers for critical subsystems, ensuring seamless performance in underwater environments.

Required skills:

- Yocto Project, BSP, real-time Linux kernel, device driver, ROS2 integration, embedded systems, Linux system configuration.

Key tasks:

- Develop a custom Yocto-based OS optimized for ROV operations, with a focus on real-time capabilities and minimal resource consumption.
- Create a Board Support Package (BSP), including low-level drivers for sensors, cameras, and communication interfaces, tailored to the ROV's hardware platform.
- Implement real-time kernel optimizations (e.g., PREEMPT-RT patches) for low-latency control of mission-critical subsystems such as thrusters, cameras, and sensors.
- Integrate ROS2 into the Yocto environment for distributed control and communication between subsystems, enabling a robust and scalable architecture.
- Optimize the BSP and OS for power efficiency, thermal stability, and high availability in harsh underwater conditions.

Hardware-in-the-Loop (HIL) Simulation Setup for ROV Systems

Summary: Design and implement a Hardware-in-the-Loop (HIL) simulation setup to validate and test ROV control systems, sensors, and actuators in a controlled environment before deployment. The goal is to simulate real-world scenarios and ensure the robustness of the ROV's hardware and software integration.

Required skills:

- Embedded systems, HIL simulation, ROS2, real-time systems, system integration, sensor fusion, test automation, and control systems.

Key tasks:

- Develop a HIL simulation environment that interfaces with the ROV's control hardware, including sensors, actuators, and communication systems.
- Integrate real-world data (e.g., sensor readings, thruster control signals) with simulation models to emulate underwater conditions and ROV behavior.
- Implement a simulation framework using ROS2 or other middleware to connect the control system with the simulated hardware.
- Test fault scenarios and failure modes (e.g., sensor malfunction, actuator failure) to evaluate the ROV's response.
- Perform automated and manual testing of the ROV's real-time performance, control algorithms, and mission scenarios.
- Create a real-time monitoring dashboard to visualize HIL data and monitor system performance during tests.

Comprehensive ROV Project Management App

Summary: Develop a comprehensive cross-platform app for seamless management and synchronization of ROV projects, ensuring efficient communication, project traceability, and streamlined operations within the company. This app will enable real-time updates, document sharing, and offline functionality for mission data entry, essential for environments without internet access. Data will be synchronized once connectivity is restored. The goal is to keep all project teams connected and informed, with a platform that supports secure, role-based access for different departments and project leaders.

Required skills:

- React Native/Flutter, Node.js/Django, UI/UX design, cloud integration, database management.

Key tasks:

- Design and implement user interfaces and backend architecture for the app.
- Develop features for offline mission data entry and synchronization.
- Integrate secure access and role-based data consultation.
- Collaborate in weekly and, if needed, daily sync meetings for progress updates and issue resolution.

Functional Safety Engineering

Functional Safety Analysis for Underwater Robotics

Summary: Develop a comprehensive functional safety analysis based on ISO 26262 standards for a remotely operated underwater vehicle (ROV), ensuring the safety and reliability of critical systems.

Required expertise:

- Knowledge of ISO 26262, systems engineering, risk analysis, embedded electronics, problem-solving, and safety validation.

Key responsibilities:

- Conduct Hazard Analysis and Risk Assessment (HARA), Failure Mode and Effects Analysis (FMEA), and Fault Tree Analysis (FTA) for critical ROV systems.
- Validate safety mechanisms of embedded software.
- Collaborate with hardware and software design teams to implement safety measures.

Expected outcome:

Comprehensive safety analysis reports and validation documentation demonstrating the ROV's adherence to ISO 26262 and functional safety standards.

Hardware Architecture and Design

DC/DC Converter 3KW Design

Summary: Design a 400V to 24V DC/DC converter capable of delivering 3KW using advanced power electronics technology. The project will focus on achieving high efficiency and reliability in the converter design.

Required expertise:

- Proficiency in power converter design, deep knowledge of power semiconductors, expertise in using SPICE tools and EFM software.

Key responsibilities:

- Analyze the requirements for high-power DC/DC conversion and select appropriate topologies.
- Design and simulate the converter circuit using advanced simulation tools.
- Test and validate the converter's performance under various load conditions.

Expected outcome:

A fully designed and tested 3KW DC/DC converter with comprehensive documentation covering its design process, performance validation, and efficiency metrics.

Design of PFC Input Stage for AC/DC Converter

Summary: Develop a power factor correction (PFC) input stage for a 5KW AC/DC converter to ensure a power factor of ≥0.99 at full load. The design will enhance the overall efficiency and power quality of the converter.

Required expertise:

- Strong knowledge of PFC circuit design, power semiconductor applications, and proficiency in SPICE tools and EFM software.

Key responsibilities:

- Design and simulate a PFC circuit to improve input power factor.
- Implement the design and test its performance in real-world conditions.
- Ensure the input stage meets industry standards for power factor and efficiency.

Expected outcome:

A working PFC input stage for a 5KW AC/DC converter, validated for power factor performance and efficiency, along with detailed design and validation reports.

Field-Oriented Control Scheme for Brushless DC Motor

Summary: Design and develop a sensorless field-oriented control (FOC) scheme for a brushless DC (BLDC) motor using the High-Frequency Injection (HFI) method. The project will focus on enhancing motor control precision and efficiency without using physical sensors.

Required expertise:

- In-depth understanding of motor design, power electronics, FOC control schemes, mastery of SPICE tools, EFM software, and microcontroller (MCU) programming.

Key responsibilities:

- Develop and implement an HFI-based sensorless FOC algorithm.
- Simulate and test the control scheme using software tools and real hardware.
- Collaborate with the firmware team for seamless integration with MCUs.

Expected outcome:

A robust sensorless FOC system for BLDC motors, validated through extensive simulation and hardware testing, with comprehensive documentation covering the design, testing, and optimization phases.

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Interested?

Send your applications with to:

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Hardware and design: rami.douzi@mare-custos.com

IMPORTANT: Please include the project's reference in the email subject otherwise your application will be rejected.