AISF

ARTIFICIAL INTELLIGENCE STUDENT FORUM

PRESENTS

VIT CODE APEX

CODE VERSE HACKATHON 2025

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Problem Statement Title - PS1 Marine Fouling

Team Name - Not Like Us

Team Members-

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IDEA TITLE

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PROBLEM STATEMENT

Ships and underwater structures often get covered with algae, barnacles, and other organisms. This slows them down, increases fuel use, raises costs, and can even harm the environment. The Navy needs a smart system that can look at images, figure out what kind of fouling is there, how much of it has grown, and predict when cleaning or maintenance will be needed.

INNOVATION IN OUR SOLUTION

- AI-powered image analysis – Our system automatically detects type and density of fouling from the hull images.
- Predictive maintenance forecasting – We predict growth trends and suggest the right time for cleaning saving millions of rupees.
- AR-enabled 3D ship model – Our immersive 3-D Model shows fouling hotspots on an interactive 3D hull for easy visualization and density mapping
- Risk & cost impact insights – Our intelligent system translates fouling into drag %, extra fuel use, CO_2 emissions, and cost for profits prediction.
- Scalable & software-first – Works without heavy hardware, uses synthetic data, and can scale across fleets.

PROPOSED SOLUTION

1. **Image Capture with ROV + UV Camera**
   An underwater ROV equipped with RGB + UV camera will scan the ship hull and captures clear, geo-tagged images.
2. **Preprocessing & Enhancement**
   Images are corrected by our software for underwater distortions using dehazing, denoising, and color correction for better visibility.
3. **Fouling Segmentation & Density Detection**
   Deep learning models (CNN/U-Net) identify fouling regions and calculate density percentage across the hull surface.
4. **Species & Growth Stage Classification**
   The AI classifier labels fouling types (algae, barnacle, slime) and stages (early, medium, severe).
5. **Fouling Index & Risk Scoring**
   A combined index evaluates drag, fuel penalty, and operational risks to prioritize critical areas.
6. **Predictive Maintenance Engine**
   Time-series forecasting predicts future fouling growth and suggests optimal cleaning schedules to minimize costs.
7. **3-D Hull Mapping & AR Visualization**
   Fouling hotspots are overlaid on a 3D digital twin of the hull, viewable in AR for immersive inspection.

TECHNICAL APPROACH

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TECH STACK

Frontend

React JS

Tailwind CSS

Backend

node.js

Express.js

Python

Computer Vision & AR

OpenCV

Unity

Density Detection

YOLOv5

U-Net

Forecasting

Meta

LSTM

Machine Learning

CNN classifier

Tensor Flow

IoT

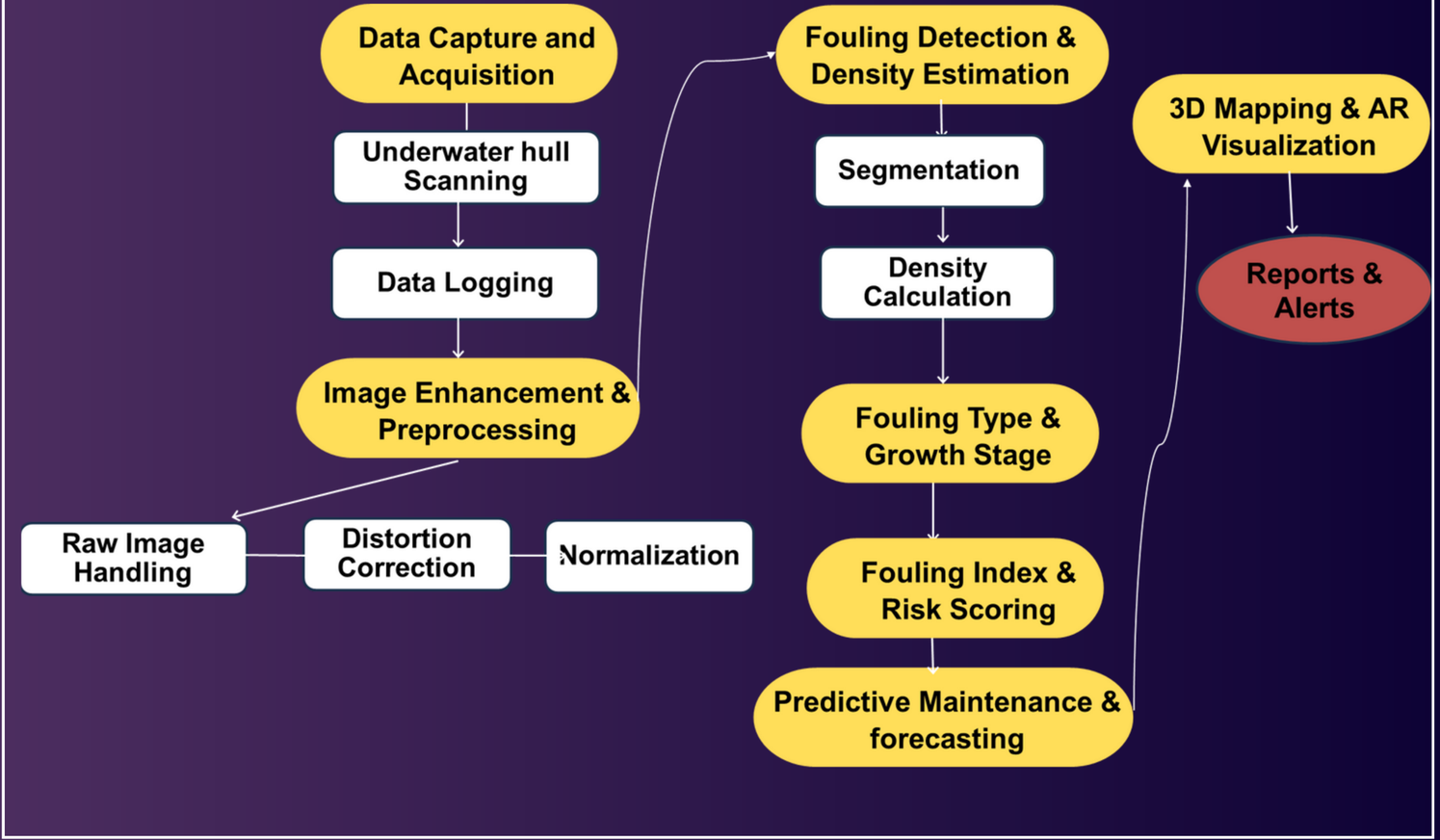
ROV With UV -light and waterproof camera (GoPro)

Web+DB

Flask + mongoDB

+

DETAILED WORKFLOW



FEASIBILITY AND VIABILITY

POTENTIAL CHALLENGES

Unclear Underwater Visibility
Dark waters, biofilm, and poor lighting reduces image clarity, making fouling harder to detect accurately.

Limited Training Data for Biofouling
Few publicly available datasets of algae and barnacle species → risk of lower AI accuracy without synthetic/augmented data.

Real-Time Integration & Scalability
Running AI detection, predictions, and 3D AR visualization together in real-time on low-power systems is resource-intensive.

STRATEGIES TO OVERCOME CHALLENGES

- **Unclear Underwater Visibility** → We use ROV-mounted UV/LED lighting and AI-based image enhancement (dehazing, color correction) to capture clear and reliable images.
- **Limited Training Data** → We use synthetic fouling images, data augmentation, and transfer learning to improve AI accuracy across species and growth stages.
- **Real-Time Integration & Scalability** → We use lightweight, optimized AI models on edge devices and a modular design to handle detection, prediction, and AR visualization efficiently.

MARKET FEASIBILITY

- **Target users:** Indian Navy, Coast Guard, commercial shipping companies, offshore platforms.
- **Problem scale:** Biofouling increases fuel costs by 10–30% and causes maintenance delays globally. Thats why our system is a game changer
- **Software-first approach:** Low-cost, scalable, and easy to deploy across multiple ships and fleets.

FINANCIAL VIABILITY

- **Low hardware cost:** Uses affordable ROVs and cameras; no need for full dry-docking.
- **Operational savings:** Reduces fuel consumption, maintenance time, and labor costs.
- **Scalable revenue model:** We will provide SaaS (Software as a Service) subscription for fleets, optional AR dashboard upgrades, predictive maintenance analytics as a service.

IMPACT AND BENEFITS

PROBLEMS IN TRADITIONAL METHODS	IMPACT & BENEFIT
• Manual hull inspection by divers	• Our ROV (Remote Operated Vehicle) + AI system makes inspection faster, safer, and consistent without diving.
• Visual inspection by eye is not that accurate to predict algaes.	• Our intelligent AI detects species, density, and stage accurately.
• Randomized maintenance approach	• This leads to high fuel costs and unexpected downtime so,our predictive maintenance optimizes cleaning schedules and saves fuel.
• No digital record or any paperwork	• Hard to track fouling growth; Our system creates digital hull records and trend analysis
• No 3D visualization tools or mapping systems	• Operators cannot see hotspots clearly therefore our AR 3D hull model highlights fouling locations for targeted cleaning.
• High manpower & operational cost	• Maintenance requires many divers and repeated inspections; on the other hand our proposed Software-driven solution reduces manpower, cost, and effort.