

StormVision

GenAI-Based Person-in-Water Detection
in Rough Seas

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Project Review - StormVision - Interim

Goal: Detect a person in water from aerial drone images and evaluate robustness under calm-to-storm sea conditions using synthetic data

Input & Output

- **Input**: Drone RGB image (real calm-sea + synthetic storm-sea)
- **Output**: Bounding Boxes (location) and Confidence Scores (probability).

What changed from the proposal

- Added synthetic storm data generation using **Stable Diffusion + ControlNet** (inpainting with object-preserving masks)
- Introduced pair-aware dataset design (ORIG vs SYNTH image)
- Changed the problem formulation from image classification to object detection (bounding boxes + confidence)

Novelty / contributions

- Built a paired real-synthetic storm dataset for person-in-water detection
- Introduced pair-aware evaluation to directly measure robustness degradation
- Demonstrated that fine-tuning with synthetic storm data improves detection robustness under severe sea conditions

Related Work (Previous Work)					
#	Paper / Year	Task	Method & Data	Key Findings & Limitations	Relevance to My Project
1	SeaDronesSee (2022) [reference]	Human detection in open water	54K frames (YOLO / R-CNN)	Finding: Small humans are hard to detect. Limit: No rough-sea conditions.	Serves as the main dataset we extend with GenAI rough-sea augmentation.
2	Person-in-Water Detection (2024) [reference]	Detect people for SAR	72K frames, YOLOv4	Finding: Accuracy drops in unseen environments. Limit: Lacks extreme sea states and extreme weather.	Shows that person-in-water detectors fail under unseen conditions, directly motivating our calm-to-storm robustness evaluation
3	SafeSea (2024) [reference]	Generate synthetic harsh sea states	Latent Diffusion (Sea editing)	Finding: Rough-sea augmentation improves robustness. Limit: Not focused on "person-in-water".	The conceptual foundation for our GenAI sea-state augmentation approach.

Examples Synthetic generation :



Dataset + EDA (300 samples)

Data generation

- **Inpainting:** Uses automated masks to protect people and boats, changing only the weather around them.
- **Structure Preservation:** Uses ControlNet to lock the image outlines.

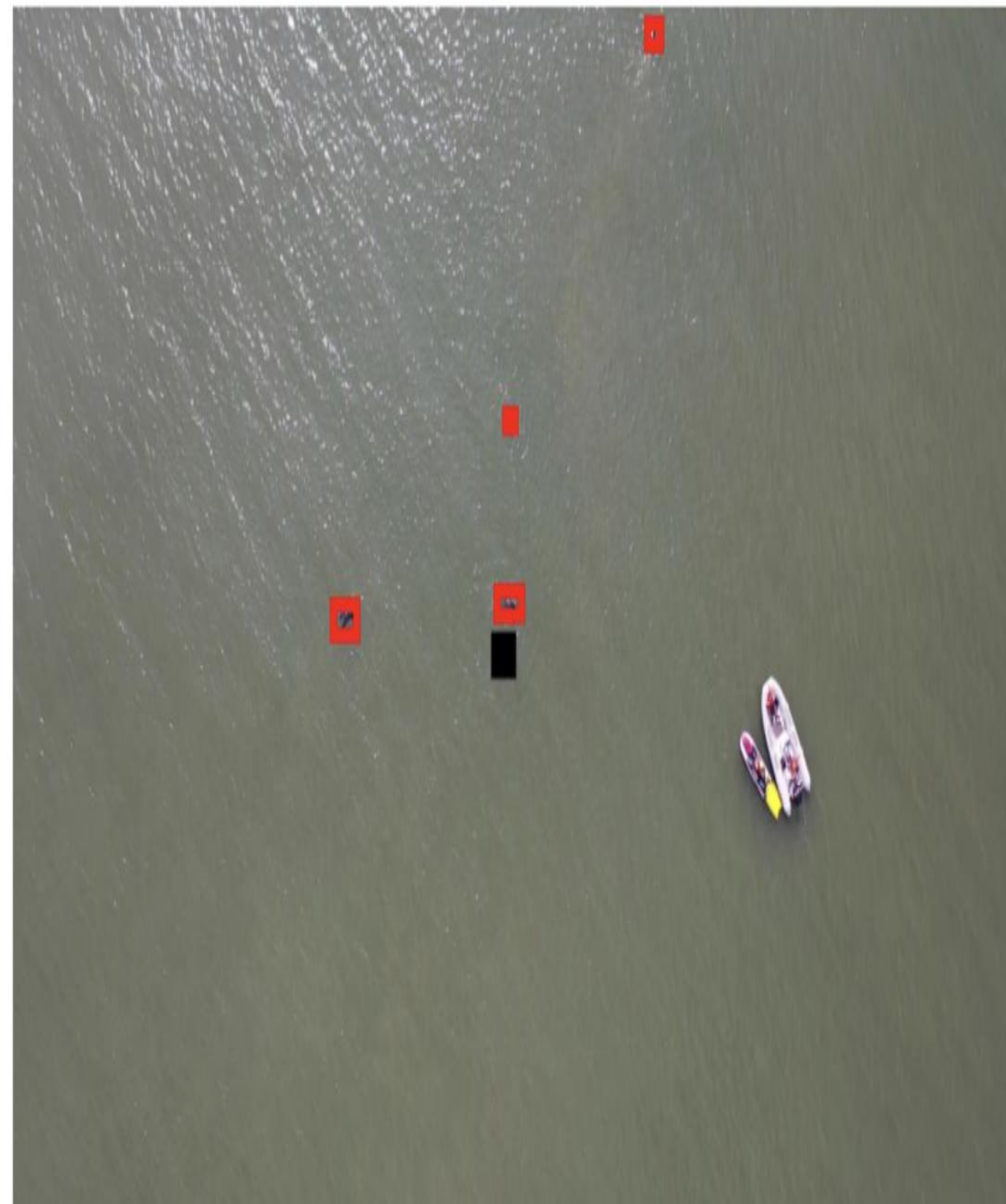
Dataset

- **Total Volume:** ~600 Images (300 Original + 300 Synthetic).
- **Positive Samples: 450 Images**
 - Contain labeled objects (People / Boats).
- **Negative Samples (Background): 150 Images**
 - "Empty" stormy sea (No objects).
 - Crucial for reducing False Positives.

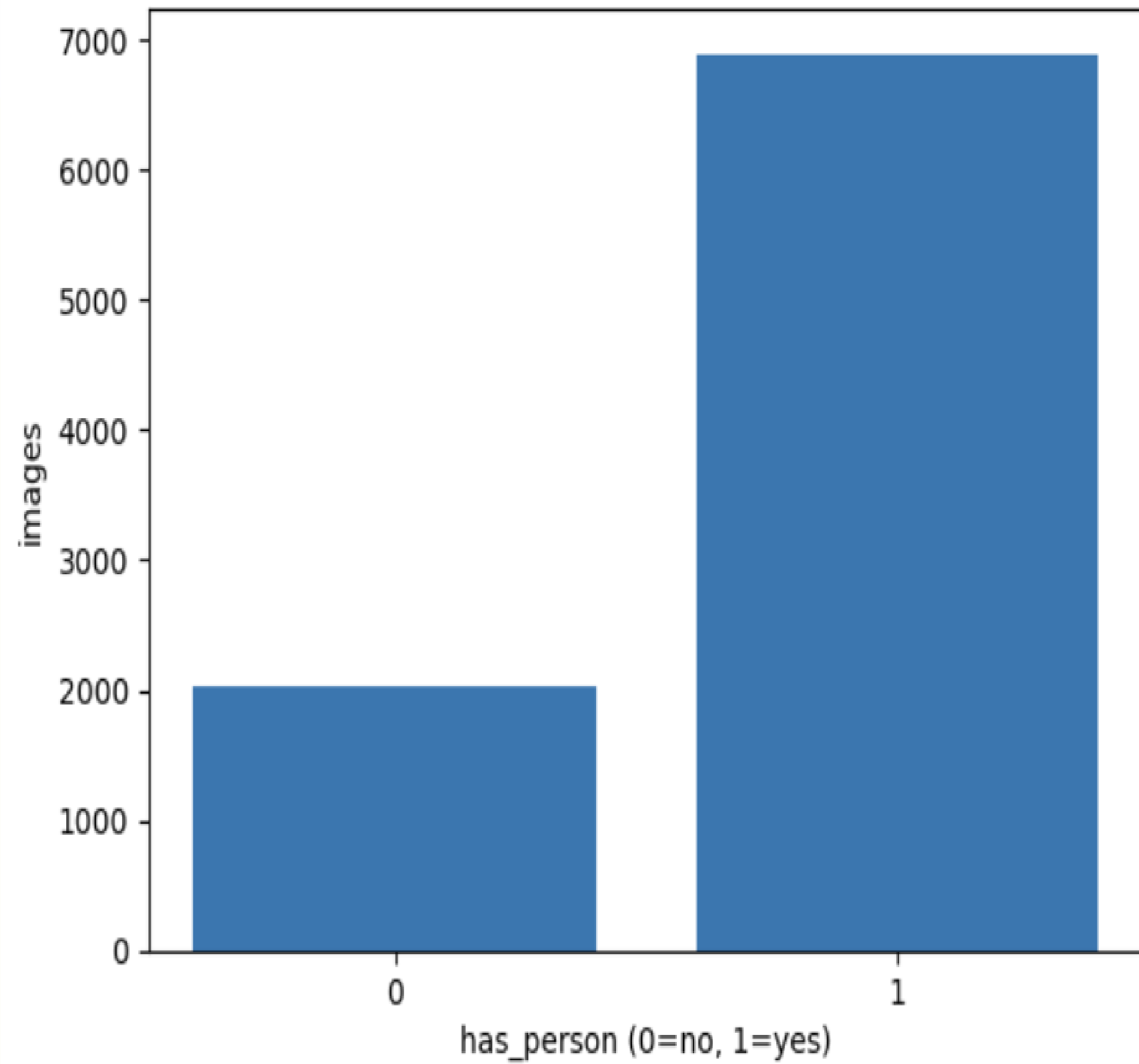
EDA highlights Original Dataset (SeaDronesSee)

- **Tiny Objects:** Targets (Persons) occupy <1% of the image pixels, making detection difficult.
- **Background Dominance:** Images are 95%+ water, creating a high signal-to-noise ratio.

8953.jpg



Class balance | Train



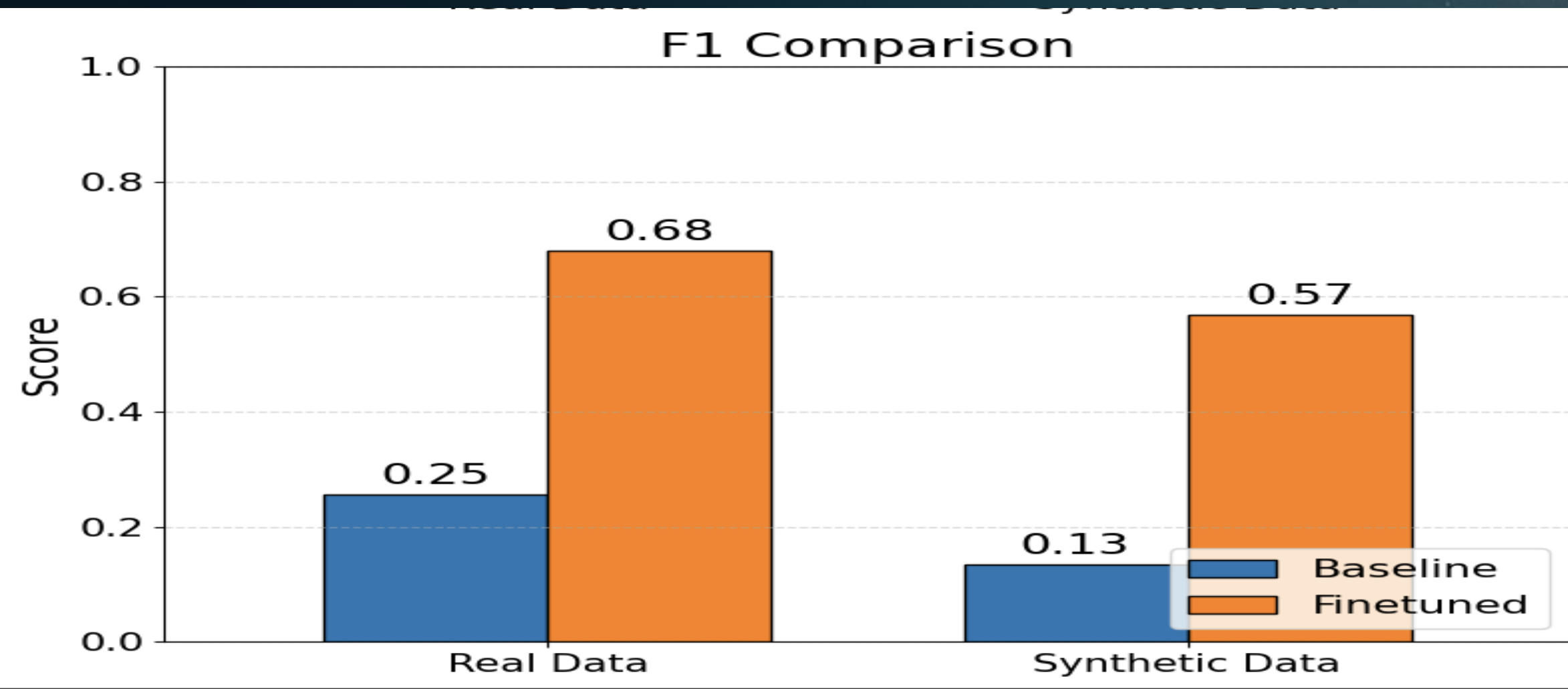
Baseline Solution and Results

Baselines

- **Model A (Baseline):** Standard YOLOv8s pre-trained
- **Model B (Finetuned):** Fine-tuned on our hybrid dataset (Real + Synthetic) to master detection in storm conditions.

Results

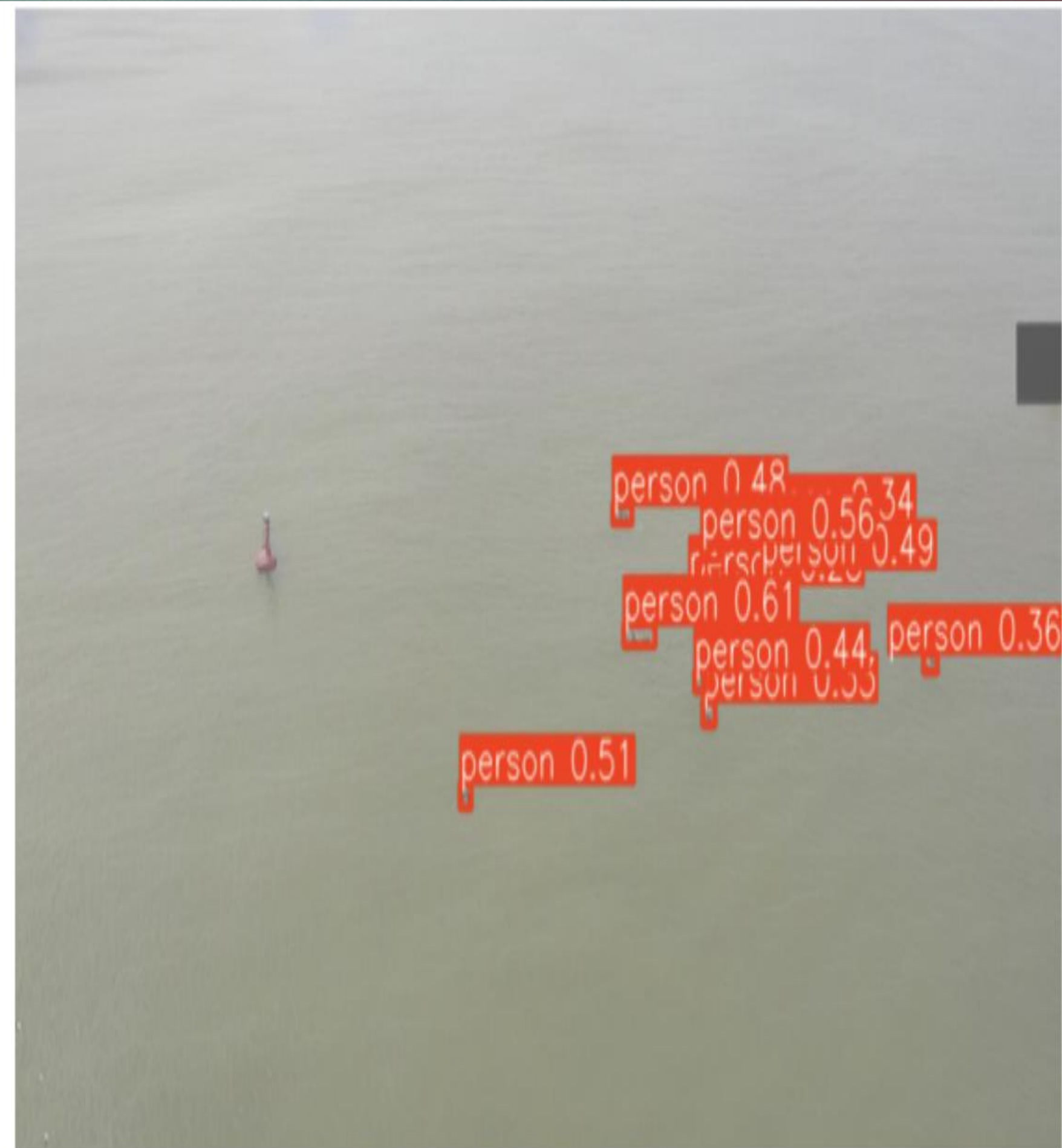
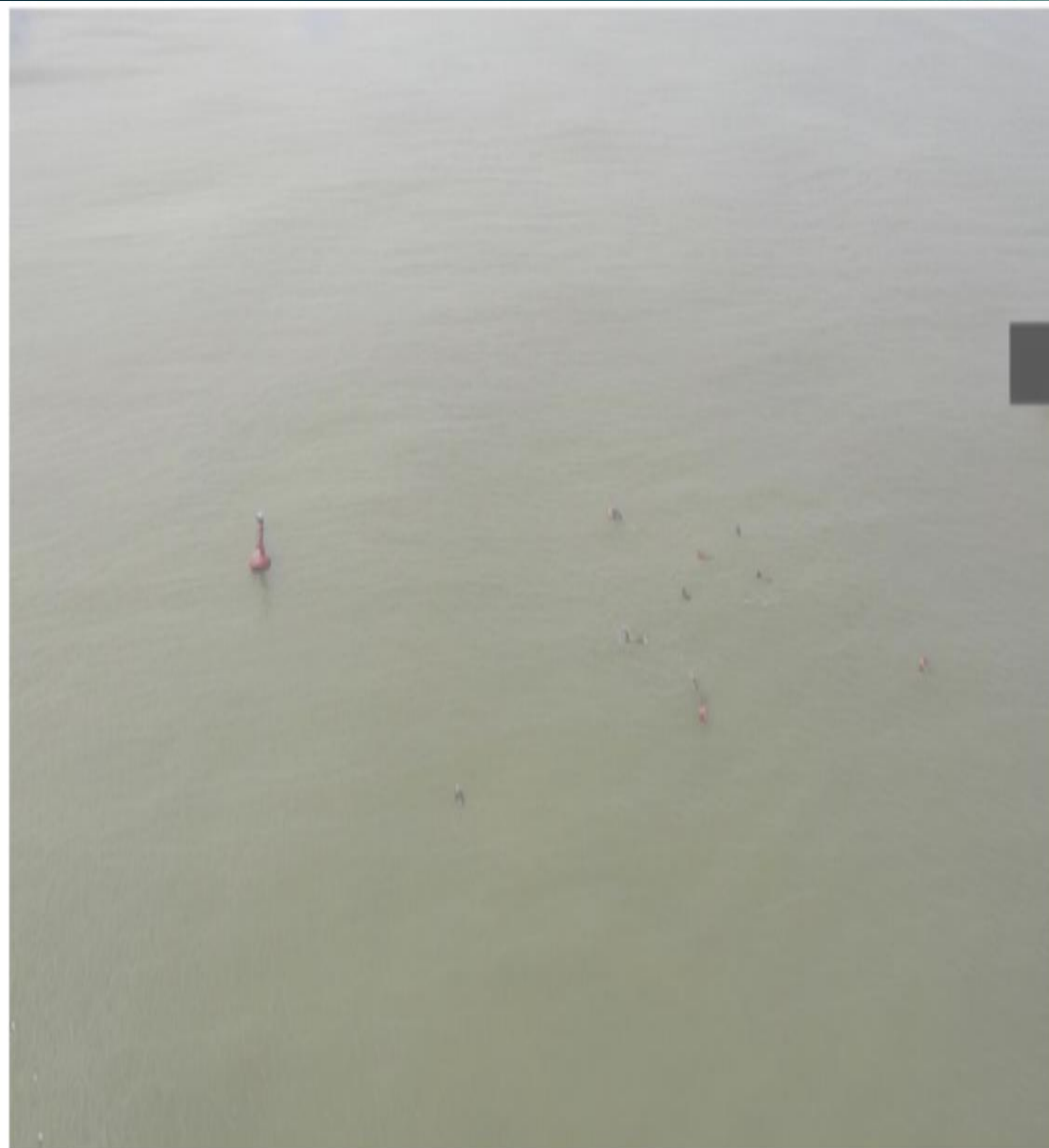
- **Higher Recall:** Significantly improved detection of small targets in storm conditions.
- **Weather Resilience:** Successfully detects objects through rain and fog, outperforming the baseline.



Baseline Model

vs

Finetune Model



Plan (Roadmap to Final Project)

Week	Phase Focus	Key Tasks (StormVision Specifics)	Weekly Deliverable
1	Data-Centric Optimization (Refining the input)	<ul style="list-style-type: none">• Hard Negative Mining: Generate additional "empty sea" images (specifically with heavy foam/whitecaps)• Extreme Scenarios: Create a small batch of edge cases (e.g., night/low-light, heavy fog mix) to test robustness.	v2_synth_dataset (Enhanced & Cleaned)
2	Model-Centric Optimization (Tuning & Training)	Architecture Comparison (Optional): Train YOLOv8m (Medium) alongside the current Small version	Final best.pt Model
3	Evaluation & Analysis (Visualizing Results)	Evaluation & Analysis	Final Results & Graphs
4	Delivery & Presentation (Packaging)	<ul style="list-style-type: none">• Repository Cleanup: Organize code, upload datasets, and write a detailed README.md (Motivation, Pipeline, Results).• Visual Abstract: Create one high-level diagram summarizing the Input -> Hybrid Pipeline -> Output.• Final Presentation: Prepare the 5-slide deck: Motivation, Novelty, Methodology, Results, and Conclusions.	Final Submission (GitHub Repo + PPT/PDF)