StormVision

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

Presenter:

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

What changed from the proposal

- Shifted focus to robust person-in-water detection under severe weather conditions
- Added synthetic storm data generation using Stable Diffusion + ControlNet (inpainting with object-preserving masks)
- Introduced pair-aware dataset design (ORIG vs SYNTH image)

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)

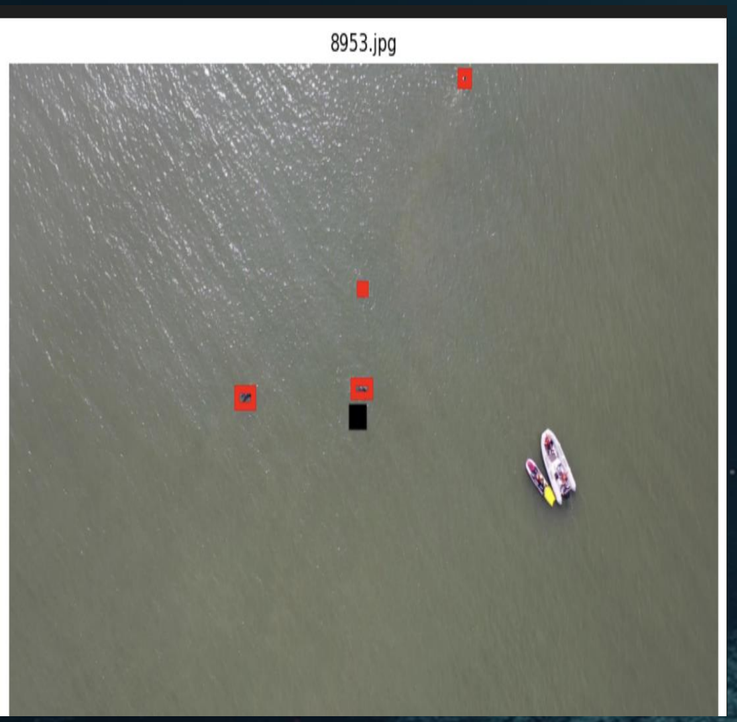
#	Paper / Year	Task	Method & Data	Key Findings & Limitations	Relevance to My Project
1	**SeaDronesSee (2022)**	Human detection in open water	54K frames (YOLO / R-CNN)	**Finding:** Small humans are hard to detect. **Limit:** No rough-sea conditions.	Serves as the main dataset we extend with GenAI rough-sea augmentation.
2	**Person-in-Water Detection (2024)**	Detect people for SAR	72K frames, YOLOv4	**Finding:** Accuracy drops in unseen environments. **Limit:** Lacks extreme sea states.	Guides evaluation strategy: Prioritize High Recall and minimize False Negatives.
3	**SafeSea (2024)**	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:

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, ensuring the new waves match the original perspective.

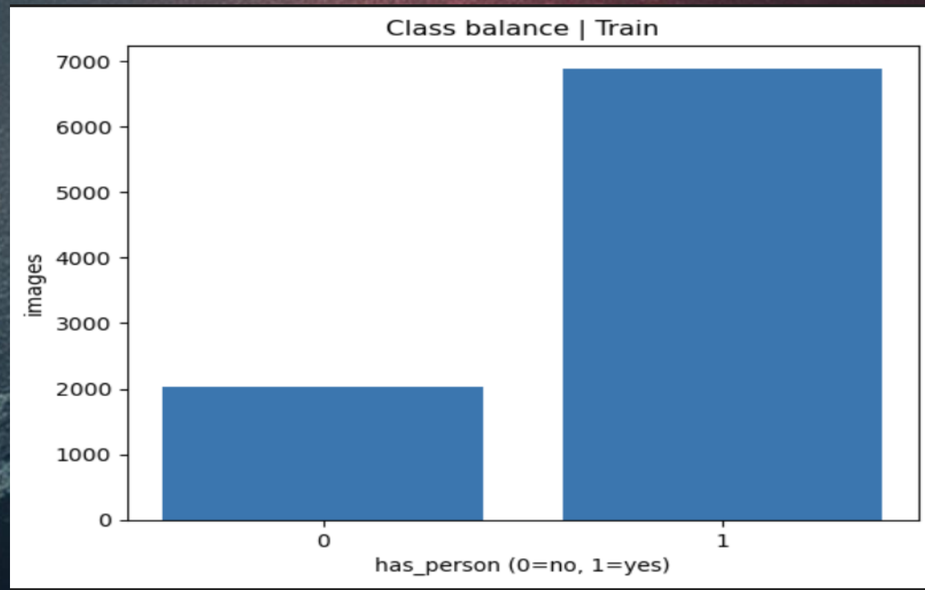


Dataset

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



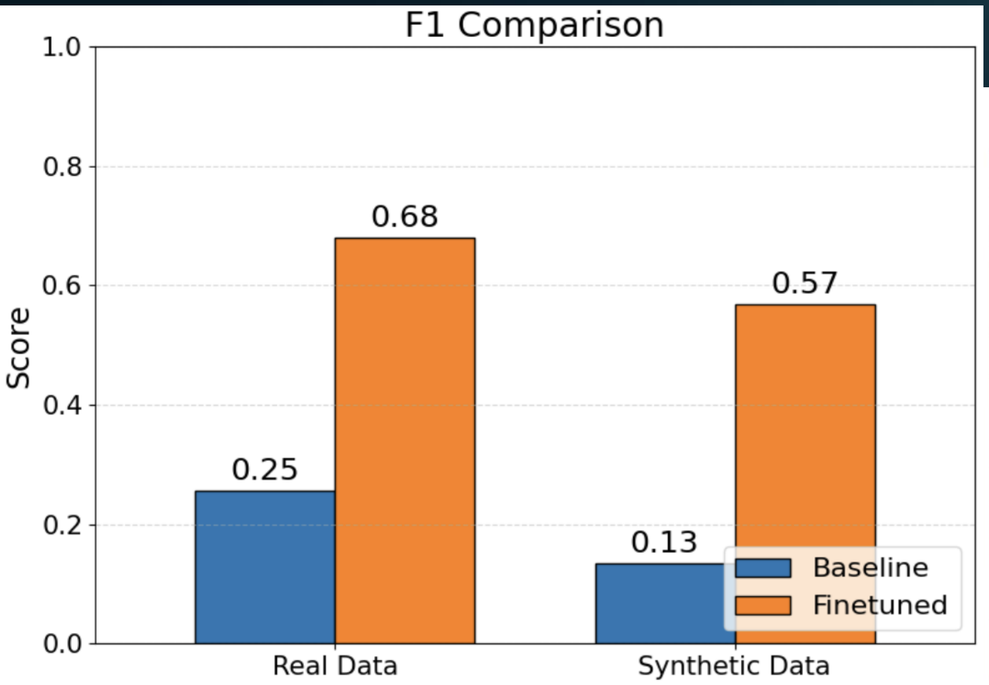
Baseline Solution and Results

Baselines

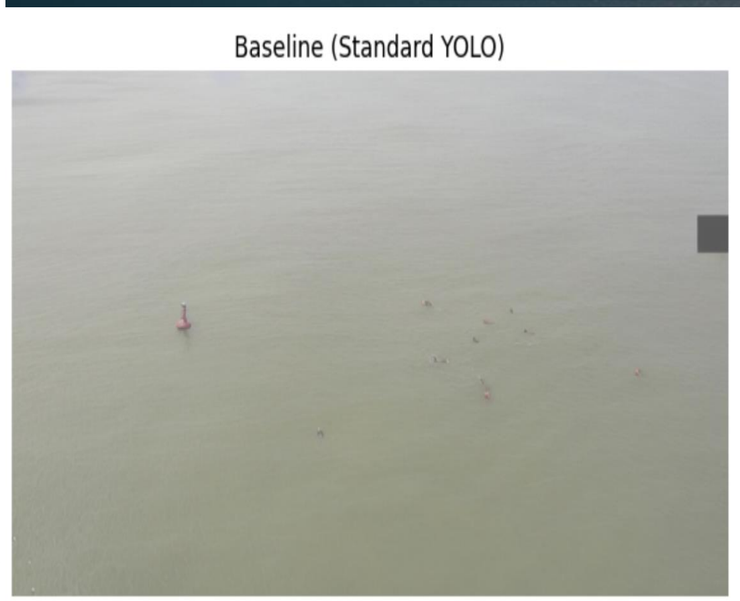
- **Model A (Baseline):** Standard YOLOv8s pre-trained
- **Model B (Finetuned):** Fine-tuned on our hybrid dataset (Real + Synthetic) to master detection in storm conditions.

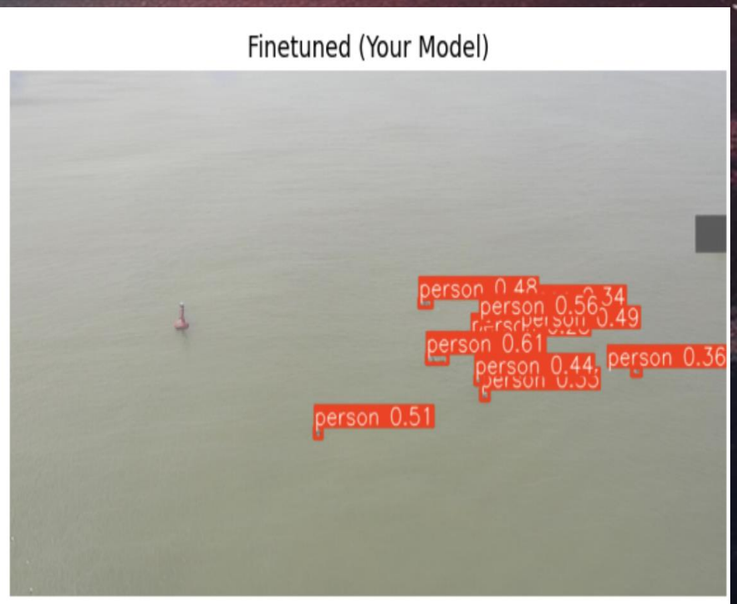
Results

- **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 Fintuned model





Plan (Roadmap to Final Project)

Week	Phase Focus	Key Tasks (StormVision Specifics)	Weekly Deliverable
1	Data-Centric Optimization *(Refining the input)*	• 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)*	• 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)