

# 1. Project Summary

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## Motivation & Specs

Oil spills on runways are invisible hazards causing loss of friction. Our goal is to build a **Real-time Computer Vision System (30 FPS)** to detect and localize these spills using semantic segmentation on edge hardware.

## Changes from Proposal

We pivoted from generic FOD (screws, trash) to exclusively **Oil Spills**. This shifts the challenge to identifying amorphous, transparent liquid textures.

## Novelty & Contributions

Due to extreme data scarcity, we developed a **Generative AI Pipeline** (Stable Diffusion + ControlNet) to synthesize realistic oil spill datasets.

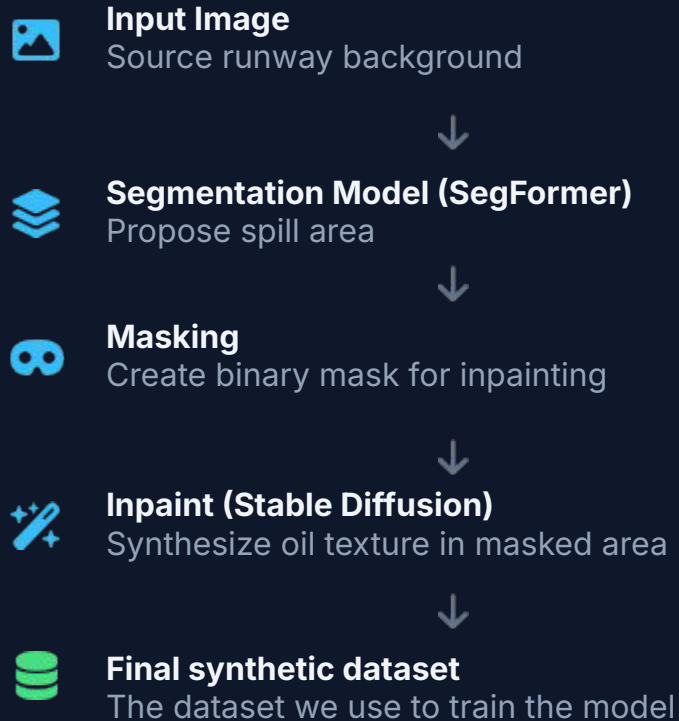


# 2. Related Work

Study / Year	Tools & Methods	Data Used	Results & Relevance
Airport-FOD3S (2025)	Generative AI: Stable Diffusion, CycleGAN Detector: YOLOv11	Real: 4,800 Syn: 19,200	<b>mAP: 86.95%</b> Validates our choice of Stable Diffusion for augmenting runway datasets.
Open-World FOD (2024)	Detection: YOLOv11, YOLOv8 GenAI: DCGAN	15 Classes Mobile camera data	Improved detection of unknown objects ("Out-of-Distribution").
FOD-S2R (Dec 2024)	Pipeline: 3-phase augmentation Sim2Real: Unreal Engine 5	Real: 3,114 Syn: 3,137 (3D)	Proved <b>Synthetic + Real</b> training outperforms Real alone. Supports our hypothesis.

# 3. Dataset Generation & EDA

## Generation Pipeline Flow

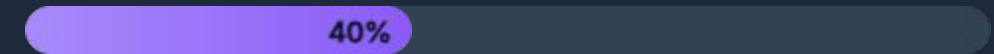


## Dataset Composition

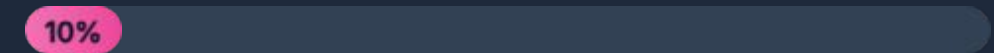
Clean Runway Images **1,000**



Generated Images (Synthetic) **800**



Real Oil Spill Images **200**



TOTAL  
IMAGES

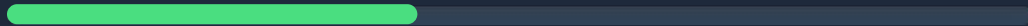
**2,000**

# 4. Preliminary Results (Epoch 14)

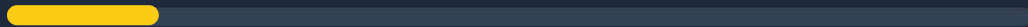
## Metric Snapshot

Comparison against COCO Baseline

mAP @ 0.50 **40%**



Recall **14.8%**



## Error Analysis

- ✓ **Low Precision (High False Positives):**  
Model currently predicts "oil" on most dark shadows and wet patches. Threshold refinement needed.
- ✓ **Low Recall (Underfitting):**  
Model misses >85% of spills. Likely due to early training stage (Epoch 14) and difficult synthetic-to-real domain transfer.

 The model failed to train properly

# 5. Project Timeline & Scope

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We are currently iterating on the dataset generation process to improve model generalization before the final defense.

