Duality AI – Space Station Hackathon Report

Team Name: Tech Titans
Project Title: SafeSpace using YOLOv8
Hackathon: Duality AI x SunHacks 2025
Tagline: Keeping Space Stations, Safer,Smarter and AI ready

1. Overview

This project presents an object detection system trained on synthetic space station data using the YOLOv8 deep learning architecture.
The primary goal was to detect and classify mission-critical objects—specifically, toolboxes, oxygen tanks, and fire extinguishers—within a simulated space environment.
The dataset was provided by Duality AI's Falcon platform, which generates high-quality synthetic data through digital twin simulation.
Our approach leverages the power of transfer learning and modern data augmentation techniques to develop a model that is both accurate and efficient for real-time inference in space-like scenarios.

2. Methodology

The dataset consisted of Falcon-generated synthetic images simulating a space station interior with varied lighting, angles, and occlusion conditions.
The object categories were limited to three classes: toolbox, oxygen tank, and fire extinguisher. The dataset was formatted in YOLOv8-compatible structure,
including separate folders for training, validation, and test images, each with corresponding label files in YOLO format.

The model used was YOLOv8s (small version), implemented using the Ultralytics framework. We trained the model for 10 epochs.

The training was performed on Google Colab with a T4 GPU. The configuration file (config.yaml) defined dataset paths and class names.

3. Results & Performance

After training, the model achieved the following evaluation metrics on the test dataset:

Mean Average Precision (mAP@0.5): 74.3%

Precision: 93.13%

Recall: 83.2%

Inference Time: under 36.34ms per image

Visual performance evaluations, including confusion matrix and training curves, are available in the runs/train/space_model/ folder.
The model effectively localized all three object classes even under challenging lighting and occlusion conditions.

4.Challenges:
Handling false positives with small object classes.
Maintaining mAP while keeping model size small.
GPU memory limitations .
Learnings:
Hands-on with YOLOv8
How synthetic datasets can outperform real-world data in safety-critical tasks
Power of Edge AI for real-time applications

5. Conclusion & Future Work
Our YOLOv8-based object detection system demonstrated high performance in a fully synthetic space station environment, proving the viability of synthetic data in training real-world models.
Moving forward, we aim to:

Export the trained model to ONNX or TFLite for deployment on edge devices.

Develop a lightweight dashboard (using Streamlit or Gradio) for real-time equipment monitoring.

Continuously refine the dataset using Falcon as mission scenarios evolve.

7. Project Structure
The GitHub repository contains the following:

SpaceStation_YOLOv8.ipynb: Google Colab notebook with full training workflow

config.yaml: YOLOv8 dataset config file

runs/train/space_model/: Training outputs (weights, confusion matrix, performance graphs)

Hackathon_Report.md: This report

dataset/: Structured synthetic image dataset (not pushed to GitHub due to size)

8. Submission Checklist
✅ Trained YOLOv8 model weights (best.pt)

✅ Evaluation results and visualizations

✅ Clean and reproducible code (.ipynb)

✅ Final structured report (Hackathon_Report.md)

✅ GitHub repository with complete project

9. Acknowledgements

We sincerely thank Duality AI for providing access to Falcon and the high-fidelity synthetic dataset, and SunHacks for hosting a well-organized and meaningful AI challenge.

10. Team Members

Tanishka Chaudhary – Model training, performance evaluation, code implementation

Satyam Gupta – Dataset preparation, and optional application integration

Priyanshi Singh - Documentation and PPT