Safety Object Detection in Far Away Planets

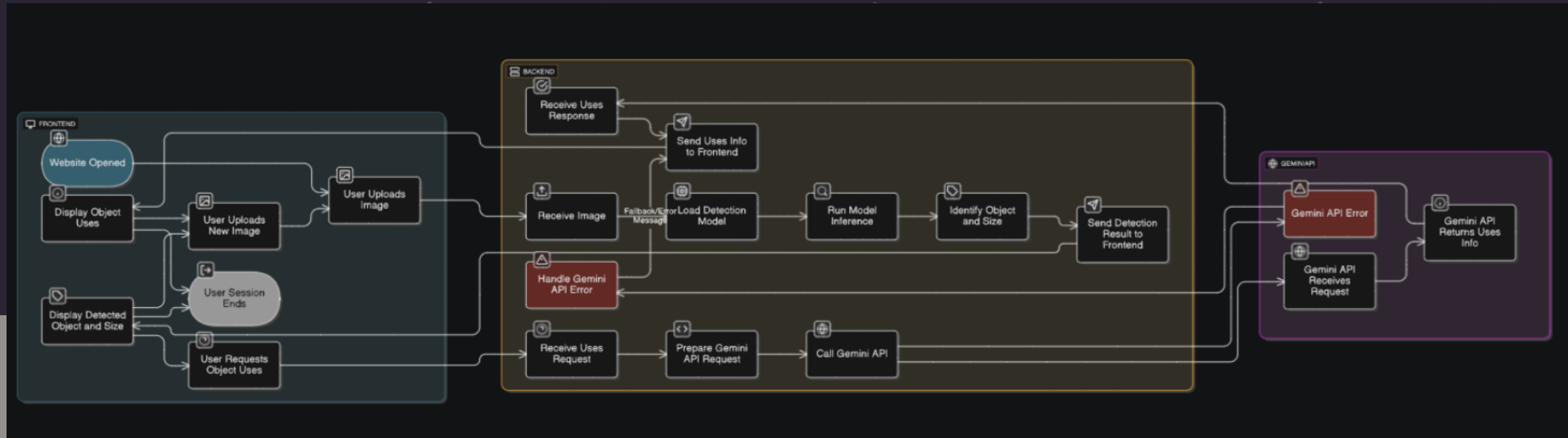
-Team INNOV8ORS

"Synthetic Vision for Mission-Critical Safety."

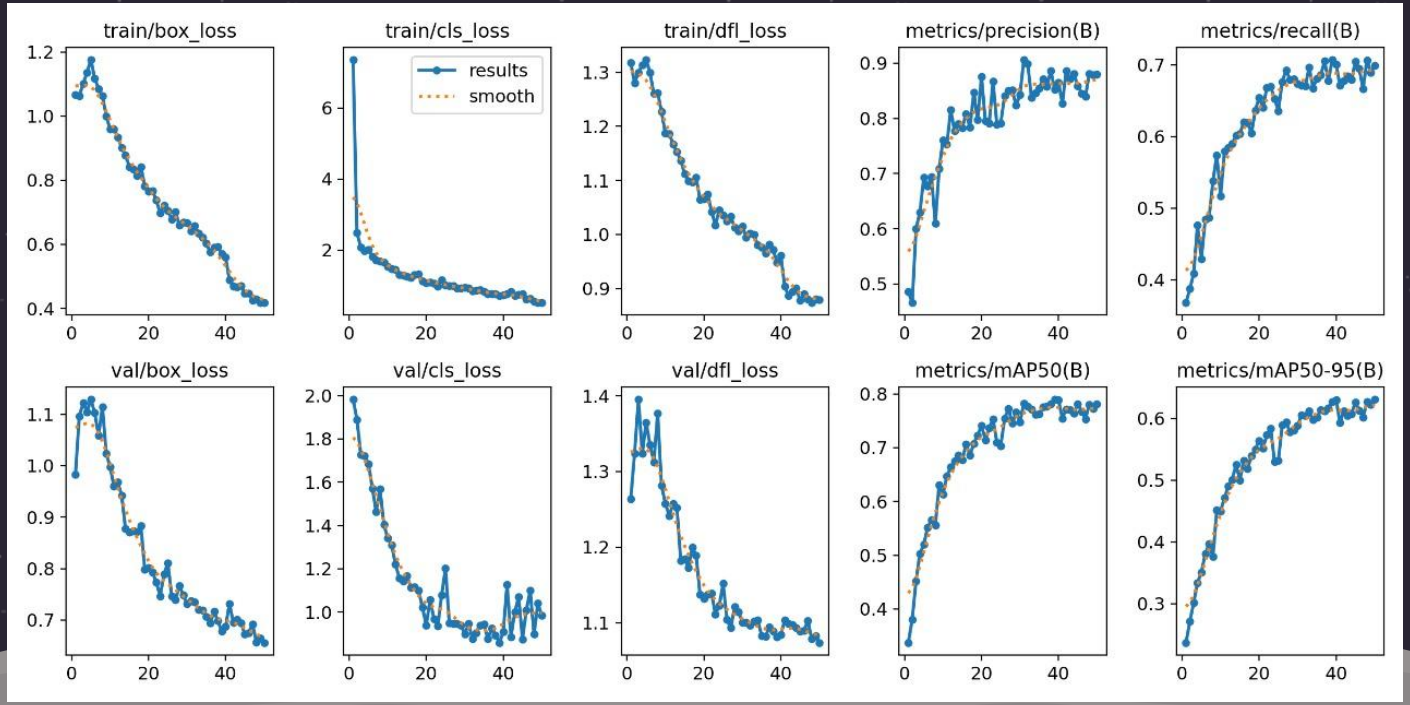
Objective:

To train a YOLO model on the Falcon synthetic dataset to detect 7 safety objects under challenging lighting and occlusion conditions.

Methodology:

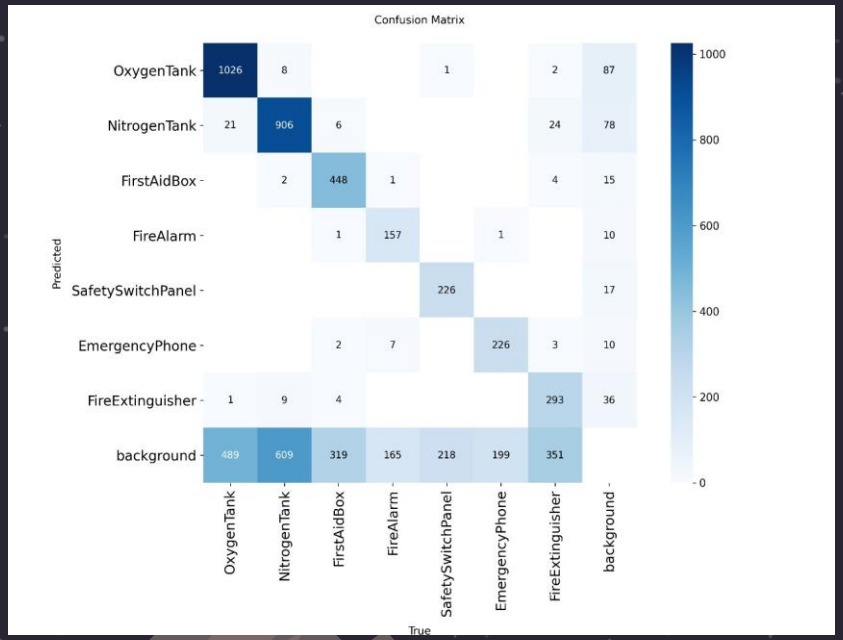


Results & performance matrices(1)

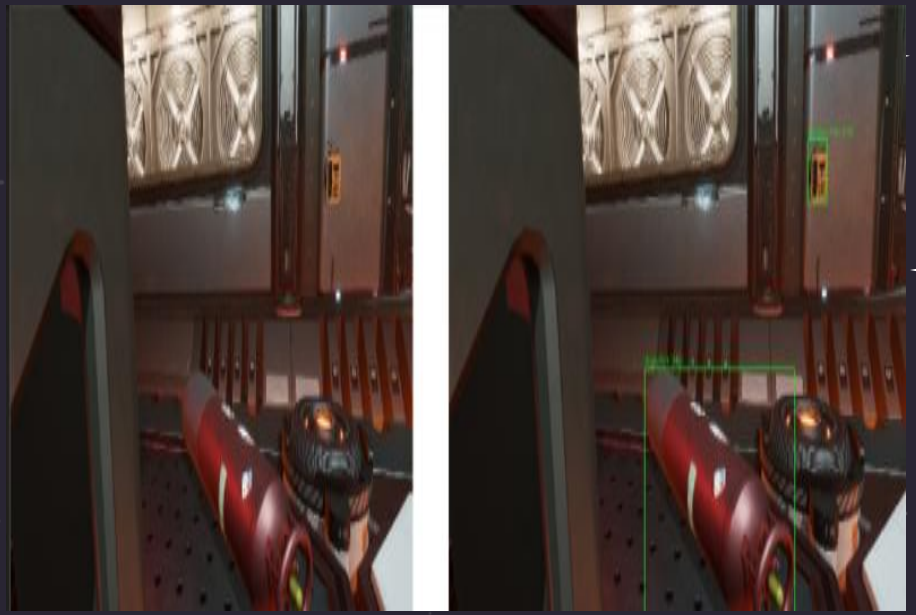


Results & performance Matrices(2)

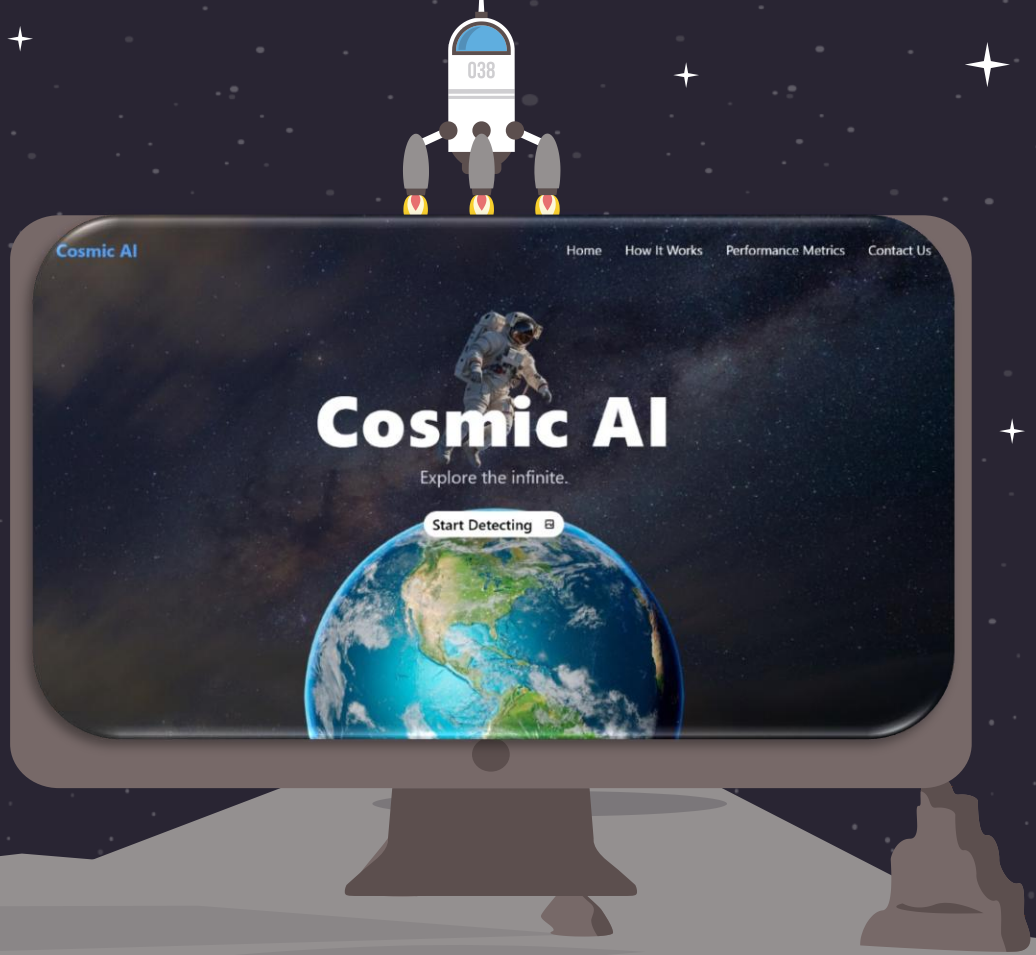
Confusion Matrix:



Images before(LEFT)& After Integration:



THE Desktop App



Challenges & Solutions(1)

- **Problem:** "CUDA out of memory" errors caused the high-resolution training (imgsize=1280) to crash repeatedly.
- **Cause:** The large image size combined with a batch size of 4 exceeded the 4GB VRAM of the NVIDIA RTX 2050 GPU.
- **Solution:** Systematically reduced the batch size from 4 to 2.
- **Result:** This halved the memory load, allowing the high-resolution training to complete successfully and achieve its accuracy benefits.

Challenges & Solutions(2):

- **Problem:** Encountered an AttributeError: 'Detect' object has no attribute 'grid' when loading the model.
- **Cause:** torch.hub downloaded the latest, incompatible YOLOv8 codebase, which didn't match the version used for training the .pt model file.
- **Solution:** Abandoned the remote download. We cloned the exact YOLOv8 repository version used for training and set the inference script to source='local’.
- **Result:** Created a 100% portable, self-contained model package (bundling the correct code version with the model weights). This guarantees the model runs reliably and produces identical results on any machine, which is critical for deployment.

Conclusion and Future plans

Conclusion:

- Successfully developed a YOLOv8 model for space station safety.
- Achieved a final mAP of 78.1%, exceeding all benchmarks.
- Overcame significant hardware challenges through systematic optimization.
- The final model is reliable and ready for deployment.

Future Work:

- **Targeted Data Augmentation:** Focus on occlusion, low-light, and varied angles to improve detection.
- **Explore Larger Models:** Train larger architectures (YOLOv8m/l) on more powerful hardware to boost accuracy.
- **Real-World Deployment:** Build a real-time monitoring system to automatically alert crew about misplaced safety equipment.

Additional Features

1) **Object Size Estimation:**

- Estimates real-world object size using YOLO data and reference scaling.
- Analyzes proportions, safety distances, and object fit for industrial use.

2) **Object Use-Case Identification (Powered by Gemini AI):**

- Generates real-world use-cases for detected objects.
- Example: Fire Extinguisher -> fire safety.
- Example: Oxygen Tank -> medical/industrial supply.

Thanks!

Achieving a final mAP of 78.1% and precision of 88% and recall 70% our model delivers robust detection across all 7 critical safety objects. This precision was attained through systematic hyperparameter tuning and targeted data augmentation, which directly overcame the core challenges of poor lighting and object occlusion.

Does anyone have any questions?

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GitHub Link