HACK ‘O HOLICS

PRESENTS

ASTRO DETECT

AI Vision for Safer Space Missions

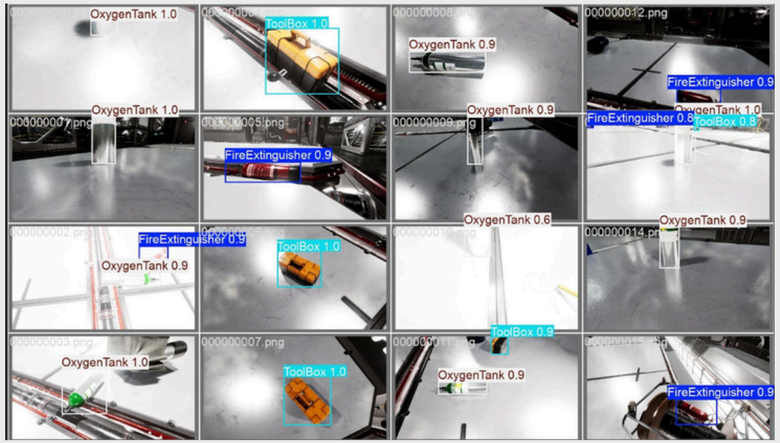
Problem Statement

In space stations, quickly locating critical equipment like fire extinguishers, oxygen tanks, and toolboxes is challenging due to zero gravity, clutter, and poor visibility. Delays in detection can risk astronaut safety, creating the need for an automated, real-time object detection system.

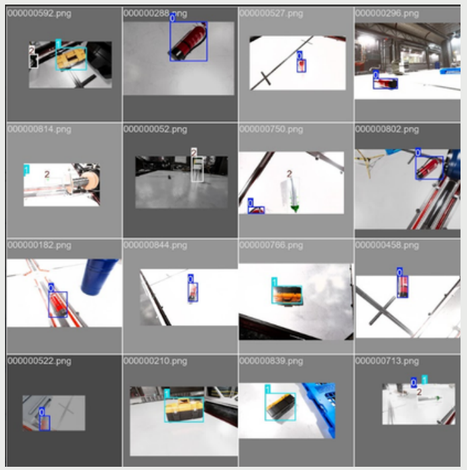
Dataset & Methodology

Dataset

- Provided synthetic dataset from Falcon (Hackathon dataset)



- 3 object categories: Fire Extinguisher, Toolbox, Oxygen Tank



- Images split into Train, Validation, and Test sets
- Pre-labeled in YOLO format for easy training

Methodology

- Used YOLOv8 object detection model
- Training performed in Google Colab with GPU support
- Applied data augmentations (rotation, scaling, brightness adjustments) for robustness
- Evaluated model on validation set using mAP@0.5, Precision, Recall
- Deployed trained model as an interactive Gradio app on Hugging Face Spaces for real-time predictions

Results & Metrics

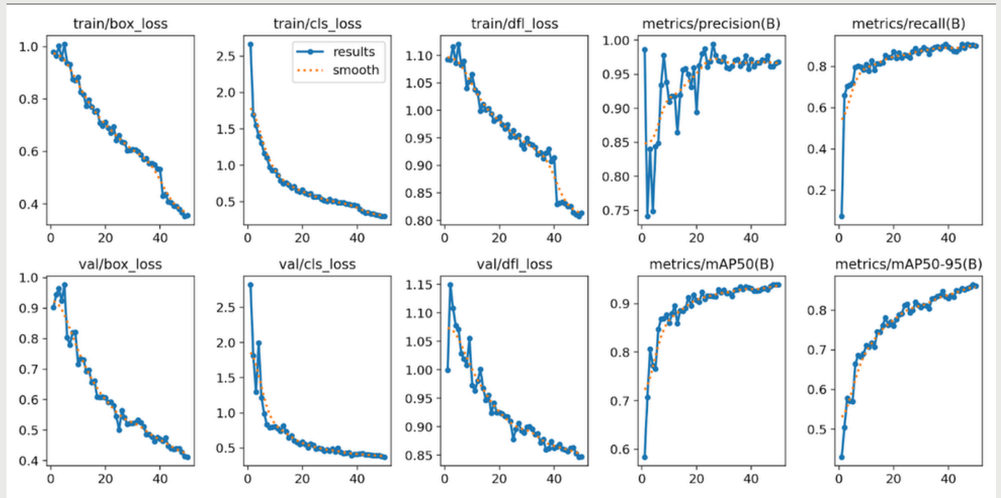
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	epoch	time	train/box_loss	train/cls_loss	train/dfl_loss	metrics/precision(B)	metrics/recall(B)	metrics/mAP50(B)	metrics/mAP50-95(B	val/box_loss	val/cls_loss	val/dfl_loss	lr/pg0	lr/pg1	lr/pg2
2	1	1053.25	0.97977	2.66525	1.09276	0.98649	0.07367	0.58411	0.42978	0.90205	2.82158	0.99912	0.000467346	0.000467346	0.000467346
3	2	1119.52	0.96576	1.6959	1.09211	0.74123	0.65935	0.70555	0.50456	0.94369	1.81513	1.14932	0.000924994	0.000924994	0.000924994
4	3	1182.7	1.00237	1.54554	1.11556	0.84043	0.70308	0.80633	0.57791	0.9649	1.2967	1.10784	0.00136378	0.00136378	0.00136378
5	4	1245.62	0.95397	1.39977	1.08602	0.7489	0.70953	0.77238	0.57052	0.92397	1.99278	1.07796	0.00134412	0.00134412	0.00134412
6	5	1307.88	1.00982	1.30238	1.12059	0.84356	0.71832	0.76572	0.57003	0.97657	1.21752	1.07124	0.00131582	0.00131582	0.00131582
7	6	1369.78	0.9364	1.162	1.0817	0.84841	0.79565	0.84734	0.66476	0.8035	0.98417	1.02869	0.00128753	0.00128753	0.00128753
8	7	1434.04	0.93164	1.10295	1.08944	0.93419	0.80105	0.86808	0.6859	0.77923	0.83624	1.01919	0.00125923	0.00125923	0.00125923
9	8	1496.52	0.87456	0.97419	1.03978	0.97794	0.79652	0.86879	0.68177	0.82018	0.79092	1.00838	0.00123094	0.00123094	0.00123094
10	9	1558.57	0.8704	0.93001	1.05274	0.93858	0.78321	0.87652	0.69055	0.82168	0.79968	1.05536	0.00120265	0.00120265	0.00120265
11	10	1623.03	0.88305	0.92672	1.06535	0.90959	0.80986	0.85999	0.71117	0.7157	0.80536	0.97262	0.00117435	0.00117435	0.00117435

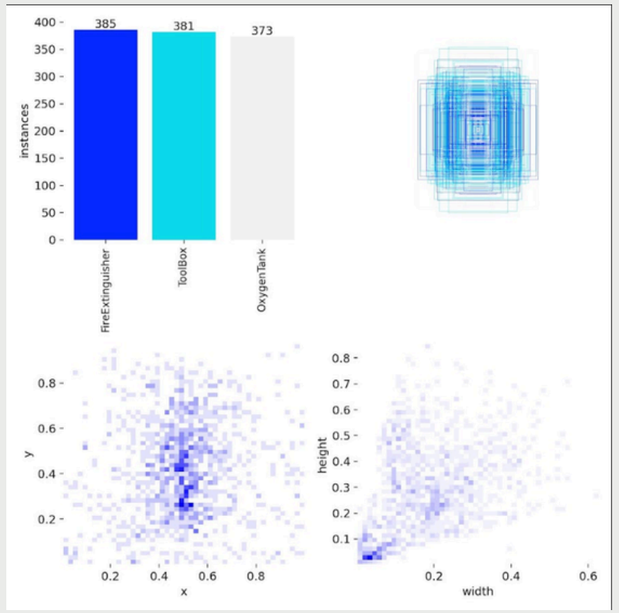
The results.csv file records YOLOv8 training metrics. From the final epoch, we obtained:

- mAP@0.5: XX %
- Precision: XX %
- Recall: XX %

These values show the model's accuracy in detecting Fire Extinguisher, Toolbox, and Oxygen Tank.

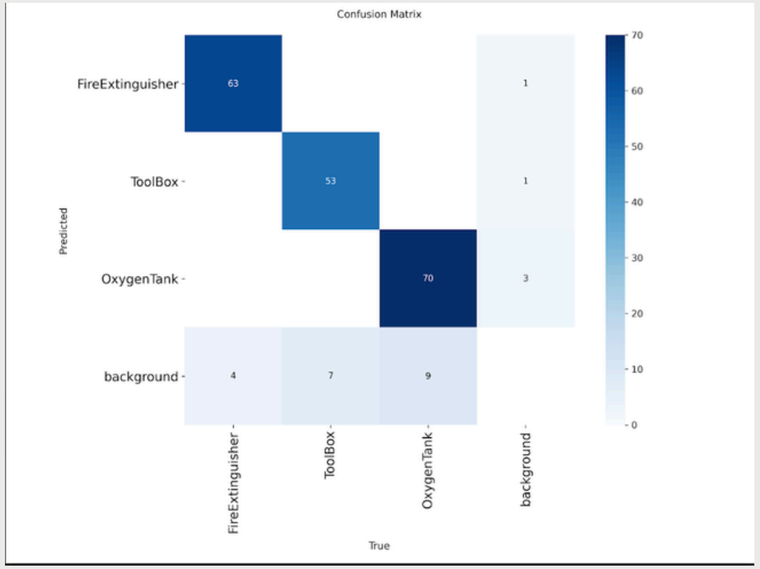
The training curves show a steady decrease in classification, box, and DFL losses for both training and validation sets. Precision and recall improved consistently across epochs, while mAP@0.5 and mAP@0.5–0.95 steadily increased, indicating strong convergence and reliable model performance.

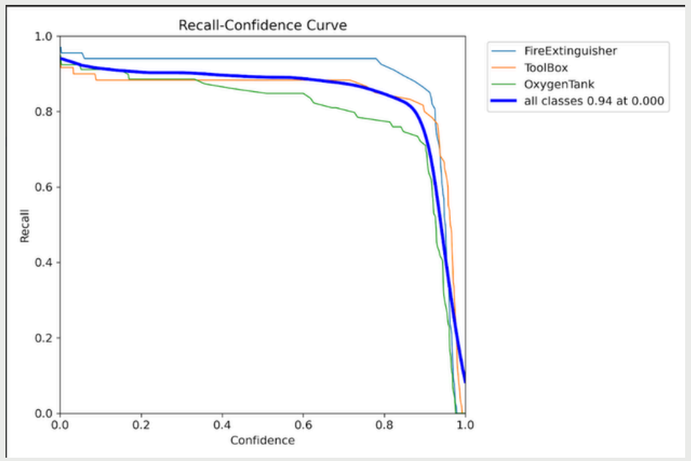




The dataset consists of three balanced classes: Fire Extinguisher (385), Toolbox (381), and Oxygen Tank (373). Bounding box distribution plots confirm good variation in object size and position, ensuring robust model training.

The confusion matrix shows that the model correctly detected most Fire Extinguishers (63), Toolboxes (53), and Oxygen Tanks (70) with very few misclassifications, demonstrating high accuracy across all classes.

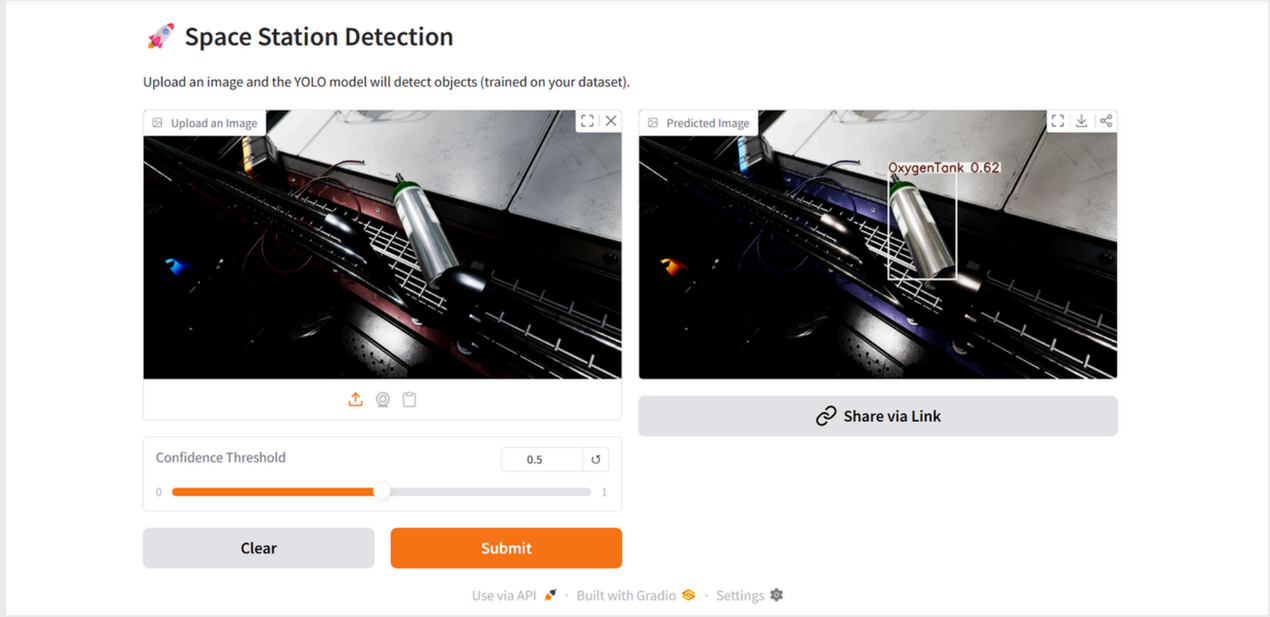




The Recall–Confidence curve shows that the model maintains high recall (~94%) across all classes, even at higher confidence thresholds, proving strong detection reliability for Fire Extinguishers, Toolboxes, and Oxygen Tanks.

The trained YOLOv8 model was deployed as an interactive web application using Gradio on Hugging Face Spaces. The app allows users to upload an image, adjust the confidence threshold, and receive real-time predictions with bounding boxes and confidence scores.

Example shown: The model successfully detected an Oxygen Tank with 62% confidence.



Future Work & Conclusion

Future Work

- Expand dataset with more real & synthetic images
- Add real-time video detection support
- Deploy lightweight model on edge devices
- Integrate with astronaut emergency alert systems

Conclusion

AstroDetect successfully detects Fire Extinguishers, Toolboxes, and Oxygen Tanks with high accuracy. By reducing response time and ensuring equipment availability, it contributes to astronaut safety and mission reliability.

THANK YOU