# Space Station Object Detection System: Enhancing Operational Efficiency

Pioneering AI-powered visual tracking for critical assets on the International Space Station and future habitats. Our goal: Improve crew safety and operational efficiency .

# The Challenge: Critical Asset Management in Space

### Time-Consuming Manual Inventories

Crew spends 15-20% of time on manual tracking.

### Misplaced Critical Items

Over 100,000 unique items on ISS, frequently lost.

### Emergency Response Delays

90-second target for fire suppression is hard to meet.

### Microgravity Complications

Searching and securing items is difficult.

# Our AI-Powered Vision System

1

### Custom Deep Learning

YOLOv8 architecture trained on specific space assets.

2

### Real-time Video Processing

Feeds from internal station cameras (e.g., Node 1, Harmony).

3

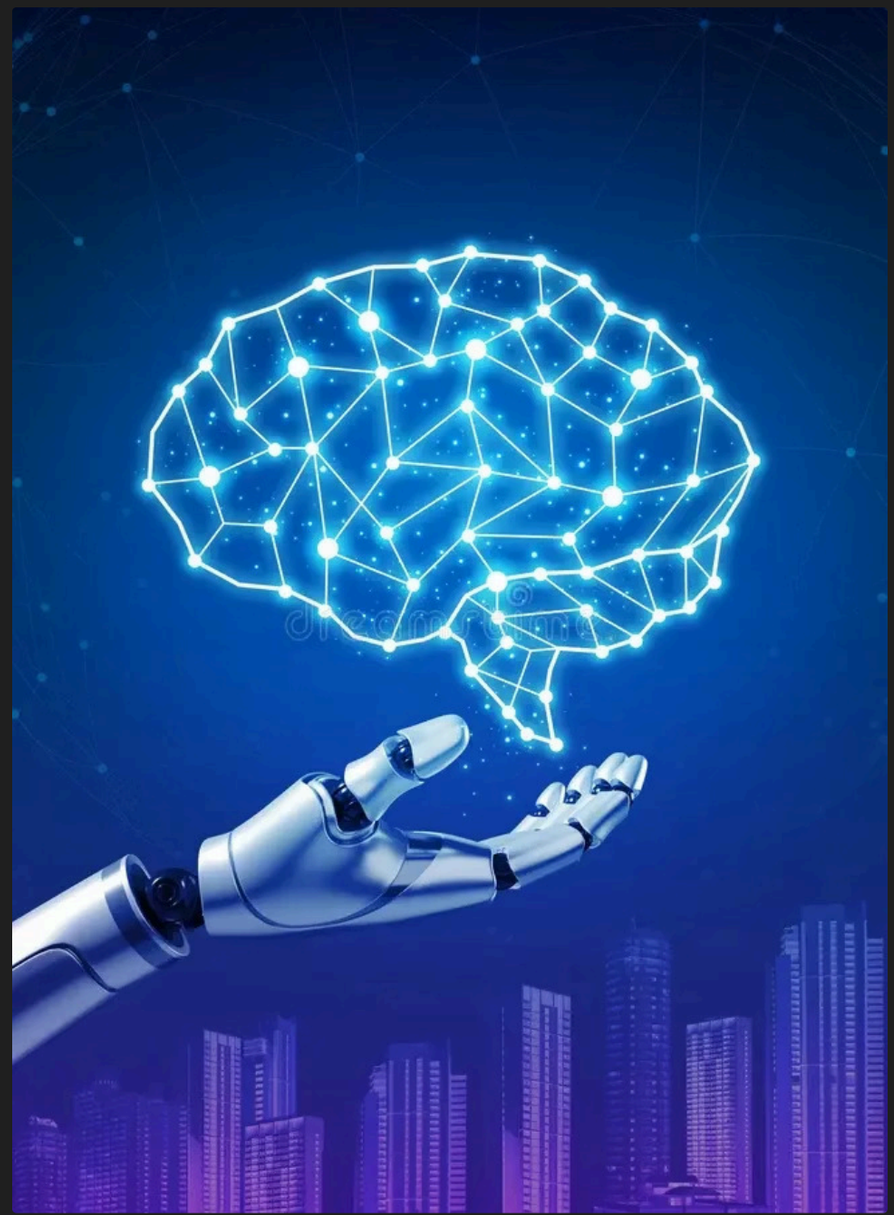
### Instant Identification & Tracking

Pinpoints objects' location and monitors movement.

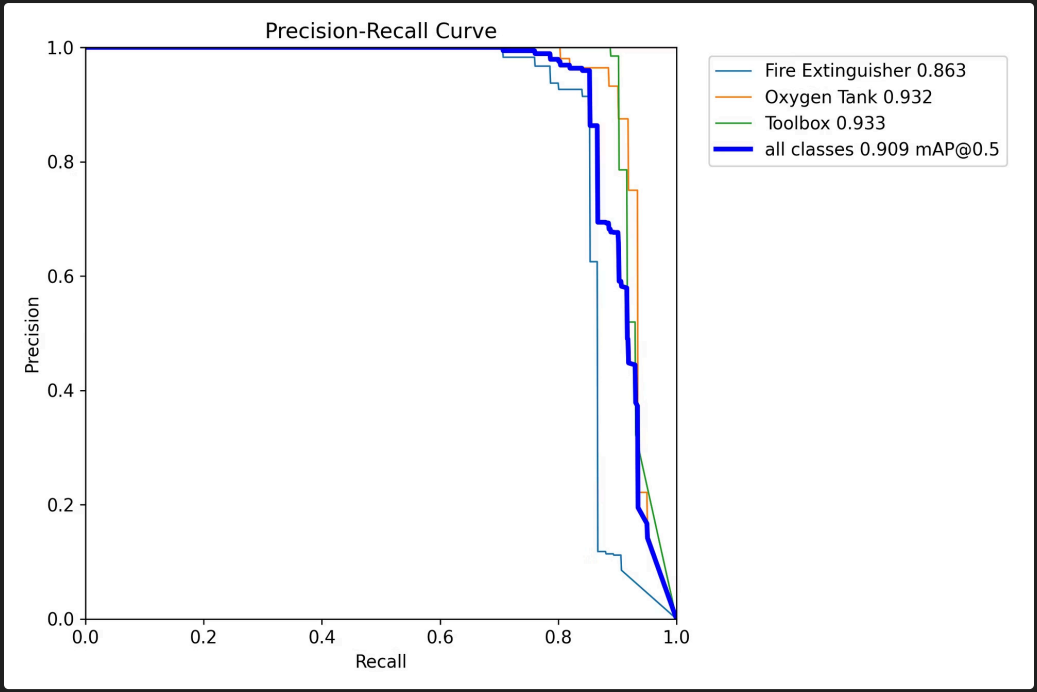
4

### Onboard Edge Processing

Runs efficiently on NVIDIA Jetson AGX Xavier.



# Model Performance & Robustness




## 0.909

### Mean Average Precision (mAP)

Achieved on our custom-annotated dataset.

## 1K+

### Annotated Images

Used for training across diverse conditions.

## 0.863

### Fire Extinguisher Precision

Highly accurate detection for critical safety items.

## 30

### Frames Per Second (FPS)

Real-time processing on test hardware.


# Key Objects for Detection

### Fire Extinguisher

Critical safety asset; enables 5-second retrieval.

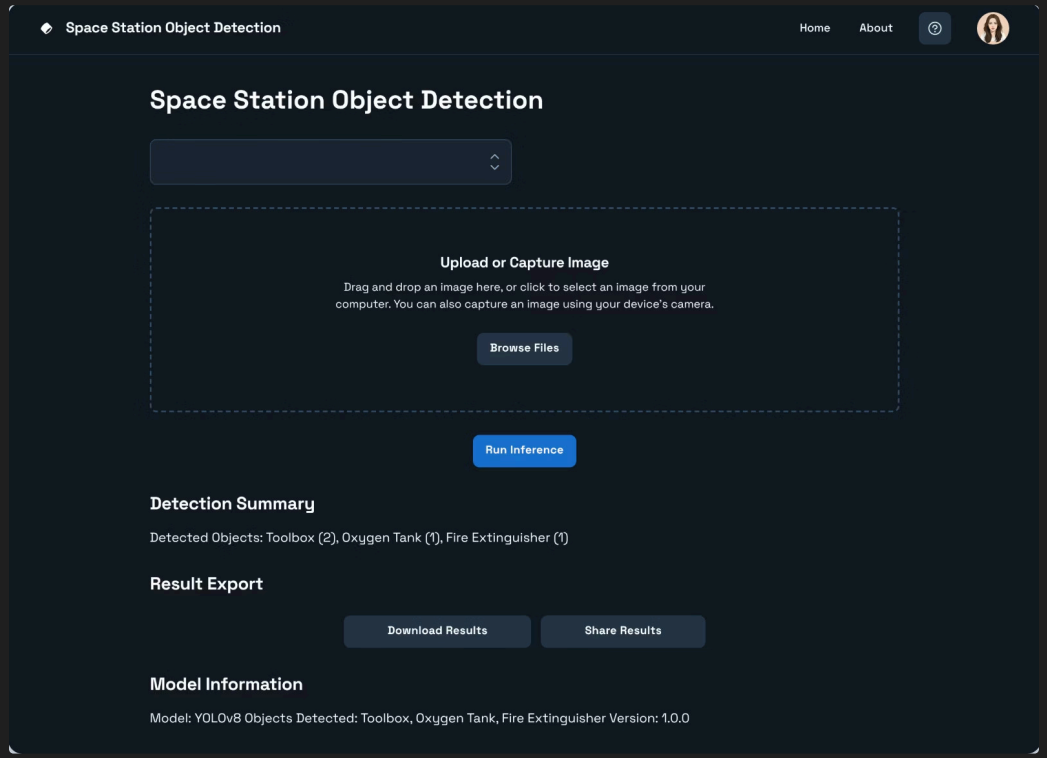
### Oxygen Tank

Life support inventory; tracks 20+ units.

### Toolbox

Maintenance efficiency; reduces search time by 70%.

# Web-Based Real-Time Monitoring Interface




## Interactive Dashboard

Accessible via crew tablets and ground control.

## 3D Station Maps

Visual object location on module layouts.

## Real-time Inventory

Instant updates and "last seen" timestamps.

## Quick Search & Alerts

"Find nearest" function and missing object alerts.

# Future Enhancements & Scalability

### NASA IMS Integration

Seamless data flow with existing inventory systems.

### 3D Tracking & Pose Estimation

Advanced spatial awareness of objects.

### Predictive Maintenance

Insights from tool usage patterns.

### Lunar & Mars Deployment

Scalable to future deep-space habitats.

### Continuous Retraining

Ensuring 99%+ accuracy with new data.

# Conclusion: A New Era of Space Operations

### Enhanced Crew Safety

Rapid access to critical safety equipment.

### Reduced Workload

Estimated 200 hours saved annually.

### Ready for Deployment

Prototyped and simulation-ready.

### Crucial for Long Missions

Every second counts in deep space.