Real-Time Object Missing and New Object Placement Detection

✨ Project Overview

This project builds a **real-time video analytics pipeline** capable of

- **Missing Object Detection**: Identifying when a previously present object disappears from the scene.
- **New Object Placement Detection**: Identifying when a new object appears in the scene.

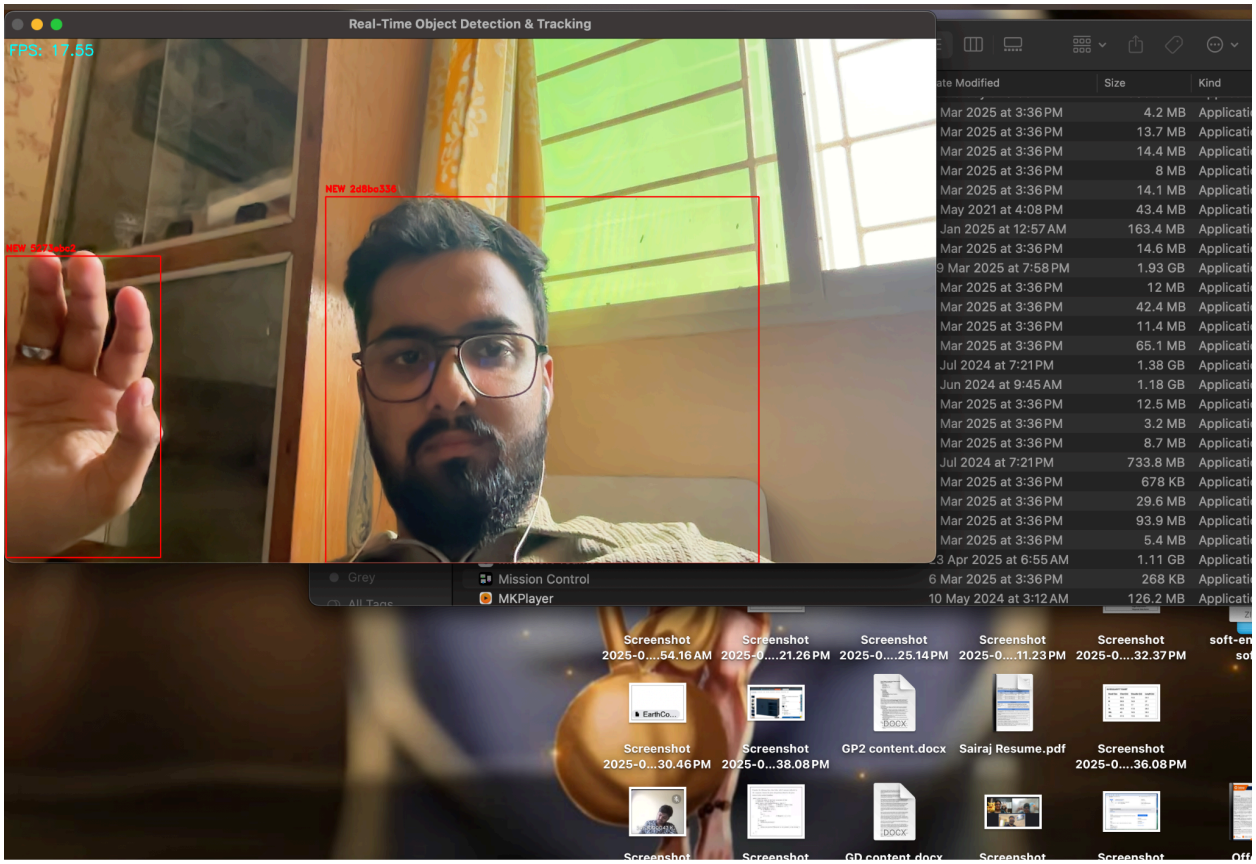
The system uses **YOLOv5** for object detection and a **simple custom tracker** to track object states across frames.

⚡ Performance

- **Achieved FPS**: **20 FPS** (real-time)
- **Input source**: Webcam (Laptop Camera)
- **Resolution**: 640x480 (default)

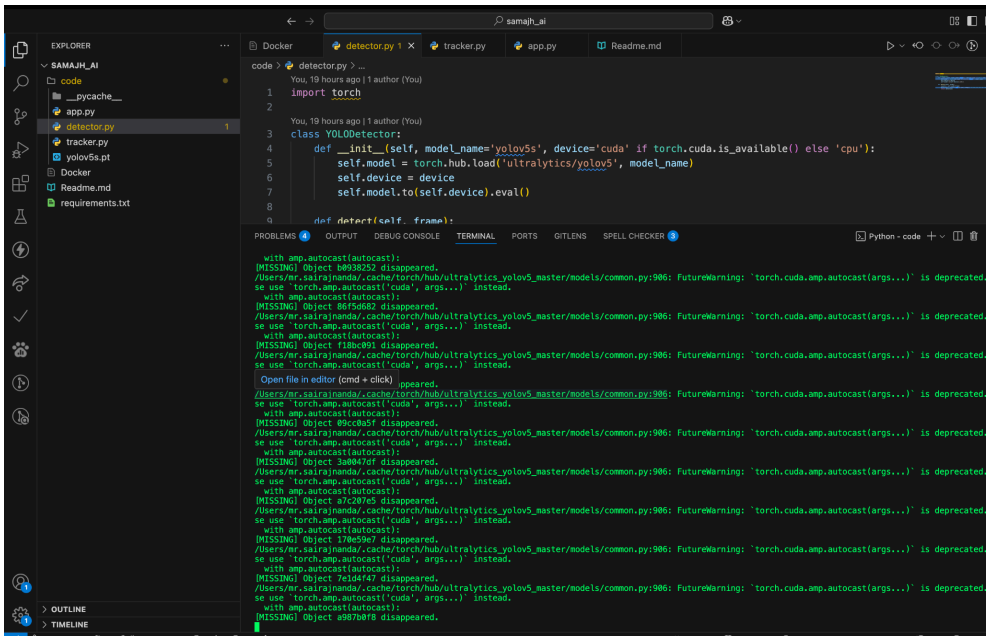
🖼️ Sample Screenshots

Screenshot 1:
Object Detection & Tracking (New Object Highlighted in Red)



Screenshot 2:

Missing Object Notification (Console log + Sound Alert)



🖥️ Hardware Configuration

- **CPU**: Apple M1 (8-Core CPU)
- **GPU**: Integrated 8-Core GPU (Apple Silicon)
- **RAM**: 16 GB Unified Memory
- **Operating System**: macOS Ventura 13.x

🧠 Techniques and Architectural Decisions

- **Object Detection**:
    - **YOLOv5s** was chosen for its excellent balance between speed and accuracy.
    - Loaded via `torch.hub` directly, reducing setup time.
- **Object Tracking**:
    - **Simple Tracker** assigns random UUIDs for each detection.
    - Comparisons across frames to find missing and newly placed objects.
- **Optimizations**:
    - Using `torch.no_grad()` to disable autograd for inference.
    - Avoid writing output video to disk during testing to preserve FPS.
    - Lightweight threading for playing sound notifications without blocking frames.
    - Clean real-time FPS counter for performance monitoring.
- **User Experience**:
    - Newly placed objects are highlighted **in red**.
    - Existing objects are highlighted **in green**.

- Sound notification on missing objects for better real-time feedback.
