An Overarching YOLO Performance Analysis

Groups: A, F, G, I

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ABSTRACT

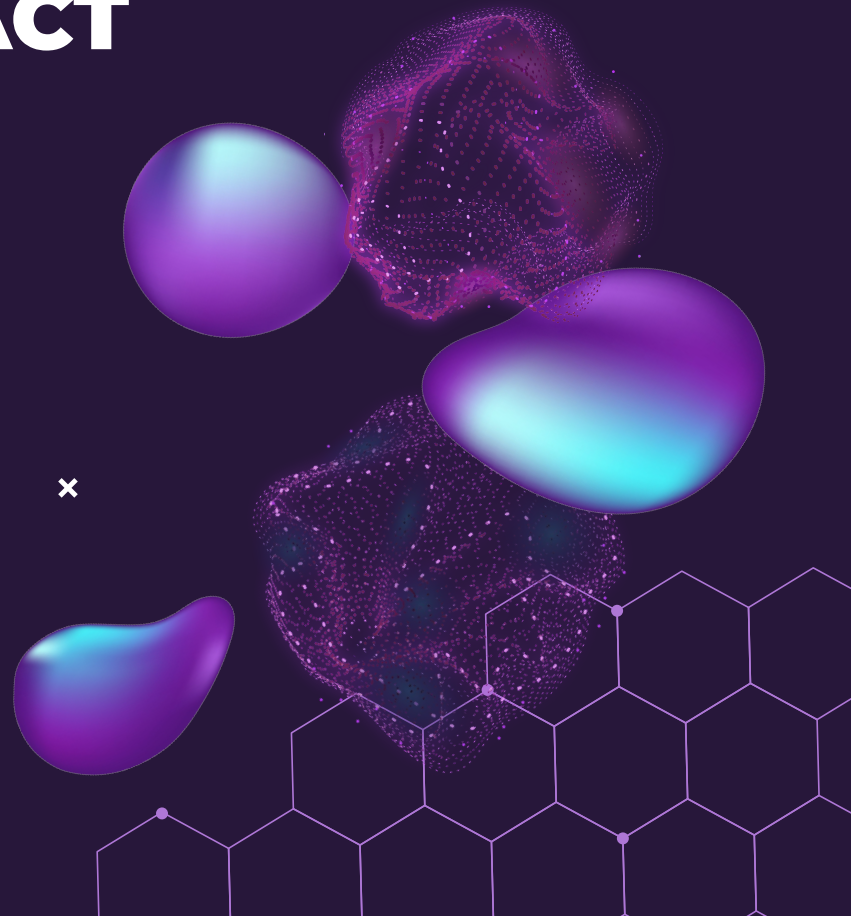
Object Detection is Critical for Robotics, Surveillance, and Autonomous Systems

This Study Benchmarks YOLOv5 and YOLOv8 on CPUs, GPUs, and Edge Devices

Objective: Provide Insights into Trade-Offs for Hardware and Model Selection

Key Results:

- YOLOv8 Excels in Speed & Accuracy, Especially on Edge Devices
- Discrete GPUs are the Most Efficient, up to 27.23x Better than CPUs

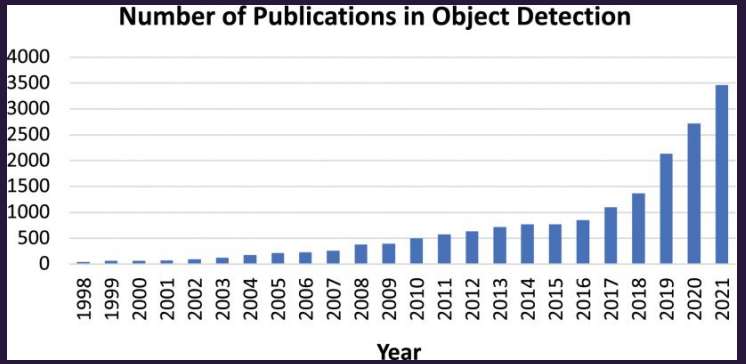


Introduction

Object Detection: Identifying Objects in Images or Video

Importance: Applications in Robotics, Autonomous Systems, Surveillance

Research Question: How do YOLOv5 & v8 Perform on Different Hardware Platforms



HARDWARE CONFIGURATIONS

1

HIGH-PERFORMANCE SYSTEMS

System 1: Intel i7-12700KF, NVIDIA RTX 4080
System 2: AMD Ryzen 9 5950X, AMD Radeon RX 6900 XT

2

INTEGRATED GRAPHICS

Intel i5-11400H (UHD Graphics), AMD Ryzen 5 5600G (Vega 7 Graphics)

3

EDGE DEVICES

NVIDIA Jetson Orin Nano, NVIDIA Jetson Nano

SOFTWARE FRAMEWORKS

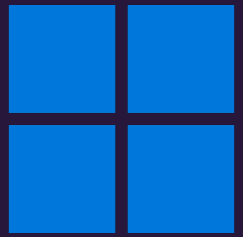
Operating Systems:

- Windows 10
- Ubuntu 20.04 LTS

Frameworks:

- YOLOv5 (Exported to ONNX for Compatibility)
- YOLOv8 (Native Framework, PyTorch 1.12.0)
- OpenCV and Roboflow for Dataset Handling

Monitoring Tools: HWiNFO64, psutil



METHODOLOGY

Dataset: COCO 2017 Val (128 Images, Batch Size 16)

Metrics:

- **Throughput:** Images/Sec
- **Inference Time:** Processing Time/Image
- **Power Efficiency:** Watts per Image/Sec
- **Memory Utilization:** CPU & GPU Memory Usage

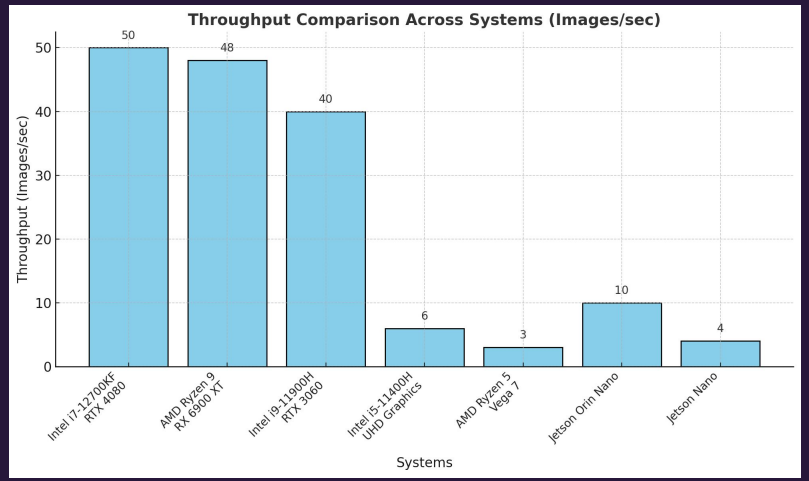
Process:

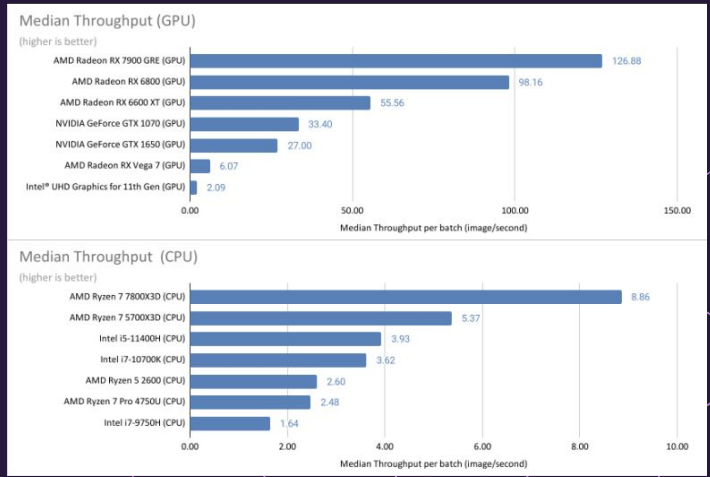
- GPU Testing First to Avoid Interference
- Removed Any Unnecessary Background Processes
- Metrics Tracked During Each Test

Results - Throughput

Observation:

- GPUs Outperform CPUs Significantly; Integrated GPUs see Lesser Performance Uplift versus CPUs
- RTX4080 (System 1) Achieves over 50 Images/Sec
- Jetson Nano (<5 Images/Sec) Limited by Processing Power





Results - Power Efficiency

System	Power Efficiency (Watts Per Image)
Intel i7-12700KF + RTX 4080	1.5
AMD Ryzen 9 + RX 6900 XT	1.8
Intel i9-11900H + RTX 3060	2.2
Intel i5-11400H + UHD Graphics	6.0
AMD Ryzen 5 + Vega 7	8.0
Jetson Orin Nano	4.0

Observation:

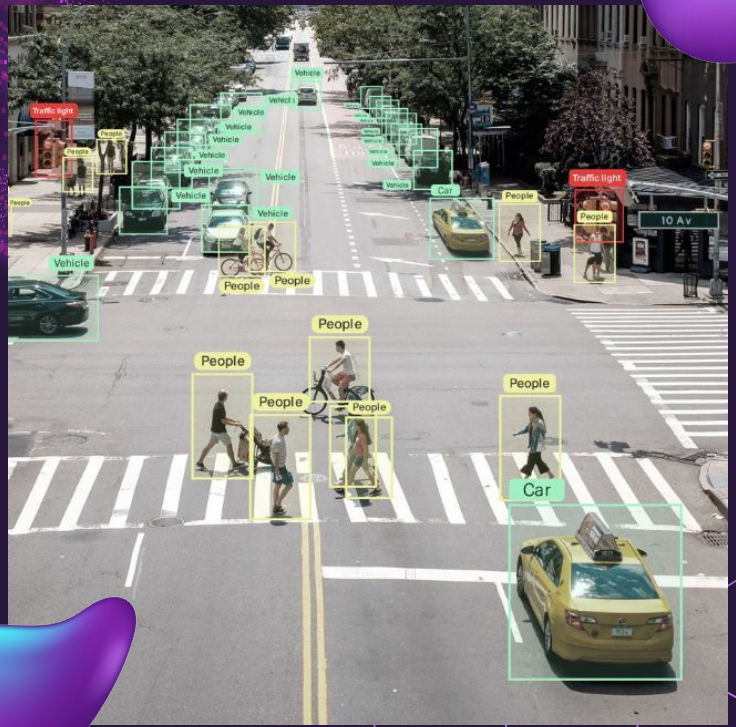
- Discrete GPUs Most Efficient (1.5-2W/Image/Sec)
- Jetson Orin Nano is Efficient for Edge Devices (~4 W/Image/Sec)
- Integrated GPUs Consume More Power for Lower Throughput

YOLOv5 vs YOLOv8 Comparison

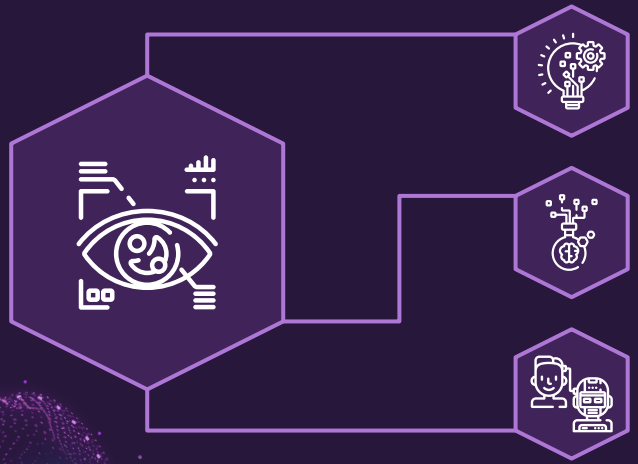
Metric	YOLOv5	YOLOv8
Throughput	Lower (Robust in Varying Environments)	Higher (Suited for Real-Time Applications)
Inference Time	Higher (Slower Processing)	Lower (Faster Processing)
Detection Confidence	Higher at Longer Distances	Slightly Lower at Longer Distances
Power Efficiency	Moderate (Less Efficient)	Higher (More Efficient on Edge Devices)

CONCLUSION

- Discrete GPUs Excel in Performance, Suitable for Large Scale Tasks
- YOLOv8 is Optimal for Real-Time Detection and Edge Devices
- YOLOv5 Remains Reliable for Scenarios Requiring Robust Confidence
- **Key Insight:** Model & Hardware Selection Depend on use Case Priorities



FUTURE WORK



GOAL 1

Explore Further Optimizations for YOLO Models on Edge Devices

GOAL 2

Investigate Reducing Memory utilization for Real-Time Tasks

GOAL 3

Expand Benchmarking to Other Detection Models