University of Alberta

Enhancing Construction Site Safety and Efficiency with YOLO v8-Based Computer Vision Model

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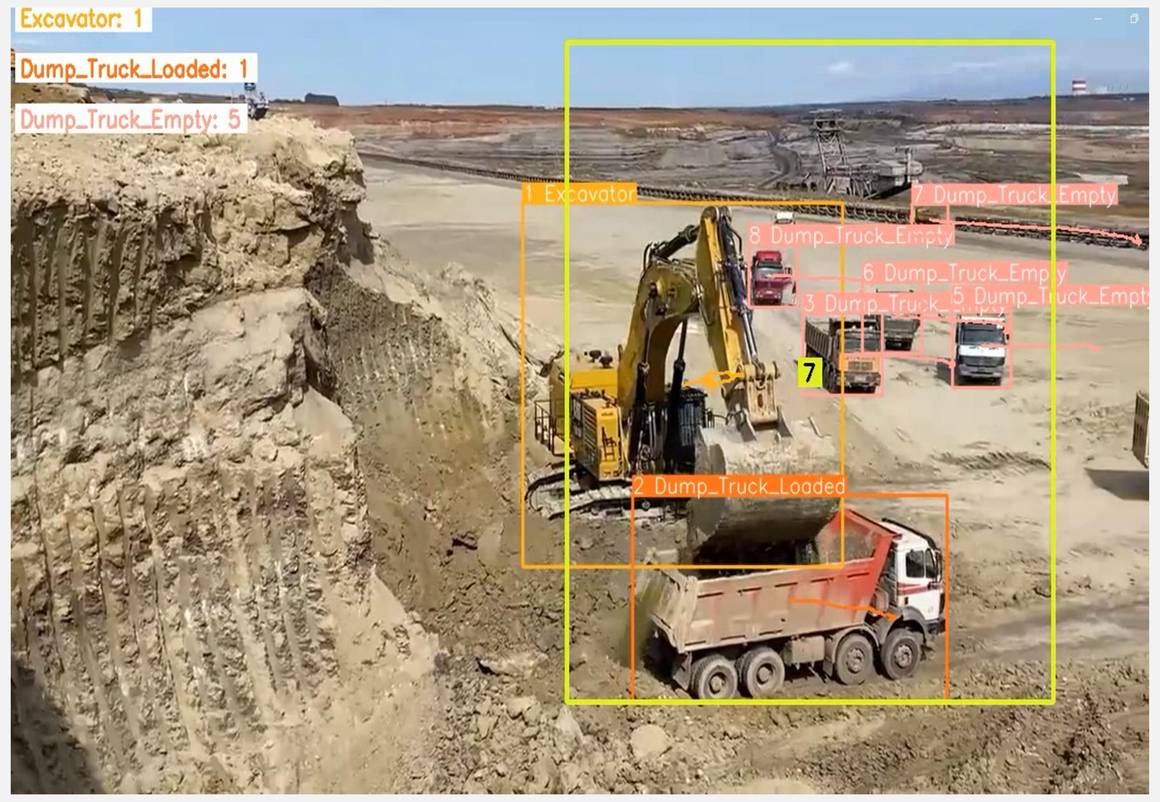
Introduction

Construction sites are inherently dynamic and complex, posing numerous safety risks and efficiency challenges. Traditional monitoring methods, primarily manual and error-prone, fail to ensure the safety and efficiency required. Our study proposes a cutting-edge solution using a fine-tuned **YOLO v8-based** computer vision model designed to accurately and efficiently detect and track construction vehicles like **Excavators, Cement trucks, Dump trucks, and Wheel loaders** in real-time, thereby enhancing safety protocols and operational workflows on construction sites.



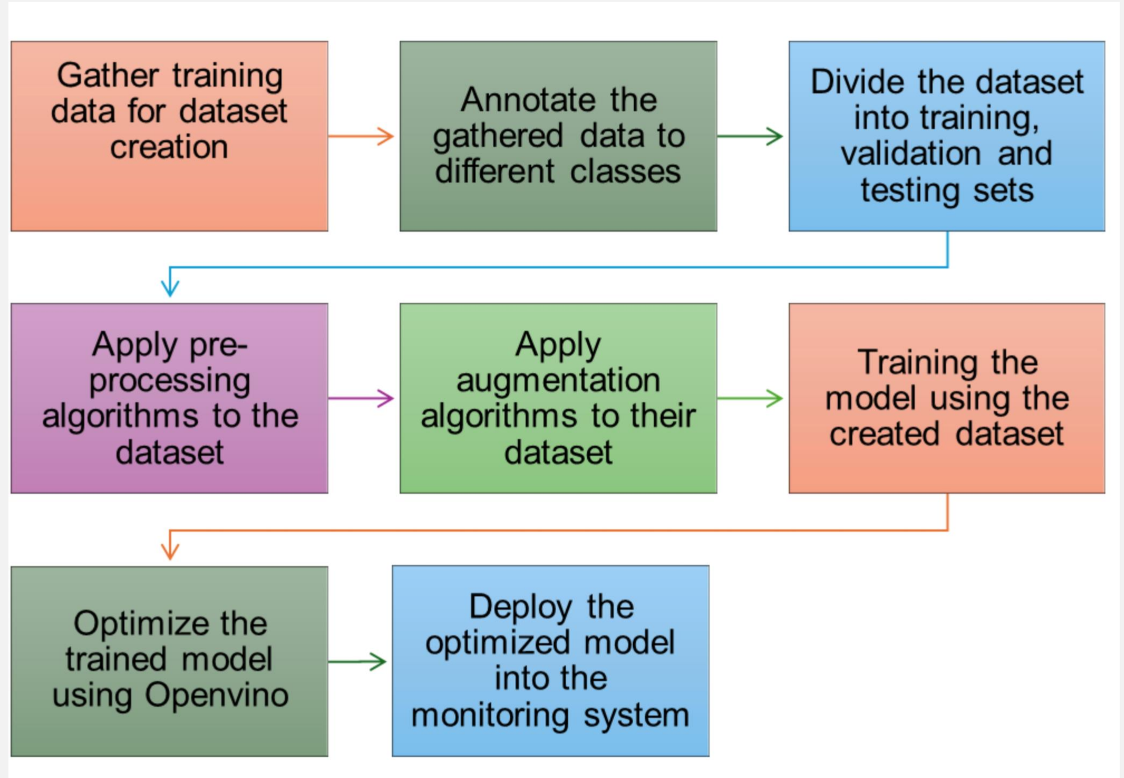
Why we choose Yolo v8s

- Real-Time Detection: YOLO v8s offers fast processing speeds crucial for the real-time detection of construction vehicles, a key requirement for monitoring dynamic construction sites.
- Efficiency on Low-Power Devices: YOLO v8s can perform well on low-power CPUs, deployable in various construction environments without the need for specialized computing resources.

Model	size (pixels)	mAP^{val} 50-95	Speed CPU ONNX	params (M)	FLOPs (B)
Yolov8 N	640	37.3	80.4	3.2	8.7
Yolov8 S	640	44.9	128.4	11.2	28.6
Yolov8 M	640	50.2	234.7	25.9	78.9
Yolov8 L	640	52.9	375.2	43.7	165.2
Yolov8 X	640	53.9	479.1	68.2	257.8

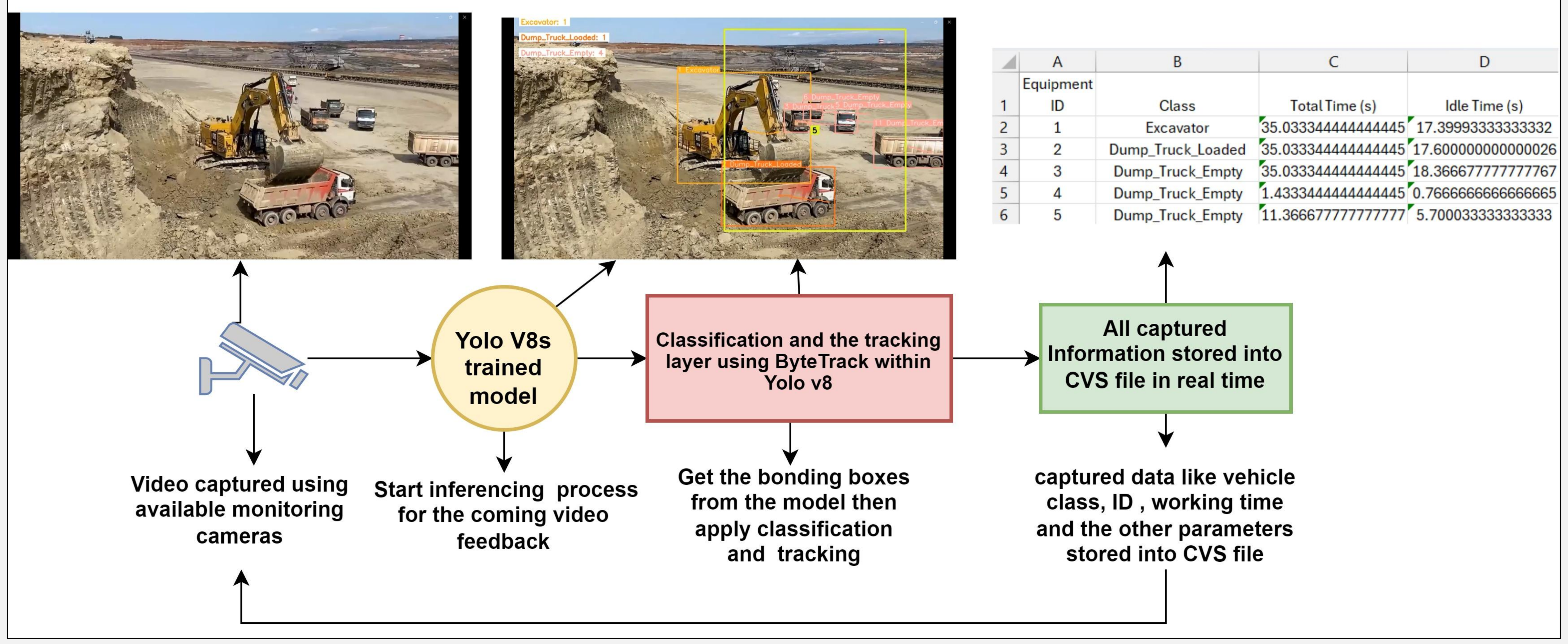
The methodology

We have trained our model by creating a new training dataset consisting of **5470 images** annotated for different construction equipment then applied different augmentation and optimization processes to expand our dataset by **300%** using the following steps:

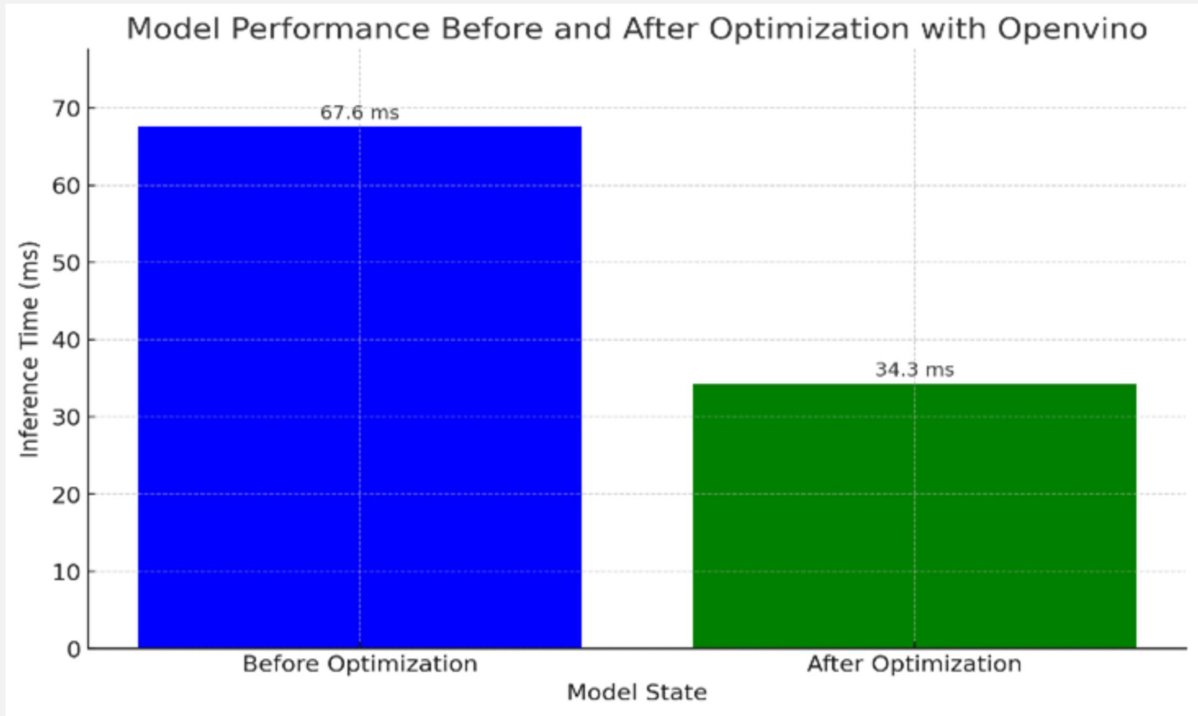


Monitoring and tracking system

Construction equipment monitoring system stages



Openvino Optimization



We optimized our model using Openvino by Intel Which enabled us to increase the performance of our model by **97% while maintaining an average of 94.3% mAP across all classes**. Openvino boosted the model's processing speed and efficiency, enabling real-time detection of construction vehicles on low-power CPUs without compromising accuracy. This optimization ensures the model can be deployed effectively in diverse construction site environments, making advanced monitoring technology more accessible and practical for enhancing site safety and operational efficiency.

Conclusion

Our research shows the potential of using computer vision models to enhance the efficiency and safety of construction sites offering a highly effective solution to one of the main challenges of the construction industry and enabling the deployment of this solution to any construction site with a minimum cost of setup and with the highest accuracy and inferencing performance possible.

Future Research

We would work on expanding our training dataset to include 100 classes with more than 100,000 images which will include construction machinery, workers, tools, structural elements, and construction quality issues like cracks to expand our system monitoring and tracking capabilities to be used as a complete solution for automatic tracking construction sites and create real-time digital twins of any construction site.