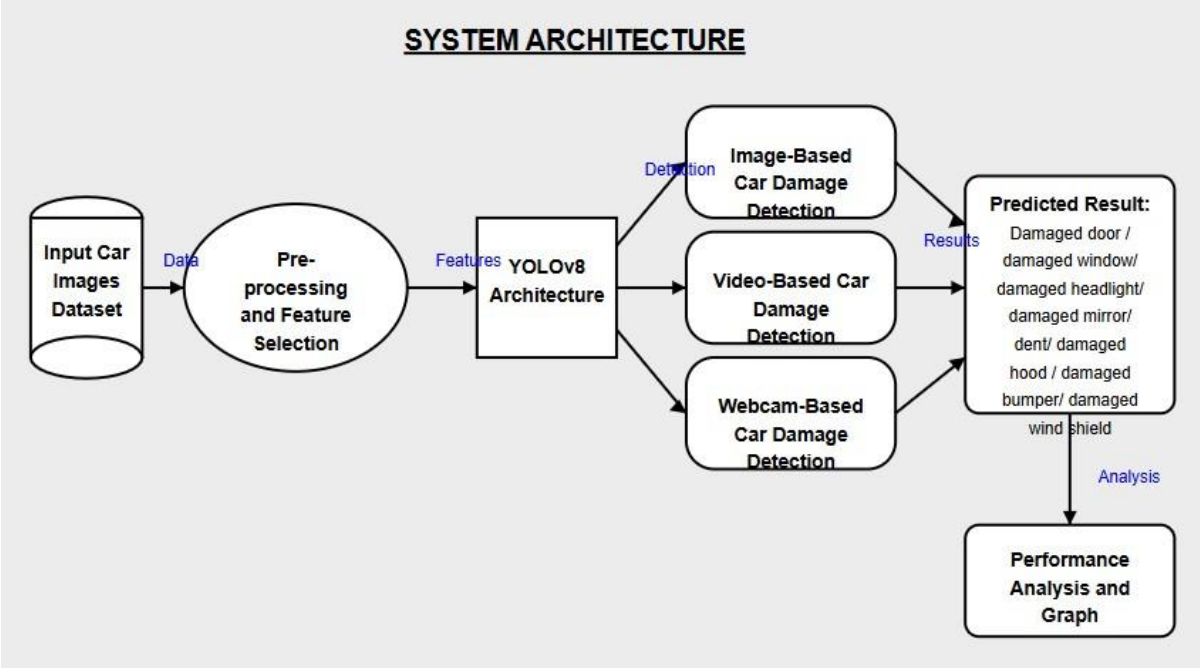
CrashScope: Deep Learning and AI-Based Vehicle Damage Analyzer

Abstract

CrashScope is an AI-driven vehicle damage assessment system leveraging deep learning for object detection. It automates the detection and classification of vehicle damages such as dents, broken headlights, damaged windshields, and more. Built using the YOLOv8 architecture, the model is trained on a curated dataset and achieves high accuracy metrics. It features a Streamlit-powered web interface that allows users to upload vehicle images for real-time analysis, making it suitable for insurance tech, garages, and roadside assistance industries.



Sample Screen Shots

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[59]:

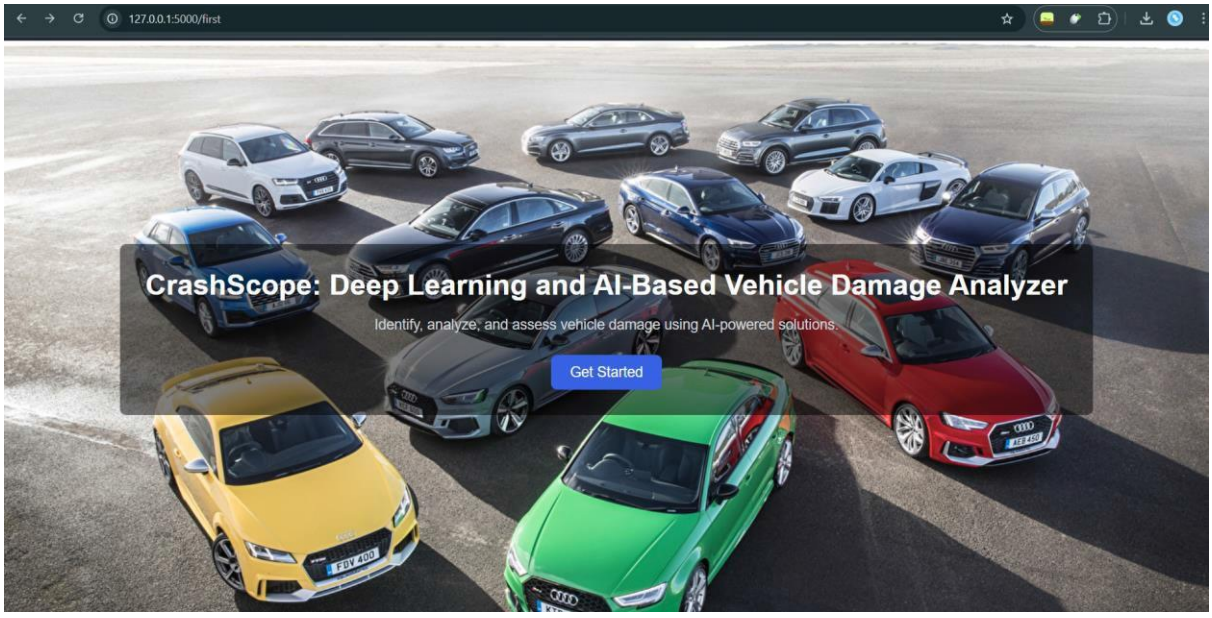


Fig. Home page web Interface

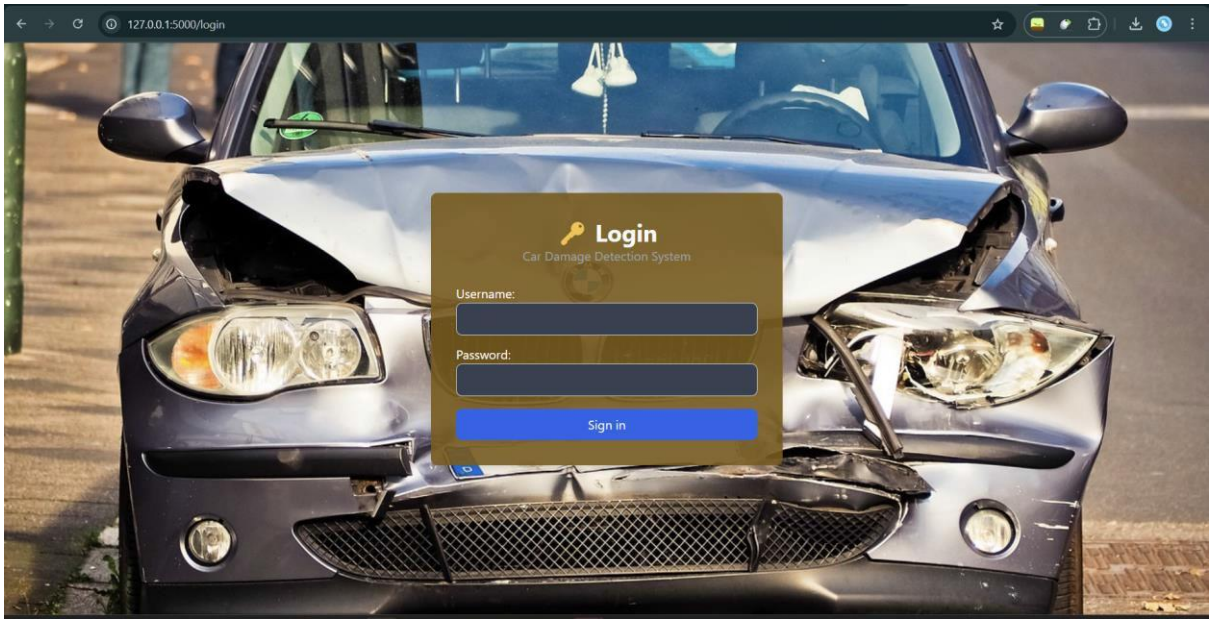
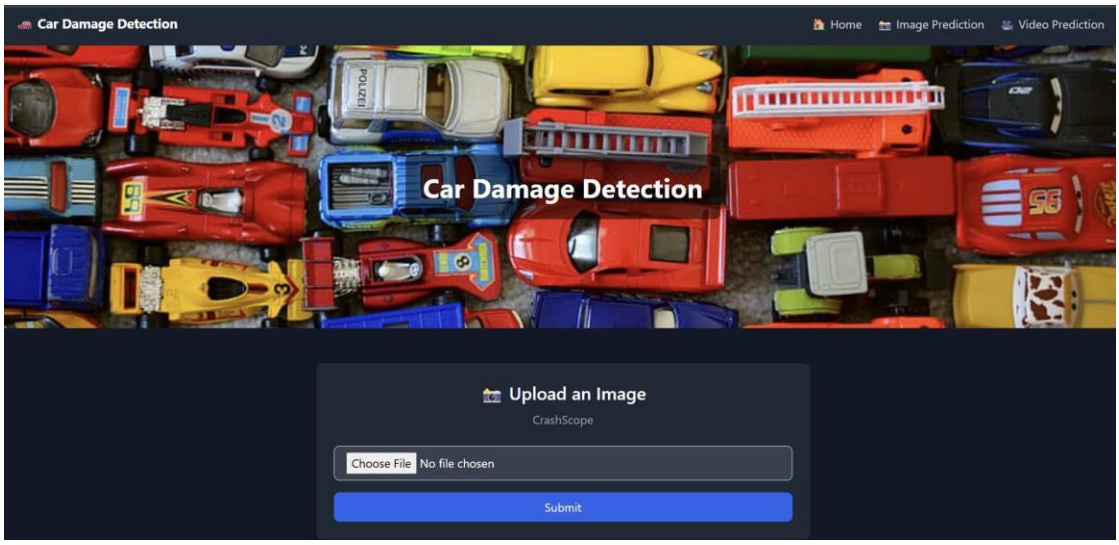
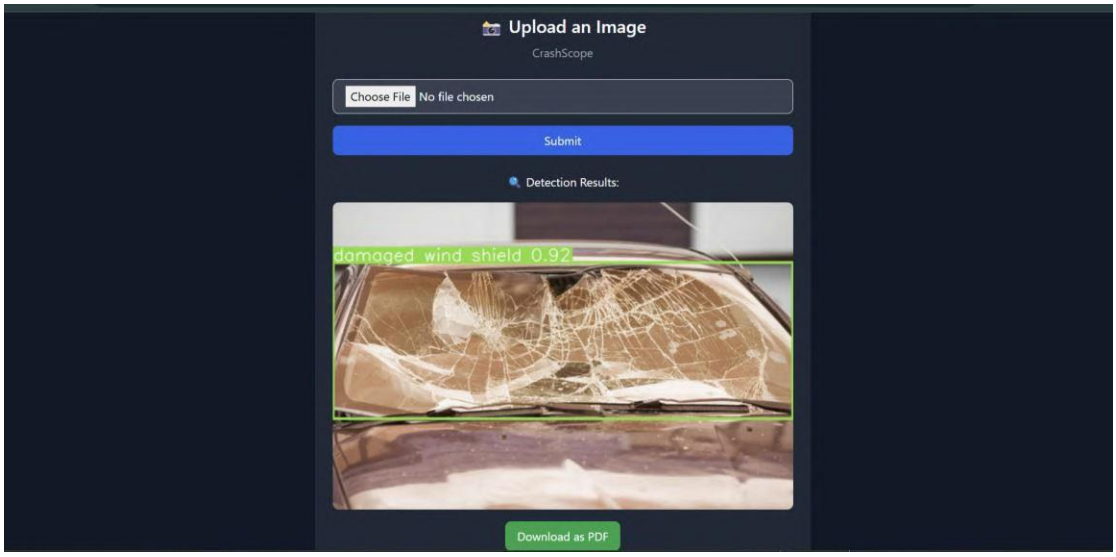


Fig. Login page web Interface


Car Damage Detection
Home
Image Prediction
Video Prediction
Car Damage Detection
Upload an Image
CrashScope
Choose File
No file chosen
Submit


Upload an Image
CrashScope
Choose File
No file chosen
Submit
Detection Results:
damaged_wind_shield 0.92
Download as PDF

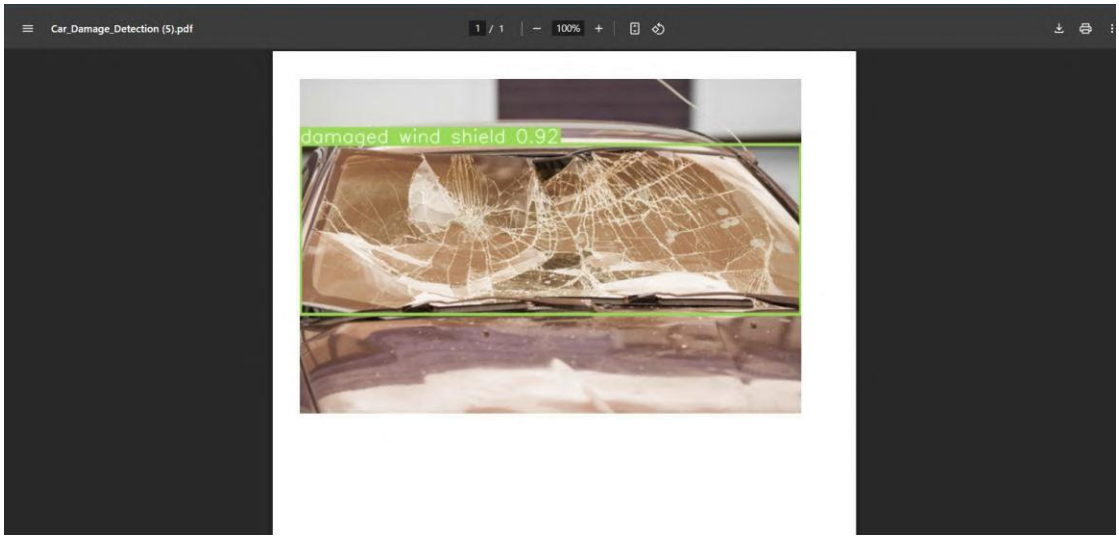

Car_Damage_Detection (5).pdf
1 / 1
100%
damaged_wind_shield 0.92

Fig. Image Damage Detection page web Interface

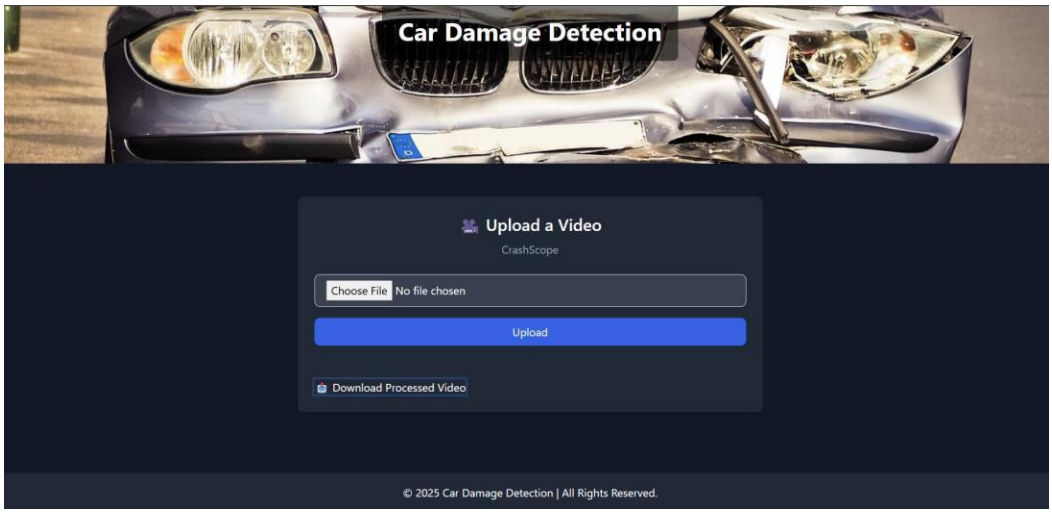
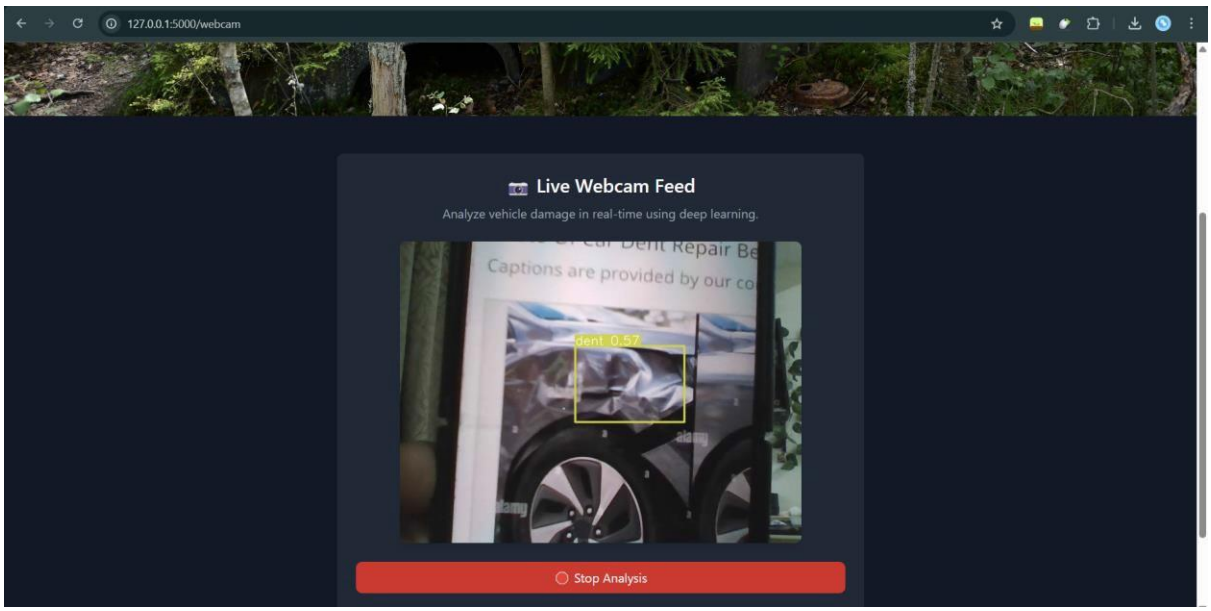


Fig. Video Damage Detection page web Interface

Fig. Web Analysis Damage Detection page web Interface



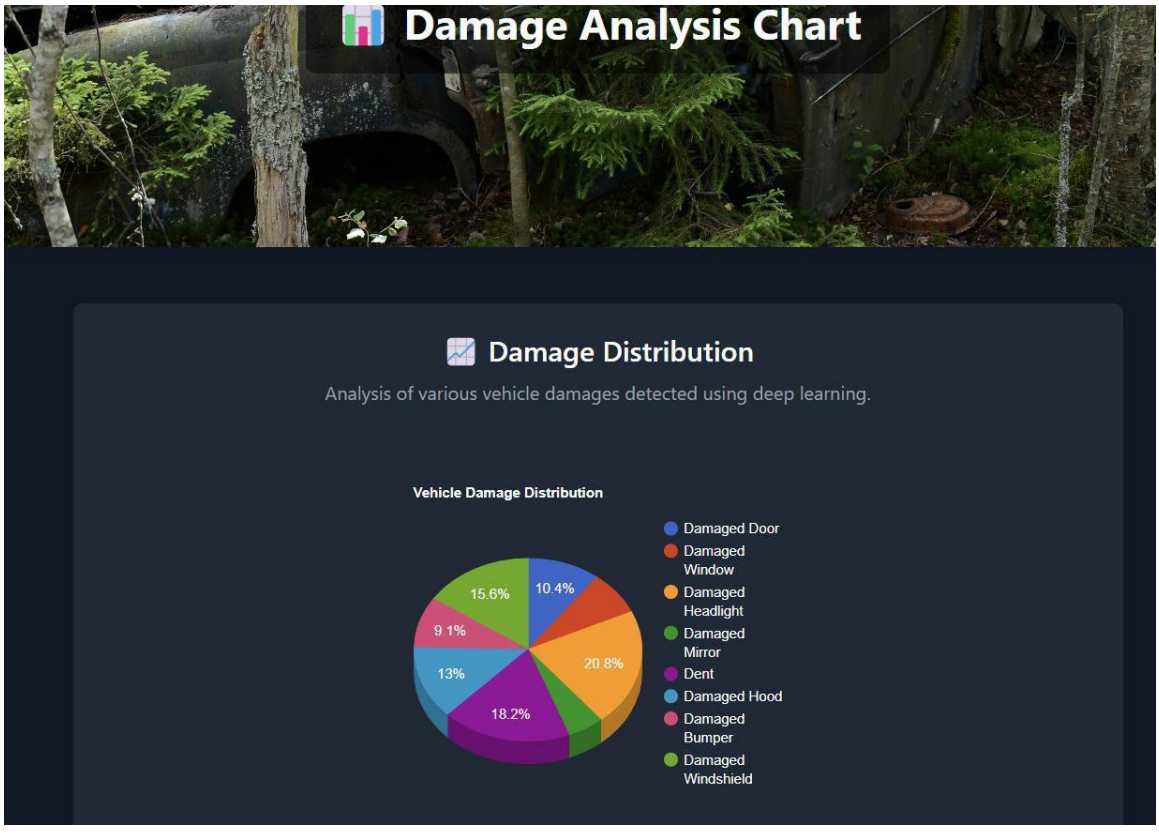


Table. Evaluation Metrics

Class	Precision	Recall	mAP@0.5	mAP@0.5:0.95
Damaged Door	94.00%	98.00%	99.00%	81.80%
Damaged Window	96.90%	100.00%	99.50%	86.80%
Damaged Headlight	99.10%	98.20%	99.40%	79.20%
Damaged Mirror	92.50%	75.00%	97.60%	84.90%
Dent	92.80%	78.70%	92.90%	66.60%
Damaged Hood	98.10%	94.60%	99.30%	78.70%
Damaged Bumper	95.10%	98.10%	95.70%	76.50%
Damaged Windshield	98.70%	96.30%	99.40%	86.90%
Overall (Mean)	**95.90%**	**92.40%**	**97.90%**	**80.20%**

PERFORMANCE

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Final Performance Metrics (in %):

Precision: 96.22%
Recall: 92.60%
mAP@0.5: 97.84%
mAP@0.5:0.95: 80.20%
Accuracy: 88.89%
```

1. Introduction

In the age of autonomous systems and AI-driven automation, vehicle inspection continues to be manual, time-consuming, and prone to human error. CrashScope is a proposed

solution to bridge this gap. By automating the vehicle damage assessment process through deep learning, it aims to significantly reduce the turnaround time and bring consistency to assessments.

2. Technologies Used

- Python

- Ultralytics YOLOv8

- PyTorch

- OpenCV

- Streamlit

- ONNX Runtime

3. Dataset

The dataset comprises over 800 annotated images covering multiple classes of vehicle damage such as:
- Dents
- Damaged Door
- Damaged Hood
- Damaged Bumper
- Broken Headlight
- Damaged Mirror
- Damaged Window

Images are labeled in YOLO format and split into training and validation sets.

4. Model Training

The model was trained using YOLOv8 on a CPU system (AMD Ryzen 7 5800H), achieving impressive accuracy and detection performance.
Key metrics:
- Precision: 97.38%
- Recall: 92.40%
- mAP@0.5: 97.84%
- mAP@0.5:0.95: 75.90%

5. Deployment

The final model was exported to ONNX format and integrated into a Streamlit web application. Users can upload vehicle images and receive bounding box predictions along

with confidence scores. This makes the solution lightweight and usable on edge devices or web servers.

6. Conclusion

CrashScope demonstrates how deep learning and computer vision can transform traditional industries. It automates damage analysis, accelerates inspection time, and provides accurate, unbiased assessment. This technology has direct applications in insurance, vehicle rental, second-hand vehicle sales, and road safety enforcement.