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Car Damage Detection Using YOLOv11 for Automated Vehicle Assessment

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Abstract: *Manual vehicle damage assessment is slow, subjective, and error-prone—creating inefficiencies in sectors like automobile insurance and fleet management. This paper presents an automated car damage detection system using the YOLOv11 (You Only Look Once version 11) deep learning algorithm to identify and classify visible vehicle damage. The system is divided into three stages: image acquisition, damage detection, and interpretation. Using a web-based interface, users upload vehicle images, which are processed using YOLOv11 to localize and categorize damages like scratches, dents, cracks, and shattered glass. Severity levels are also determined and displayed via a real-time dashboard. The model demonstrates high accuracy and speed, making it suitable for real-world applications such as insurance claim processing and automated inspection systems.*

Keywords: YOLOv11, Car Damage Detection, Deep Learning, Vehicle Assessment, Real-time Object Detection, Insurance Automation

I. INTRODUCTION

Manual inspection of vehicle damage is resource-intensive and often inconsistent. Errors in assessment can delay claims, increase costs, and reduce service quality. With the advancement in computer vision and AI, there is an opportunity to automate this process for greater efficiency and accuracy. YOLO (You Only Look Once) has emerged as a leading object detection algorithm for real-time applications. This work leverages YOLOv11 to identify different types of vehicle damage from images and classify their severity levels to assist industries in insurance, maintenance, and fleet management.

II. LITERATURE REVIEW

Multiple studies have applied AI for traffic monitoring and accident prediction. Adewopo and Elsayed (2024) introduced ensemble deep learning for accident detection. Tamagusko et al. (2022) used synthetic images and transfer learning to improve detection under data scarcity. Zhou et al. (2021) proposed unsupervised traffic warning systems. However, few models focus on the detailed classification and assessment of vehicle damage. This study aims to bridge that gap using advanced object detection techniques.

III. PROPOSED METHODOLOGY

3.1 System Architecture

The system operates in three main phases:

1. Image Acquisition – Users upload car images via a web interface.
2. Damage Detection – YOLOv11 processes the image and marks areas of damage with bounding boxes.
3. Result Interpretation – Detected damage is categorized by type and severity, and results are displayed in a report.

3.2 Damage Classification

Damages are categorized as:

- Scratch
- Dent
- Crack
- Shattered Glass

Each type is further classified into:

- Minor
- Moderate
- Severe

Classification is based on dimensions, shape, and intensity of the detected area.

3.3 Alert Generation

Post-classification, alerts are generated including damage details, type, and severity. These can be viewed on-screen and optionally sent via email or SMS.

IV. IMPLEMENTATION DETAILS

4.1 Technologies Used

- Programming Language: Python
- Libraries: OpenCV, TensorFlow, Keras
- Framework: PyCharm IDE
- Database: MySQL
- Deployment: Web-based with cloud and edge compatibility

4.2 Modules

1. Image Acquisition Module
2. Damage Detection Module (YOLOv11)
3. Damage Classification Module
4. Alert Generation Modul
5. User Interface and Report Module

V. EXPERIMENTAL RESULTS

The model was tested on a custom dataset with labeled car images.

- Detection Accuracy: 91.3%
- False Positives: 4.7%
- Average Processing Time: 0.3 seconds/image
- Severity Classification Accuracy: 89.2%
  The system effectively identified multiple damage types in varied lighting and background conditions. Reports were generated in real-time with detailed annotations and severity labels.

VI. CONCLUSION AND FUTURE WORK

The proposed system offers an efficient, real-time solution for car damage assessment using YOLOv11. It reduces human dependency, enhances accuracy, and provides detailed reporting. Future enhancements may include video-based assessment, multilingual interfaces, and mobile integration. Expanding the training dataset and using graph neural networks could further improve classification and real-world adaptability.

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