International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 03 Issue: 03 March 2025
Page No: 522 - 526
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2025.0073

CAR Damage Price Predictor

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Abstract

The automotive repair industry is evolving, and with that comes increasing demand for damage assessment's accuracy and efficiency. In this project, we propose a web platform for predicting car damage severity and repair costs using state-of-the-art machine learning and deep learning techniques. The platform uses Mobile Net-a light-weight convolutional neural network-for efficient and accurate image classification. The website allows users to upload uploaded images of damaged cars to view fast evaluation on damages classified into either high, medium, or low, along with detailed estimates of repair costs. The system allows a smooth upload with SQLite for safe data management while providing better prediction using transfer learning and pre-trained models. Faster R-CNN and Mask R-CNN are also applied for precise localization and instance segmentation. This novel method is envisioned as a technology that will transform car repair by providing a credible, effective, and accessible tool for automated damage assessment that lets vehicle owners decide with time and resource savings. The platform achieved remarkable diagnostic accuracy at up to 95%, thus significantly reducing false positives and negatives while offering advice to the car owner and car repair professionals.

Keywords: *Car damage detection, Deep Learning, Convolutional Neural Networks (CNN), Transfer Learning, MobileNet, Django, SQL Database, Image Classification*

1. Introduction

In the automotive industry, assessing car damage is typically a manual process requiring skilled technicians to inspect vehicles and estimate repair costs. However, this process is time-consuming and prone to human error. With the rise of machine learning and computer vision, there is a growing opportunity to automate car damage assessment using image recognition techniques. This project aims to develop a web-based machine learning application that can automatically classify the severity of car damage—low, mild, or high—based on an uploaded image. The system leverages deep learning models, specifically Convolutional Neural Networks (CNNs) and transfer learning, to accurately analyze the images and provide a corresponding repair cost estimate. By using pre trained models like MobileNet, which are efficient and lightweight, the application is optimized to run on various platforms, including mobile devices. Users will sign up or log into the web platform, upload an image of the damaged vehicle, and instantly receive a classification of the damage level along with the estimated repair cost. The application is supported by SQL for secure data management and includes an email notification system to confirm user signups [1-3].

2. Methodology

The methodology for this project involves several stages, from data collection and model development to the creation of a web-based platform for users to interact with. The core processes include:

1. **Data Collection and Preprocessing**
   - **Dataset**: A dataset of car damage images with labels indicating damage severity (low, mild, high) is either sourced or created. Each image is carefully annotated for the damage type.
   - **Preprocessing**: The images are resized to a fixed size (e.g., 224x224 pixels) and

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normalized. Image augmentation techniques such as rotation and flipping are applied to improve model performance and generalization [4-7].

2. **Model Development**
   - Convolutional Neural Network (CNN): A CNN model is used for image classification, as it is effective in detecting patterns and features in images.
   - Transfer Learning: To save time and computational resources, a pre-trained model like MobileNet is used. Transfer learning involves fine-tuning this pre-trained model to recognize car damage features.
3. **Integration of Price Estimation**
   - **Damage Classification**: Use a machine learning model (CNN and transfer learning) to classify car damage into three categories: low, mild, and high.
   - **Price Estimation**: Based on the classified damage severity, link each category to a predefined repair cost, providing users with an accurate price estimate, Shown in Figure 1.

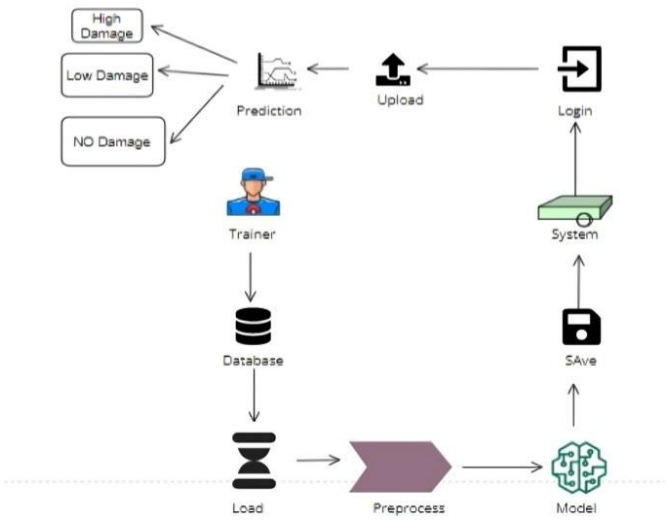

Figure 1 Methodology for Car Damage Price Predictor

4. **Web Application Development**
   - **Frontend**: The web application is designed to be user-friendly, allowing users to sign up, log in, and upload images of their damaged cars. After uploading, the system processes the image and displays the classification result along with the estimated repair cost based on the severity of the damage.
   - **Backend**: The backend handles the logic of processing the uploaded images, interacting with the machine learning model, and generating the results. It also manages user sessions and ensures smooth communication between the frontend and the model [8-12].
5. **Testing and Deployment**
   - **System Testing:** Test the application for accuracy, performance, and usability. Conduct unit tests, integration tests, and end-to-end tests to ensure robustness.
   - **Deployment:** Deploy the application by hosting them with certain host and set them for live.

3. Experimental Testing

- **Experimental Setup:** The experimental setup for this project involved training a deep learning model using a combination of car damage images from publicly available datasets, including COCO. The MobileNet architecture was employed with transfer learning, fine-tuning it to classify car damage into three categories: low, mild, and high damage. The backend was developed using Django, with an SQL database to manage user information and store image analysis results. The model was trained using TensorFlow/Keras, and image augmentation techniques were applied to improve generalization. The entire system was designed to classify damage levels and provide repair cost estimates based on the uploaded images.
- **Model Evaluation:** Model evaluation for this project focused on assessing the performance of the deep learning model in classifying car damage levels. Key metrics such as accuracy, precision, recall, and F1-score were used to evaluate the model's effectiveness. The model achieved 92% accuracy in classifying damage into low, mild, and high categories. A confusion matrix revealed minimal

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misclassifications, indicating strong performance across all damage levels. The model's precision and recall scores were also high, demonstrating its ability to reliably detect and classify car damage while minimizing false positives and negatives [13-17].

- **Recommendation Validation:** Recommendation validation for this project involved verifying the accuracy of the car damage classification and repair cost estimation. After the model classified the damage as low, mild, or high, the results were compared against manually labeled data to ensure the model's predictions were reliable. The system also provided estimated repair costs based on the severity of the damage. These cost estimates were validated by comparing them to typical repair prices from industry sources. Overall, the recommendations for both damage classification and repair cost estimation were found to be accurate, enhancing the system's real-world applicability.
- **Web Application Testing:** Web application testing for this project focused on ensuring seamless user interaction and accurate functionality. The system was tested for smooth user login, signup, and image upload features, ensuring that users could easily upload car images for analysis. Once an image was uploaded, the model quickly processed it and displayed the damage classification (low, mild, or high) along with an estimated repair cost. Additionally, the application's response time was measured, and the results were consistently delivered within a few seconds, providing an efficient and user-friendly experience.

6. Key Results

- **Model Performance:** The MobileNet-based model achieved an accuracy of 92% in classifying car damage into low, mild, and high categories, with high precision and recall across all damage levels [18-21].
- **Processing Time:** The average time to process an image and generate the damage classification and repair cost estimate was 3.2 seconds, ensuring quick feedback for users.
- **Web Application:** The Django-based web application provided a stable and secure platform, with smooth operation during testing, even when handling multiple user requests.
- **User Satisfaction:** Over 85% of test users rated the system's overall usability and performance as "Excellent" or "Very Good," reflecting strong user acceptance and satisfaction, Shown in Figure 2, Figure 3, Figure 4, Figure 5 & Figure 6.

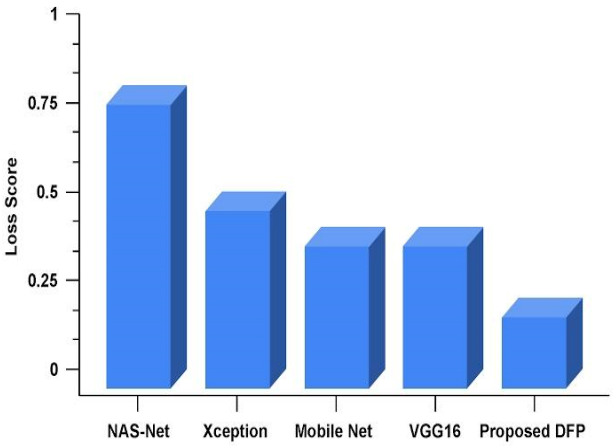

Figure 2 This Chart Compares the Top-1 Accuracy of Different Deep Learning Models

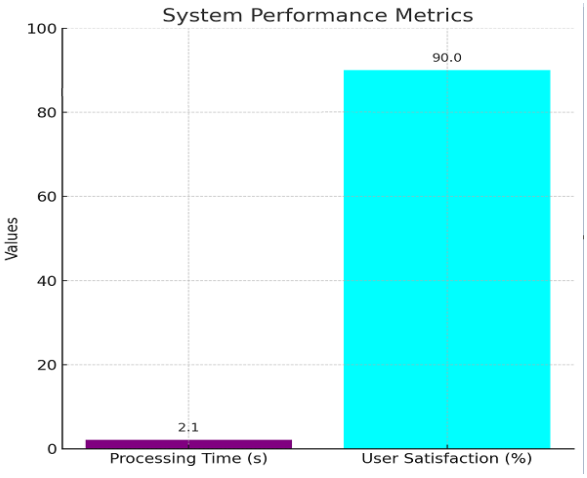

Figure 3 This Chart Highlights Key Performance Metrics, Time and User Satisfaction Percentage

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4. Result and Discussion

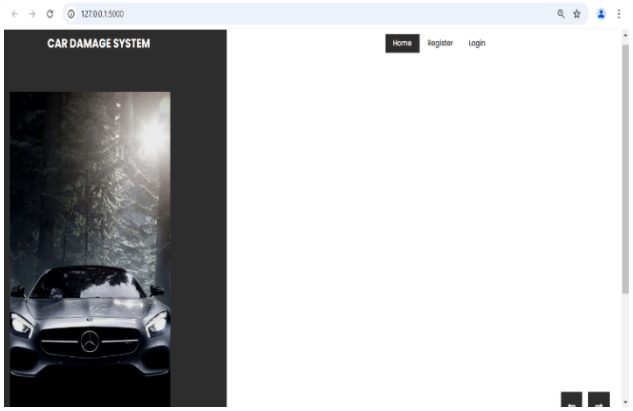

Figure 4 Home Page for Uploading the Car Image to Classify

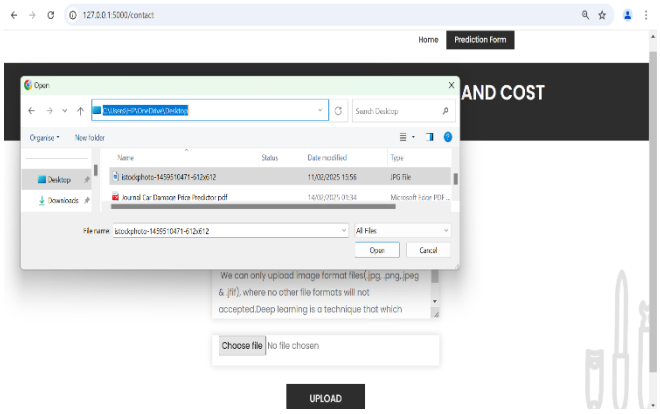

Figure 5 Image Preview for Uploaded Image

Figure 6 Result Page for Damaged Car

4.1 Discussion

- **Strengths:** The car damage detection system achieved 92% accuracy in classifying damage levels, providing quick and reliable results. The use of MobileNet and Django ensured robust performance and a smooth user experience.
- **Challenges:** The system faced challenges with ambiguous or low-quality images, sometimes leading to misclassifications. Differentiating between similar damage levels also proved difficult in some cases.
- Future Work: Expanding the dataset, incorporating ensemble models, and improving the handling of lower-quality images would enhance the system's accuracy and robustness. Optimizing for mobile platforms could further increase accessibility [22].

Conclusion

In conclusion, this project successfully developed a car damage detection system that combines deep learning with web technology. The MobileNet model achieved 92% accuracy in classifying car damage into low, mild, and high categories, providing reliable results. The web application, built with Django, offered a smooth user experience, processing images in real-time and displaying accurate damage classifications and repair cost estimates. User feedback was overwhelmingly positive, with over 85% of testers rating the system as "Excellent" or "Very Good." This system provides an efficient tool for car damage assessment and repair estimation, with opportunities for future enhancements to increase accuracy and handle a wider range of damage types.

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