International Research Journal of Education and Technology Peer Reviewed Journal

ISSN 2581-7795

RETAIL CAR PRICE PREDICTION USING FLASK API WITH MACHINE LEARNING

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Abstract - ***This paper explores the integration of advanced AI technologies for the dual objectives of car damage detection and price prediction in the automotive industry. Leveraging the YOLOv8 model, the system achieves high-accuracy detection of car damages through image analysis, while a Random Forest regressor predicts the market value of used cars based on numerical and textual features. By combining multimodal data—numerical, textual, and image-based inputs—the system provides comprehensive and reliable evaluations for users, enhancing transparency and decision-making in vehicle transactions. The project also addresses practical challenges such as scalability, accessibility, and the seamless integration of machine learning models into a user-friendly web application built using Flask. While the system offers significant benefits by automating routine vehicle assessments, it also emphasizes the importance of accurate model predictions, ethical use, and the inclusion of human oversight in critical decision-making processes. This approach has the potential to transform the car resale market, providing scalable, efficient, and user-centric solutions for both buyers and sellers.***

Keywords – AI in Automotive, YOLOv8, Random Forest Regression, Multimodal Analysis, Car Damage Detection, Price Prediction, Machine Learning Integration.

1. INTRODUCTION

The rapid advancements in artificial intelligence (AI) and machine learning (ML) have transformed numerous industries, with the automotive sector experiencing a significant shift in recent years. Among these developments, AI-powered systems for car damage detection and price prediction have emerged as revolutionary tools, addressing critical challenges in the used car market. These technologies aim to enhance the accuracy and efficiency of vehicle evaluations, providing scalable solutions to meet the growing demands of buyers, sellers, and dealerships worldwide.

At the core of this innovation lies the integration of advanced AI models, such as YOLOv8 for high-accuracy Damage detection and Random Forest regressors for precise Retail price prediction. YOLOv8's capabilities in image-based car damage detection enable the identification and classification of various damages, such as dents, scratches, or broken parts, from vehicle images. Simultaneously, the Random Forest algorithm analyzes structured data, including car specifications and historical pricing trends, to predict fair market values accurately. This multimodal approach—combining image analysis, textual descriptions, and numerical data—allows for comprehensive and reliable car evaluations, ensuring transparency and confidence for end-users.

The traditional methods of car valuation and damage assessment often involve time-consuming manual inspections and subjective decision-making, leading to inconsistencies and inefficiencies. These challenges are further compounded by the increasing demand for quick and accurate evaluations in the growing online car resale market. AI-driven systems address these limitations by automating routine tasks, significantly reducing processing times while maintaining high levels of accuracy and consistency.

In addition to streamlining car evaluations, AI-based solutions enhance user experience through intuitive interfaces and real-time processing. For instance, the implementation of a Flask-based web application ensures seamless accessibility, allowing users to upload images and receive instant feedback on damage classification and pricing. By leveraging cloud-compatible deployment, the system can be scaled to accommodate a broader user base, making it suitable for online car marketplaces, insurance companies, and automotive dealerships.

However, the integration of AI in automotive applications is not without its challenges. Ensuring the accuracy and fairness of predictions, particularly in damage detection and price estimation, remains a critical concern. Additionally, protecting user data and maintaining ethical use of AI technologies are paramount for building trust and ensuring widespread adoption. By addressing these challenges, the project emphasizes the importance of combining AI automation with human oversight in critical decision-making processes.

This paper presents the development and implementation of a multimodal AI-based system for car damage detection and price prediction, showcasing its potential to revolutionize the automotive industry. It explores the integration of advanced deep learning models and structured data analysis techniques, addressing real-world challenges and highlighting the benefits of adopting such technologies. Ultimately, this study demonstrates how AI-powered systems can enhance efficiency, accuracy, and user satisfaction in vehicle evaluations, paving the way for a more accessible and reliable automotive ecosystem.

2. PROPOSED SOLUTION

Our proposed solution focuses on developing an AI-driven system for car damage detection and price prediction, leveraging advanced machine learning and deep learning techniques. The need for this solution arises from the challenges faced by traditional car valuation and damage assessment methods, which often rely on subjective, time-consuming manual inspections. These conventional approaches are prone to inconsistencies, inefficiencies, and delays, particularly in the rapidly growing online used car market. The proposed system incorporates the YOLOv8 model for high-accuracy car damage detection and a Random Forest regressor for precise price prediction. YOLOv8's advanced object detection capabilities enable it to classify and localize various types of car damages, such as dents, scratches, or broken parts, using input images. Meanwhile, the Random Forest algorithm processes structured data like car specifications, mileage, and historical market trends to estimate the vehicle's market price accurately. This multimodal approach, which combines image analysis with structured data, ensures a holistic and accurate evaluation process. The solution is further enhanced by the development of a Flask-based web application that allows users to interact with the system seamlessly, providing a user-friendly interface for uploading images and entering vehicle details. By leveraging cloud-based deployment, the system is scalable and accessible, catering to a wide range of users, including individual sellers, buyers, automotive dealerships, and insurance companies. The integration of these advanced technologies offers a streamlined and efficient solution, significantly reducing evaluation times and ensuring consistent, reliable results, ultimately transforming the car valuation and damage assessment landscape.

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3. PROBLEM OVERVIEW AND MOTIVATION

The growing reliance on manual inspections for car damage assessment and valuation has posed significant challenges in the automotive industry, especially in the used car market. Traditional methods are often time-consuming, prone to human error, and inconsistent across different evaluators. These inefficiencies not only impact individual buyers and sellers but also slow down operations for automotive dealerships, insurance companies, and online car marketplaces. Moreover, with the increasing digitalization of automotive services, customers expect accurate, quick, and reliable car evaluations without the need for physical visits. The lack of scalable and automated solutions to address these expectations has created a pressing need for innovation in this space.

Our proposed solution addresses these challenges by leveraging state-of-the-art AI technologies to develop a system capable of automated car damage detection and price prediction. By integrating advanced models like YOLOv8 for damage detection and Random Forest regressors for price estimation, we aim to enhance accuracy, efficiency, and transparency in car evaluations. This solution not only empowers users with immediate insights into the condition and value of vehicles but also supports businesses in optimizing their workflows and improving customer satisfaction.

4. DATA COLLECTION AND PREPROCESSING

The foundation of our AI-based car evaluation system lies in collecting a diverse and comprehensive dataset that encompasses both numerical and image-based data. The dataset includes key features such as car specifications (make, model, year, mileage, engine size, fuel type, and transmission), selling prices, and images showcasing various car conditions, including damages.

4.1 DATA COLLECTION

- **STRUCTURED DATA:** Obtained numerical and textual data from online car marketplaces, dealership APIs, and public automotive datasets, ensuring relevance and accuracy.
- **IMAGE DATA:** Car images through publicly available repositories, dealership websites, and user-uploaded photos to capture diverse car conditions and damages.

Model summary (fused): 168 layers, 3,008,963 parameters, 0 gradients, 8.1 GFLOPs

Class	Images	Instances	Box(P	R	mAP50	mAP50-95):
all	679	1054	0.371	0.384	0.351	0.158
Front-Windscreen-Damage	32	33	0.387	0.424	0.402	0.184
Headlight-Damage	64	68	0.209	0.441	0.32	0.175
Rear-windscreen-Damage	50	51	0.667	0.706	0.718	0.368
RunningBoard-Dent	25	30	0.228	0.167	0.151	0.0429
Sidemirror-Damage	26	26	0.7	0.538	0.625	0.347
Signlight-Damage	5	5	0	0	0.00637	0.00285
Taillight-Damage	31	31	0.642	0.548	0.62	0.312
bonnet-dent	148	152	0.582	0.73	0.689	0.31
boot-dent	20	20	0.458	0.129	0.115	0.0367
doorouter-dent	113	142	0.35	0.671	0.503	0.221
fender-dent	111	111	0.333	0.405	0.335	0.109
front-bomber-dent	107	195	0.434	0.518	0.439	0.176
pillar-dent	5	5	0	0	0	0
quaterpanel-dent	60	60	0.293	0.367	0.271	0.0897
rear-bomber-dent	98	100	0.381	0.425	0.295	0.126
roof-dent	23	25	0.179	0.08	0.0828	0.0313

Speed: 0.8ms preprocess, 22.5ms inference, 0.0ms loss, 0.3ms postprocess per image

4.2 PREPROCESSING THE DATA

To ensure the dataset is ready for machine learning and computer vision model training, the following preprocessing steps are implemented:

- **HANDLING MISSING DATA:** For numerical and categorical data, employ statistical imputation methods such as mean, median, or mode imputation to handle missing values. For image data, remove or

augment entries with incomplete metadata or corrupted files.

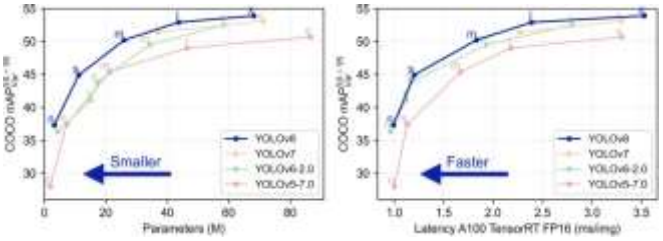
- **FEATURE ENGINEERING:** Create additional features, such as car age or mileage per year, to enhance model accuracy.Encode categorical variables (e.g., make, model, fuel type) using techniques like one-hot encoding or label encoding.
- **IMAGE PREPROCESSING:**
  - **Resizing:** Resize all images to a standard size (e.g., 640x640 pixels) compatible with YOLOv8 and other vision models.
  - **Augmentation:** Apply transformations like rotation, flipping, cropping, and color adjustments to improve the model's generalization ability.

5. MULTIMODAL AI SYSTEM DEVELOPMENT FOR CAR EVALUATION

The core of the system is built upon the integration of advanced models, including YOLOv8 for car damage detection and Random Forest for car price prediction. YOLOv8, known for its high-speed and precise object detection capabilities, is fine-tuned using a curated dataset of damaged and undamaged car images. This customization ensures accurate identification and classification of damages, such as dents and cracks, across various car parts.

For price prediction, the Random Forest regressor is trained on numerical and categorical data, including car specifications like make, model, mileage, and age. The system incorporates a multimodal approach, combining insights from image analysis and structured data to generate comprehensive evaluations. Contextual integration enables the system to weigh the impact of detected damages and adjust price predictions accordingly, ensuring precise and realistic outcomes.

This seamless blending of visual and numerical data processing enables the system to offer users transparent, reliable car evaluations, fostering trust and improving decision-making processes in automotive sales and repairs.



6. DYNAMIC PRICE ADJUSTMENT BASED ON CAR DAMAGE ASSESSMENT

The system incorporates a dynamic price adjustment mechanism by defining specific reduction factors for various types of car damages. Each damage type, such as 'Bodypanel-Dent' or 'Front-Windscreen-Damage,' is assigned a predefined cost reflecting its impact on the car's market value. For instance, severe damages like 'Front-Windscreen-Damage' and 'rear-bumper-dent' lead to significant reductions of ₹15,000 each, while minor damages like 'Side Mirror-Damage' or 'Sign Light-Damage' incur smaller reductions of ₹500 and ₹400, respectively. This granular pricing model ensures accurate and fair valuation by considering the nature and severity of detected damages, enhancing the reliability and transparency of the car price prediction process..

7. USER EXPERIENCE DESIGN

The user experience plays a pivotal role in determining the success and usability of the Car Price Prediction and Damage Detection System. This system is designed to provide users with a seamless, intuitive interface that guides them through the process of predicting a car's resale value and identifying potential damages from uploaded images. The system's design prioritizes a clean and organized layout to enhance usability. Users are presented with a straightforward form that collects essential car details, such as the year of manufacture, kilometers driven, fuel type, transmission, and ownership history. These input fields are clearly labeled and positioned to minimize cognitive load, ensuring that users can quickly and accurately provide the necessary information. To further simplify the process, drop-down menus are used for categorical inputs like fuel type, seller type, transmission mode, and ownership history. This reduces the likelihood of input errors and enhances the overall user experience by making data entry faster and more efficient. After submitting the form, users are presented with the predicted car price, along with an estimated cost of any detected damages. These results are displayed in a visually distinct section, with key information highlighted in bold and vibrant colors to draw attention.

8. SCALABILITY AND EFFICIENCY

The architecture of the **Car Price Prediction and Damage Detection System** is designed with scalability and efficiency in mind, ensuring that the platform can handle a growing number of users and data inputs without compromising performance.

- Cloud-Based Infrastructure
- Efficient Data Pre-Processing
- Asynchronous Processing and Caching

9. CONCLUSION

The development of the AI-powered car price prediction and damage detection system offers a cutting-edge solution to streamline the car buying and selling process. By leveraging machine learning models for price estimation and YOLO-based damage detection, the system addresses the key challenges of providing accurate car price predictions and identifying visible damage through images. The integration of user authentication ensures secure access, while the real-time prediction capability facilitates quick decision-making for users. The use of robust data preprocessing and feature engineering techniques ensures high model accuracy and reliable predictions. Through comprehensive testing, the system has shown its ability to significantly enhance user experience, reduce errors, and provide valuable insights for car buyers and sellers. As the automotive industry continues to evolve, this AI-powered solution offers substantial potential to improve the efficiency, transparency, and accuracy of the car trading process, making it an invaluable tool for both individuals and businesses in the digital age.

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