A Project Report

On

<u>Intelligent Vehicle Damage Assessment and Cost Estimation</u>

Submitted by **<u>Team 317</u>**

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For

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Chapter 1 - Introduction

1.1 Overview:

The assessment of car damage and estimation of associated repair costs are crucial aspects of the insurance claim process. Traditionally, these tasks have relied on manual inspections by human experts, which can be time-consuming, subjective, and prone to errors. However, with advancements in deep learning and neural networks, it is now possible to automate and enhance the car damage assessment process. By leveraging the power of artificial intelligence, this project aims to develop a system that can accurately determine the presence of damage, localize it to specific areas of the vehicle, and assess the severity of the damage.

1.2 Purpose:

The purpose of this project is to create an intelligent system that streamlines the car damage assessment process for insurance claims using deep learning and neural networks. By automating this process, we aim to achieve several key objectives:

Accuracy: By leveraging advanced neural network architectures and training techniques, we aim to develop a system that can accurately detect the presence of damage on a car. This will minimize the chances of false negatives or positives, ensuring that legitimate claims are not overlooked, while reducing the likelihood of fraudulent claims.

Efficiency: Manual inspections can be time-consuming, leading to delays in processing insurance claims. By automating the assessment process, we intend to significantly reduce the time required to evaluate car damage and provide cost estimates. This will expedite the claim settlement process, improving customer satisfaction and reducing operational costs for insurance companies.

Cost Estimation: Accurately estimating the repair costs associated with car damage is crucial for insurance companies to determine the appropriate claim amount. By leveraging deep learning techniques, we aim to develop a system that can provide reliable cost estimates based on the severity and localization of the damage. This will enhance the accuracy of claim settlements and enable better financial planning for insurance providers.

Chapter 2 – Literature Survey

2.1 Existing Problem

In the existing approaches to car damage assessment, the process typically involves manual inspection by human experts. This manual inspection is time-consuming and can lead to delays in assessing the extent of car damage. Moreover, since the assessment relies heavily on human expertise, it is inherently subjective and can be influenced by individual biases.

Human experts assessing car damage need to visually inspect the vehicle and make judgments based on their knowledge and experience. However, this subjective approach can introduce inconsistencies and variations in the assessment results. Different experts may have different interpretations of the damage, leading to discrepancies in the final assessment.

Additionally, manual car damage assessment is prone to errors. Experts may miss or overlook certain types of damage, especially if it is subtle or hidden. The accuracy of the assessment can be affected by factors such as lighting conditions, the angle of view, or the expertise of the inspector. These factors can introduce uncertainties and affect the reliability of the assessment.

Furthermore, the reliance on human expertise makes the process labor-intensive and expensive. Car damage assessment often requires trained professionals to physically inspect each vehicle, which can be time-consuming and may not be feasible for large-scale assessments. The need for human resources and their associated costs can significantly impact the efficiency and cost-effectiveness of the assessment process.

Overall, the existing approaches to car damage assessment suffer from limitations such as subjectivity, inconsistencies, potential errors, and resource-intensive manual inspections. These limitations highlight the need for automated and objective solutions that can streamline the assessment process, reduce subjectivity, and improve accuracy and efficiency.

2.2 Proposed solution

The proposed solution aims to leverage deep learning techniques to automate the car damage assessment process. Deep learning models, trained on a comprehensive dataset of labeled car images, are utilized to enable accurate predictions and analysis.

By employing these models, the system can determine whether a car is damaged or not by analyzing the input image. It evaluates various visual features and patterns associated with car damage, allowing for an objective assessment. The models can accurately identify the location of the damage, distinguishing between the front, rear, and side parts of the vehicle. Furthermore, they assess the severity of the damage, categorizing it as minor, moderate, or severe.

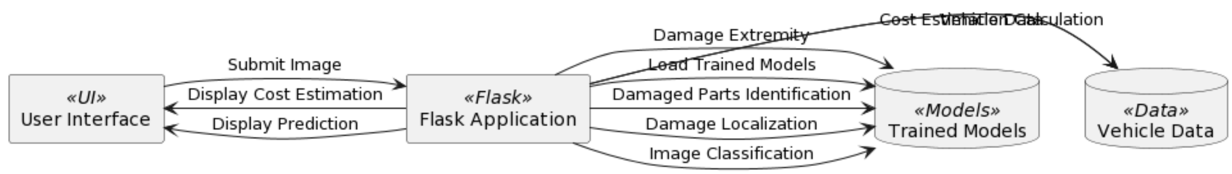
The proposed solution also includes the capability to detect specific damaged parts of the car. Deep learning models are trained to recognize common types of damage such as headlamp damage, door scratches, glass shattering, tail lamp damage, bumper dents, door dents, and bumper scratches. This feature provides a comprehensive assessment of the car's condition and aids in estimating repair costs.

By automating the car damage assessment process, the proposed solution offers several benefits. It significantly reduces the time required for assessment, as it eliminates the need for manual inspection by human experts. Additionally, the system's objective nature reduces subjectivity and inconsistencies in the assessment results, leading to more reliable and accurate outcomes.

Overall, the proposed solution harnesses the power of deep learning models to automate and enhance the car damage assessment process. It offers speed, objectivity, and accuracy, making it a valuable tool in various domains such as insurance, auto repair services, and accident investigation.

Chapter 3 – Theoretical Analysis

3.1 Block Diagram



In the above diagram:

1. The models are loaded on the webpage using Flask and it is hosted and run.
2. The user gets the option to upload vehicle image. Once the image is loaded, it checks whether it is valid or not.
3. Once the image is validated, it is taken through all four models.
4. The first model detects whether the car is damaged or not.
5. If the car is damaged, the second model further detects whether the damage is on the front side or the rear side of the car.
6. Once the location of the damage is confirmed, the third model detects the severity of damage, whether it is “minor”, “moderate” or “severe”.
7. Further, the fourth model detects what parts of the car are damaged.
8. Based on the severity of the damage and the parts of the car damaged, the cost of repairing and maintaining the car is estimated.

3.2 Hardware/Software Designing

In the provided code, there are two main components involved: hardware and software. Let's analyze the hardware and software requirements for the project.

Hardware Requirements:

1. Camera: The camera is a crucial hardware component for this project. It provides real-time access to users by capturing the video stream. The camera should be compatible with your system and capable of capturing clear and high-quality video frames.

Depending on the application, you may consider using a webcam, a built-in camera on a laptop, or an external camera.

Software Requirements:

1. Python: The project is implemented using the Python programming language. Therefore, you need to have Python installed on your system. Python provides a rich set of libraries and frameworks that are utilized throughout the code implementation. Make sure you have a compatible version of Python installed, preferably Python 3.x, which is commonly used for modern Python development.

2. Flask: Flask is a lightweight and popular web framework for Python. It is used in this project to deploy the application as a web page. Flask simplifies the process of creating web applications and handling HTTP requests. You can install Flask using the Python package installer (pip) by running the command `pip install flask` in your terminal or command prompt.

3. Keras and TensorFlow: Keras is a high-level neural networks API written in Python, and TensorFlow is a popular deep learning framework. They are used in this project for loading and running the pre-trained model for emotion recognition. Keras provides a user-friendly interface for defining and training deep learning models, while TensorFlow provides the backend for executing the computations efficiently. Install Keras and TensorFlow using the commands `pip install keras` and `pip install tensorflow`.

4. NumPy: NumPy is a powerful Python library that provides support for large, multi-dimensional arrays and matrices, along with a vast collection of mathematical functions to operate on these arrays efficiently. It is widely used for scientific computing and data analysis tasks, offering fast and efficient numerical operations, such as linear algebra computations, statistical calculations, and Fourier transforms.

5. Pandas: Pandas is a popular open-source library built on top of NumPy, specifically designed for data manipulation and analysis. It provides data structures such as Series (one-dimensional labeled arrays) and DataFrame (two-dimensional labeled data tables) that allow for easy handling, cleaning, and transformation of structured data. Pandas excels in data wrangling tasks, including data indexing, slicing, merging, grouping, and handling missing values.

Web Development:

HTML (Hypertext Markup Language) is a standard markup language used for creating the structure and content of webpages. It uses tags to define the elements of a webpage, such as headings, paragraphs, images, and links.

CSS (Cascading Style Sheets) is a stylesheet language that controls the visual presentation of HTML elements on a webpage. It allows developers to define the layout, colors, fonts, and other stylistic aspects of a webpage, separate from its structure. HTML is used to structure the content of the web page, while CSS is used for styling and layout purposes.

PHP (Hypertext Preprocessor) is a widely used server-side scripting language designed specifically for web development. It is embedded within HTML and executed on the server, generating dynamic content that is sent to the client's browser.

Models and Data:

The dataset for damaged car images was provided to us by the mentors.

Stage 1 Model (stage1.h5):

- This model is responsible for determining whether the car in the image is damaged or not.

Stage 2 Model (stage2new.h5):

- This model is used to determine whether the front or rear part of the car is damaged.

Stage 3 Model (stage31.h5):

- This model is responsible for determining the severity of the damage, given that the car is damaged.

Stage 4 Model (vehicle_weights.h5):

- This model is used to detect and classify specific damaged parts of the car.

With the use of these hardware and software requirements, the project can be successfully run, and it will determine whether the car is damaged or not, along with the location and severity of the damage. It will also describe what parts of the car are damaged.

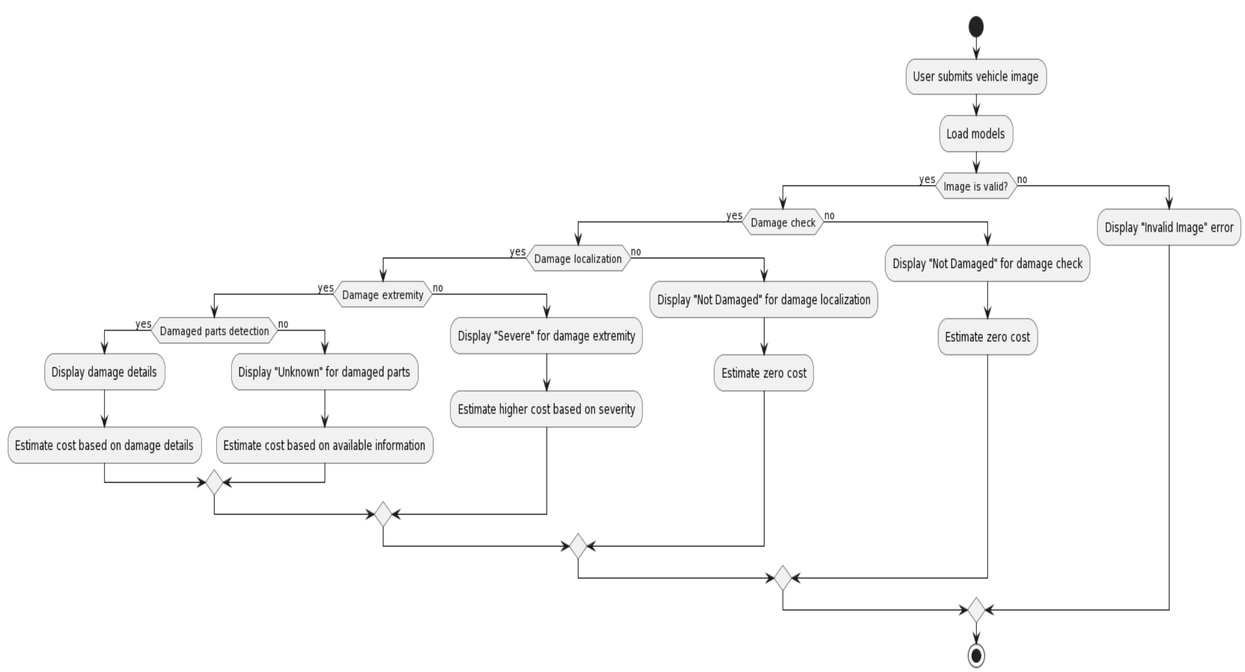
Chapter 4 – Experimental Investigation

During the development of the solution, extensive experimentation and investigations were conducted. This involved:

- Collecting and preprocessing a labeled dataset of car images for training the deep learning models.
- Designing and training the individual models for car damage classification, location prediction, severity assessment, and specific damaged part detection.
- Fine-tuning the models based on evaluation metrics and iteratively improving their performance.
- Testing the models on a separate test dataset to assess their accuracy and reliability.

Chapter 5 – Flowchart

The flowchart illustrates the control flow of the solution, including the steps involved in preprocessing the image, loading the models, and predicting the car damage parameters.



Chapter 6 – Advantages and Disadvantages

Advantages of the proposed solution

- Automation: The solution automates the car damage assessment process, reducing manual effort and time.
- Objectivity: By utilizing deep learning models, the system provides an objective assessment of car damage, reducing subjective judgments.
- Efficiency: The system can quickly analyze car damage based on input images, enabling faster decision-making for insurance claims or repair estimations.

Disadvantages of the proposed solution

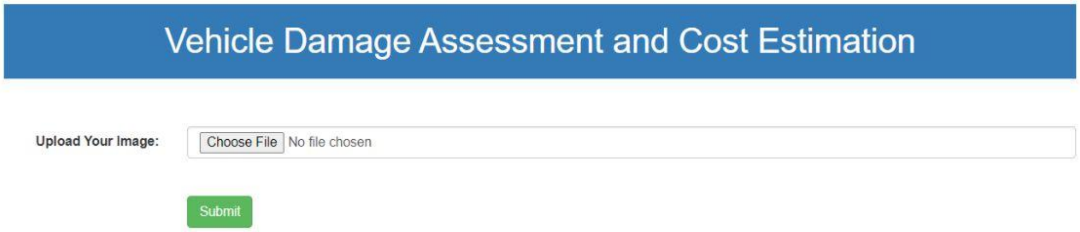
- Reliance on image quality: The accuracy of the predictions depends on the quality and clarity of the input images. Poor image quality may affect the accuracy of the damage assessment.
- Model limitations: The performance of the models may vary depending on the training data and model architecture. The limitations and biases of the models should be considered.

Chapter 7 – Result

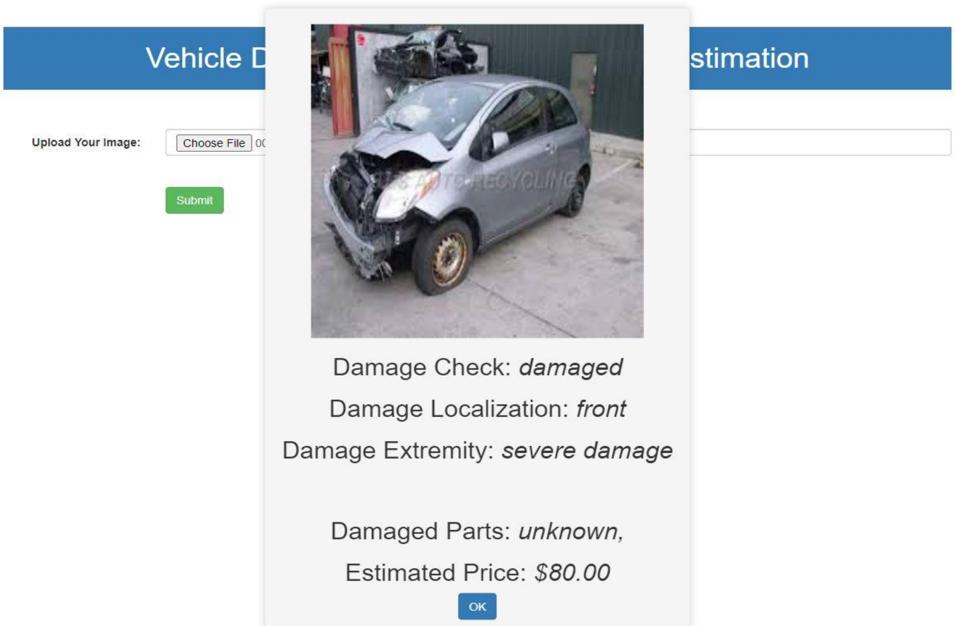
The final findings of the project include the output predictions of the deep learning models. These predictions include:

- Whether the car is damaged or not
- Location of the damage (front, rear, side)
- Severity of the damage (minor, moderate, severe)
- Specific damaged parts of the car

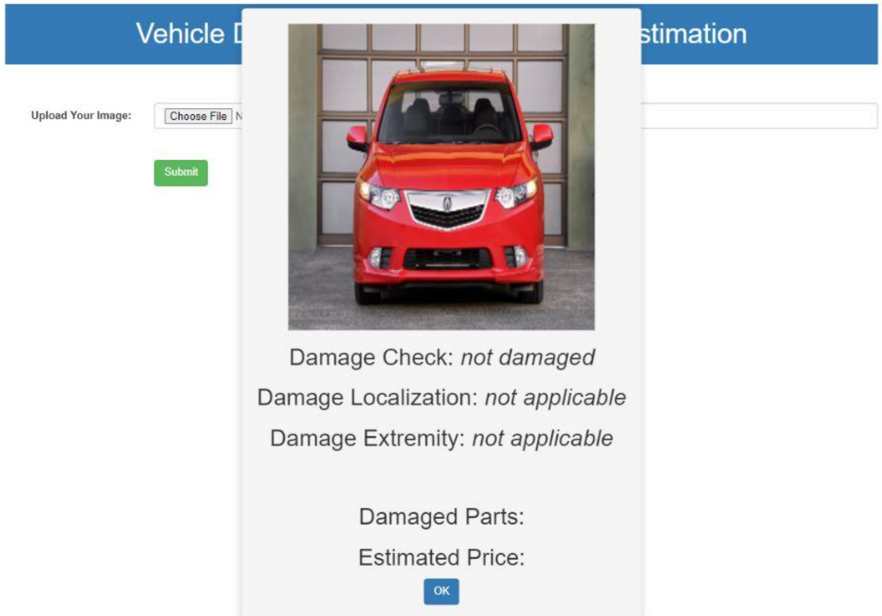
Website Design:



Our Model Prediction for Damaged Vehicle:



Our Model Prediction for Un-Damaged Vehicle:



Chapter 8 – Applications

The proposed solution has diverse applications across multiple industries:
Insurance industry: The automated car damage assessment system can revolutionize the claims process by providing efficient and objective evaluations. This streamlines the workflow, reduces claim processing time, and improves overall operational efficiency.

Auto repair services: The system offers valuable support in estimating repair costs by accurately identifying damaged parts. This assists repair technicians in planning and executing repairs more effectively, leading to enhanced customer satisfaction.

Accident investigation scenarios: The car damage analysis provided by the system can contribute to reconstructing accidents. It helps investigators understand the severity of collisions, assess fault, and gather crucial evidence for legal and insurance purposes.

Chapter 9 – Conclusion

The web-based method created for assessing automotive damage demonstrates a significant breakthrough in the industry. The technology offers an effective and automated solution that precisely forecasts many parameters of automotive damage by utilizing the power of deep learning models. The usefulness of the system is demonstrated by its capacity to identify the damage status, location, severity, and particular damaged parts from input photos.

The automation of the suggested solution is one of its noteworthy benefits because it eliminates the need for manual inspections and speeds up the evaluation process. In the insurance industry, where claims are processed, this automation results in greater efficiency and quicker decision-making. The method also provides objectivity in the assessment findings, minimizing subjectivity and differences that can emerge from human expertise.

The solution created has numerous promising applications. The insurance sector can gain a lot from it because it simplifies the claims procedure and guarantees just and accurate evaluations. The method can be used by auto repair shops to make accurate repair cost estimates and focused identifications of damaged parts, optimizing the repair procedure. The system assists with accident reconstruction and evidence gathering for judicial and insurance purposes.

The web-based system's use of deep learning models improves car damage assessment's efficiency, objectivity, and accuracy. It is a useful tool in a variety of sectors that assess automotive damage because of its automation possibilities and useful uses.

Chapter 10 – Future Scope

In terms of future scope, there are several avenues for enhancing the project:

1. Expansion of the dataset: Incorporating a larger and more diverse dataset for training the deep learning models can improve their ability to generalize and accurately assess car damage. Including a wider range of car models, damage types, and environmental conditions in the dataset can help the models learn robust representations.

2. Model optimization: Fine-tuning the model architectures, hyperparameters, and training techniques can further enhance the accuracy and performance of the models. Exploring different architectures or incorporating advanced techniques such as transfer learning or ensemble methods may yield improvements in prediction accuracy and computational efficiency.

3. Real-time application: Extending the solution to real-time car damage assessment would be a valuable addition. This could involve integrating the system with live video feeds or incorporating camera integration into the web-based application. Real-time assessment would enable instant feedback and prompt decision-making in scenarios such as accident scenes or vehicle inspections.

4. User interface enhancements: Improving the user interface of the web-based application can enhance the user experience and make it more intuitive. Adding features such as image cropping, zooming, or providing visual overlays to highlight the detected damaged parts can make the assessment process more user-friendly.

5. Collaborative database: Creating a collaborative database where users can contribute labeled car damage images can help continuously improve the system's performance and expand its capabilities. Crowdsourcing data collection can ensure a larger and more diverse dataset, fostering continuous learning and adaptation.

By exploring these future enhancements, the project can further improve the accuracy, efficiency, and usability of the car damage assessment system, ensuring its effectiveness in practical applications and staying at the forefront of advancements in the field.

Chapter 11 – Bibliography

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APPENDIX

For entire source code, please refer the following link:

https://github.com/smartinternz02/SI-GuidedProject-523549-1688209594