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Automotive Customization for Car Body Modification and Torque Efficiency Optimization in Web Platform

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Abstract: Automotive customization is rapidly evolving with the integration of digital platforms that enable personalized vehicle design and performance optimization. This project presents a web-based platform for car body modification and torque efficiency optimization, allowing users to virtually customize vehicle exteriors while simultaneously analyzing performance impacts. The system enables users to modify body components such as bumpers, spoilers, hoods, and panels, and evaluates their influence on aerodynamics, weight distribution, and torque utilization. Torque efficiency optimization is achieved by correlating vehicle mass, drivetrain parameters, and aerodynamic drag to recommend design configurations that improve power transmission and fuel efficiency. The web platform combines an interactive user interface with simulation-based analytical models to provide real-time feedback on design choices. This approach bridges the gap between aesthetic customization and mechanical performance, supporting informed decision-making for designers, automotive enthusiasts, and small-scale manufacturers. The proposed solution reduces trial-and-error costs, shortens design cycles, and promotes performance-aware customization. Overall, the platform demonstrates how digital tools can enhance vehicle personalization while maintaining or improving torque efficiency and overall driving performance.

I. INTRODUCTION

A. Background Information of the Study

The automotive industry has experienced rapid technological advancement in recent years, especially in the areas of vehicle customization and performance optimization. Car enthusiasts, designers, and manufacturers increasingly seek ways to personalize vehicles while maintaining or improving their performance. Traditionally, vehicle modification requires physical prototyping, which is expensive, time-consuming, and often involves multiple trial-and-error iterations.

With the development of web technologies and simulation tools, digital platforms now enable users to visualize and test modifications virtually before implementing them in real life. Automotive customization platforms allow users to modify car components such as bumpers, spoilers, hoods, wheels, and body panels. However, most existing customization tools focus primarily on aesthetics and do not consider how these modifications affect vehicle performance.

One critical factor in vehicle performance is torque efficiency, which determines how effectively engine power is transmitted to the wheels. Torque efficiency is influenced by several parameters including vehicle weight, aerodynamics, drivetrain configuration, and resistance forces. Improper modifications can negatively impact these factors, leading to reduced performance and fuel efficiency.

II. METHODOLOGY

This project proposes a web-based automotive customization platform that allows users to modify vehicle body parts while simultaneously analyzing the impact on torque efficiency. The platform integrates visual customization with performance analytics, enabling users to make informed design decisions. By combining aesthetic customization with mechanical analysis, the system aims to reduce design costs, improve vehicle performance awareness, and provide an efficient tool for automotive enthusiasts and designers.

The proposed system is developed using a web-based architecture that integrates vehicle customization tools with performance analysis models. The methodology consists of several stages.

First, the user interface is designed to allow users to select and modify different car body components such as bumpers, spoilers, hoods, and panels. The interface provides an interactive environment where users can visualize the customized vehicle design.

Next, a database of vehicle parameters is created, including base vehicle specifications such as mass, engine torque, drivetrain configuration, and aerodynamic characteristics.

When a user modifies a component, the system updates the vehicle parameters accordingly. For example, adding a spoiler may affect aerodynamic drag, while replacing body panels may change the overall weight.

The platform then applies analytical models to calculate torque efficiency based on parameters such as:

1) Vehicle mass
2) Aerodynamic drag coefficient
3) Engine torque
4) Gear ratio
5) Rolling resistance

These calculations estimate how efficiently torque from the engine is transferred to the wheels under different design configurations.

Finally, the system provides real-time feedback to the user, displaying performance metrics such as estimated torque efficiency, fuel consumption impact, and aerodynamic performance. Users can compare different configurations to identify optimal designs.

III. LITERATURE SURVEY

P. Soranansri et al. (2025), "Tribological Performance of AlCrN, TiAlN and Arc-DLC Coatings." This study compares the friction, wear, and adhesion characteristics of three major coating systems under dry and lubricated conditions. The authors demonstrate that AlCrN maintains stable friction behaviour across high temperatures, making it ideal for high-load automotive components. The paper also discusses surface film formation and adhesion mechanics. From this article we take temperature-dependent friction and wear data to incorporate into our performance-degradation and maintenance warning models.

R.P. Putra (2025), "Aerodynamic Approach to Two-Passenger City Car Design." This study provides validated CFD and wind-tunnel evaluation techniques for estimating drag coefficient, frontal area, and flow separation zones. The article discusses how aerodynamic shape optimization affects vehicle mileage and stability. From this article we take frontal area estimation methods and Cd approximation techniques to fill missing manufacturer data in our vehicle database.

ResearchGate (2025), "Car Recommender System using Collaborative Filtering and Ontology-based Conversational System." This article introduces a hybrid recommendation model that integrates ontology representation and collaborative filtering. It demonstrates improved user experience and accuracy by combining rule-based logic with ML-based personalization. From this article we take hybrid recommender design principles to strengthen our modification recommendation logic.

W. Cai et al. (2024), "An Inspiration Recommendation System for Automotive Design." This research explores a recommendation approach for automotive designers using behaviour-mining and clustering algorithms. It highlights the importance of personalization and inspiration-based design selection. From this article we take clustering logic and design-preference modelling for enhancing aesthetic-modification recommendations.

M. E. Soares et al. (2024), "Mechanical and Tribological Behaviour of AlCrN on NiP Deposits." The study emphasizes the effect of underlayer materials on coating behaviour. AlCrN on NiP shows improved adhesion and wear performance. This is relevant to multilayer systems commonly used in performance automotive parts. From this article we take multilayer durability characteristics and coating–substrate compatibility patterns for supporting-mod dependencies.

M.A.J. Selvam (2023), "Analyzing Downforce Generated by Rear Spoiler using CFD." This paper focuses on downforce variations with spoiler angle and shape. It quantifies lift reduction and slight increases in drag. Such aerodynamic insights are essential for safe high-speed driving. From this article we take angle-vs-downforce relationships to model stability effects in recommended aerodynamic upgrades.

H.T. Diep (2023), "Remapping and Simulation of EFI System using Piggyback ECU." This study demonstrates how ignition timing, fuel curves, and boost parameters influence performance after ECU retuning. The paper provides measured torque increases and efficiency changes. From this article we take ECU-tuning parameter effects to support horsepower and torque estimation calculations.

C. Bayındırlı (2023), "Numerical and Experimental Enhancement of Drag Using Vortex Generators." The paper demonstrates that small vortex generators can meaningfully reduce drag by controlling boundary-layer separation. From this article we take Cd-reduction values and methods for suggesting micro-aero additions in aerodynamic recommendations.

L. Zou et al. (2022), "Mechanical and Tribological Improvement of AlCrVN via Nb Alloying." This materials paper demonstrates how alloy additions improve hardness, wear resistance, and oxidation stability. From this article we take property improvement mechanisms used in discussing durability of coated automotive components.

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M.C. Chiu et al. (2021), "Developing a Personalized Recommendation System." This article explores personalization using NLP and hybrid recommendation strategies. It includes evaluation metrics such as precision and recall. From this article we take personalization strategies and evaluation methods to enhance the user profile module.
ResearchGate (2013–2016), "Aerodynamic Analysis of Rear Diffusers Using CFD." This series of studies evaluates diffuser geometry and its influence on drag and flow separation. From this article we take typical % improvements in Cd and pressure recovery to strengthen our diffuser-modelling logic.
P. Reategui (2019), "Recommender Systems for Variant Management in the Automotive Industry." his work demonstrates integration of rule-based and machine-learning systems for configuring automotive variants. It introduces modular component selection and compatibility checks. From this article we take configuration-mapping strategies and rule-based diagnostic methods for designing our modification rules engine.

IV. RESULTS AND DISCUSSIONS

The developed platform successfully demonstrates the integration of vehicle customization with torque efficiency analysis. Users are able to visually modify vehicle components and instantly observe how these changes influence performance metrics.
The system shows that certain modifications such as aerodynamic spoilers and lightweight body panels can improve torque efficiency by reducing drag and overall vehicle weight. Conversely, heavy decorative modifications may reduce efficiency by increasing resistance and power loss.

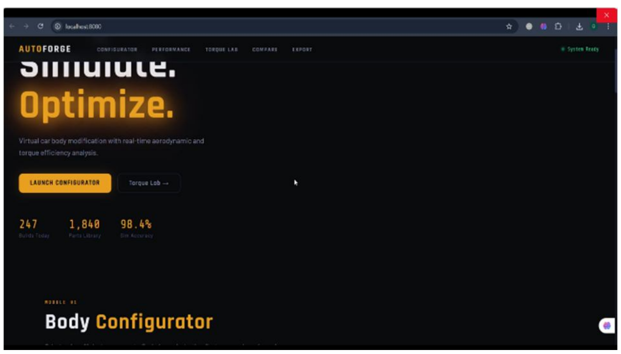

FIG 1 – Home page

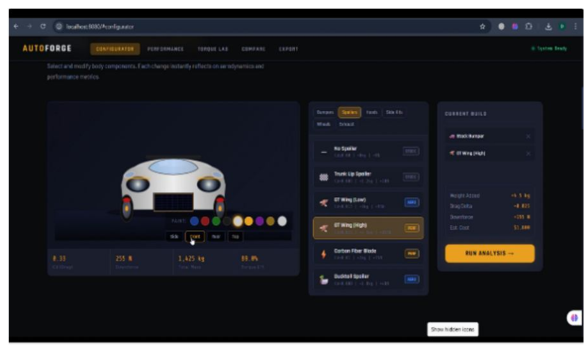

FIG 2 – Customization page

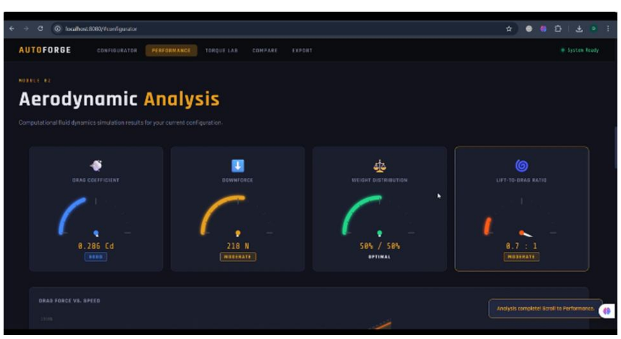

FIG 3 – Analysis page

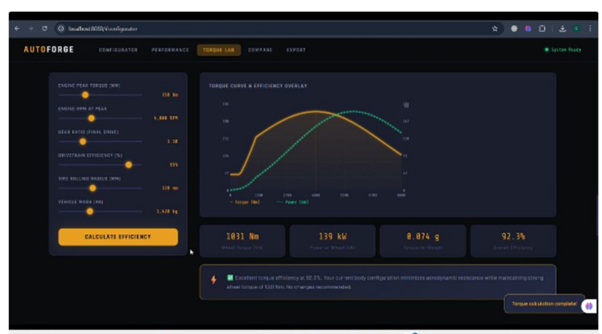

FIG 4 – Torque optimize page

The real-time feedback provided by the platform helps users understand the relationship between **vehicle design and mechanical performance**. This promotes more informed decision-making during the customization process.
Additionally, the web-based implementation ensures that the system is accessible from multiple devices without requiring specialized software installations.
Overall, the results indicate that combining visual customization with performance analysis can significantly improve the vehicle design process and reduce unnecessary modifications that negatively affect performance.

V. WORKING

The working process of the system involves several steps:

1) User Access
   - The user logs into the web platform and selects a base vehicle model.
2) Vehicle Customization
   - The user can modify different body components such as:
     - Front bumper
     - Rear spoiler
     - Hood
     - Side panels
     - Wheels
3) Parameter Update
   - Each modification updates parameters like vehicle weight, drag coefficient, and airflow characteristics.
4) Torque Efficiency Calculation
   - The system applies mathematical models to evaluate torque transmission efficiency considering updated parameters.
5) Performance Feedback
   - The platform displays performance indicators including:
     - Torque efficiency percentage
     - Estimated fuel efficiency
     - Aerodynamic performance
6) Design Comparison
   - Users can compare multiple design configurations to select the best combination of aesthetics and performance.

VI. CONCLUSION

This project presents a web-based automotive customization platform that integrates car body modification with torque efficiency optimization. The system enables users to visualize vehicle modifications while simultaneously analyzing their impact on performance parameters such as aerodynamics, weight distribution, and torque utilization. By providing real-time feedback on design changes, the platform helps users make informed decisions that balance aesthetics with mechanical efficiency. The proposed approach reduces design costs, minimizes trial-and-error processes, and shortens development cycles. The platform demonstrates how digital tools can enhance vehicle personalization while maintaining or improving driving performance. Future improvements may include advanced simulation models, integration with 3D rendering technologies, and support for additional vehicle performance parameters.

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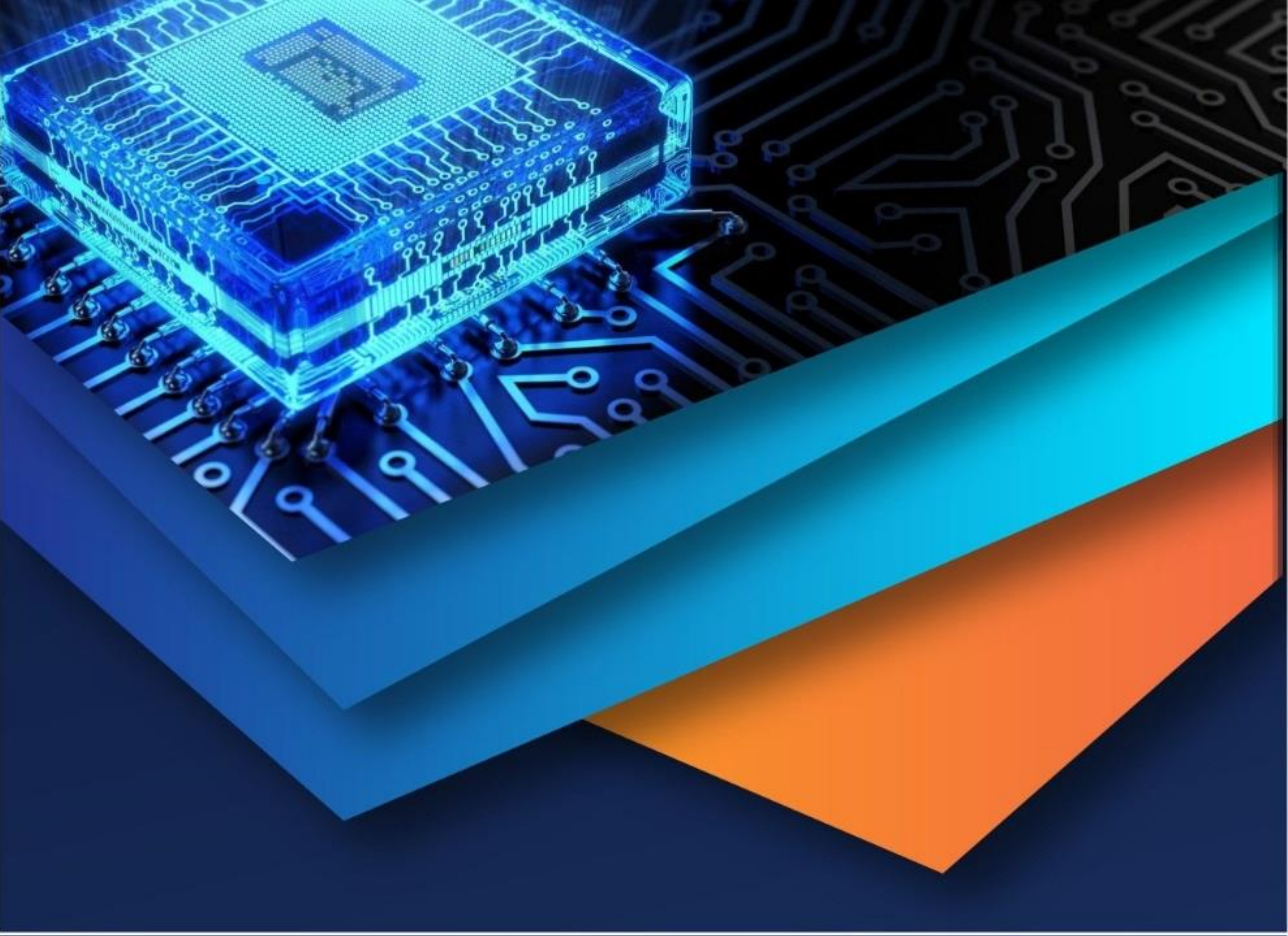

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