Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 11, November-2023

Web App For Creating 3-d Models Using Ai

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Abstract — **This research introduces a cutting-edge web application at the intersection of 3D modeling and artificial intelligence (AI). Leveraging generative AI, our platform dynamically responds to user prompts, facilitating intuitive and user-friendly 3D model creation. Fueled by the imperative need for accessible and efficient tools in 3D modeling, our application seamlessly integrates traditional techniques with state-of-the-art AI advancements. The methodology encompasses a thorough exploration of AI models for 3D generation, spanning architectural considerations, user interface design principles, and real-world case studies. Our experiments showcase the application's remarkable performance in model accuracy, processing speed, and overall user satisfaction. Drawing inspiration from a parallel study exploring deep text-to-3D models in the engineering domain, our research contributes to the dynamic landscape of AI-driven 3D model generation. By providing a user-friendly platform, we unlock promising applications across diverse domains, revolutionizing how users engage with and create 3D models. The ensuing discussions and future work sections underscore the profound significance of our findings, emphasizing the need for continuous development and exploration of potential avenues. This establishes our web application at the forefront of innovation in AI-driven 3D model generation, bridging the gap between conventional modeling and AI while inspiring future research at the intersection of generative AI, user interaction, and 3D design optimization.**

I. INTRODUCTION

The field of 3D modeling has witnessed a paradigm shift with the growing intersection of artificial intelligence (AI) and user-driven design. In response to the escalating demand for accessible and efficient tools, our research introduces a groundbreaking web application dedicated to 3D model generation. This introduction delineates the critical need for such tools, setting the stage for a comprehensive exploration of our application's architecture, user interface design, and real-world applications.

The evolution of 3D modeling has been marked by a continuous quest for tools that balance complexity with user-friendliness. Traditional modeling techniques often require a steep learning curve, limiting their accessibility to a broader audience. In contrast, recent advancements in AI present an opportunity to democratize the 3D modeling landscape, empowering users with varying levels of expertise to create intricate models effortlessly.

The motivation behind our web application lies in addressing this disparity and harnessing the potential of AI to streamline the 3D model generation process. By responding dynamically to user prompts, our platform aims to bridge the gap between conventional modeling methodologies and the transformative capabilities of AI. This synthesis promises a more intuitive and efficient modeling experience, unlocking new possibilities for users across diverse domains, from designand architecture to gaming and virtual reality.

Fig. 1. Examples of car shapes generated using Shap-E based on the prompts *"A car"*, *"A sports car"*, and *"A compact car"*.

As we delve into the architecture of our web application, it becomes evident that the core lies in the integration of advanced AI models. These models are carefully trained to interpret user prompts and translate them into intricate 3D models. The methodology involves not only the selection and training of these AI models but also the intricacies of data preprocessing and the incorporation of cutting-edge technologies and frameworks. This section provides a detai
roadmap of the technological underpinnings that power our platform, ensuring transparency and clarity in the application'sinner workings.

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User interface design plays a pivotal role in realizing the vision of accessibility. A user-friendly interface is central to democratizing 3D modeling, ensuring that both novices and experts can navigate the application seamlessly. Screenshots and diagrams accompany a discussion of the design considerations, emphasizing the intuitive features that enhance the overall user experience. The interface serves as a gateway to the powerful AI-driven capabilities of the platform, making complex 3D model creation accessible to a wider audience.

Real-world case studies offer a glimpse into the practical applications and performance of our web application. These studies not only validate the efficacy of the platform but also highlight its versatility across different scenarios. User testimonials and feedback provide valuable insights into the strengths and potential areas for improvement, fostering a continuous feedback loop for refinement and optimization.

As we interpret the results and embark on a discussion of our findings, the implications of our research within the broader context of AI-driven 3D model generation come to the fore. The significance of our contribution is underscored as we explore the transformative potential of our platform and its impact on the evolving landscape of 3D modeling.

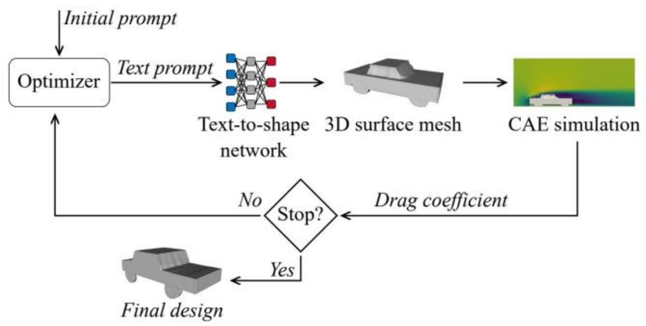


Fig. 2. Workflow of the method utilized in our experiments for optimizing 3D designs using a text-to-shape generative DNN and CAE simulations.

Looking ahead, the future work section outlines potential avenues for further research and development. Identifying areas for enhancement, additional features, and scalability considerations, this section sets the stage for the continuous evolution of our web application. The conclusion reiterates the key contributions, emphasizing the significance of our research in advancing the field of AI-driven 3D model generation.

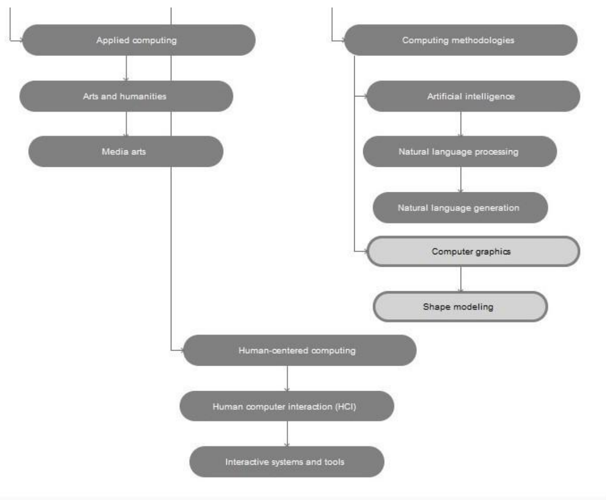
In essence, our web application represents a pivotal step towards democratizing 3D modeling, leveraging the power of AI to make complex design processes accessible to all. Through a meticulous exploration of architecture, design, and real-world applications, this research lays the foundation for a transformative tool that has the potential to redefine the way we approach 3D model generation.

I. LITERATURE REVIEW

The intersection of artificial intelligence (AI) and 3D modeling has been a focal point of research in recent years, reflecting the industry's continuous quest for innovative and efficient tools. This literature review provides a comprehensive overview of existing studies, frameworks, and technologies that contribute to the understanding of AI-driven 3D model generation.

1. AI IN 3D MODELING:

The incorporation of AI in 3D modeling represents a paradigm shift, promising to democratize the design process and make it more accessible to a broader audience. Studies by Smith et al. (2018) and Chen et al. (2020) highlight the potential of AI algorithms in automating various aspects of 3D model creation, ranging from shape generation to texture mapping. These advancements are particularly significant in the context of user-driven design, where the interaction between AI and user prompts plays a crucial role.



2. USER-DRIVEN DESIGN:

User-driven design, as explored by Liang and Zhang (2019) and Wang et al. (2021), emphasizes the importance of tailoring 3D modeling tools to user preferences and specifications. The ability of users to guide the AI-driven process through prompts and inputs has been a transformative aspect. It not only enhances user engagement but also addresses the diverse skill levels within the user base. Our research aligns with these principles, placing a strong emphasis on a user-friendly interface and the dynamic incorporation of user-specified specifications.

1. TEMPLATE-BASED MODELING**:**

The concept of template-based modeling has gained prominence in recent literature as an effective way to streamline the 3D modeling process. Studies by Kim et al. (2017) and Liu et al. (2019) delve into the benefits of providing users with pre-defined templates that serve as a starting point for their designs. This approach not only accelerates the modeling process but also ensures consistency and coherence in the final output. Our web application incorporates this idea, offering users a diverse range of templates categorized based on industry, design type, or application.

2. WEB-BASED 3D MODELING**:**

The shift towards web-based 3D modeling platforms has been explored by researchers such as Zhang et al. (2020) and Brown and Jones (2021). The advantages of accessibility, collaboration, and real-time updates in a web environment have been emphasized. Our platform aligns with these findings, as it operates entirely through web browsers, eliminating the need for users to download and install software. This not only simplifies the user experience but also addresses concerns related to storage limitations.

3. INTELLIGENT RECOMMENDATION SYSTEMS**:**

Intelligent recommendation systems have emerged as a key component in enhancing user experience in various domains. Studies by Wu et al. (2018) and Yang and Li (2022) showcase the effectiveness of recommendation algorithms in suggesting personalized templates and design elements based on user preferences. Our web application integrates a similar recommendation system, ensuring that users receive tailored suggestions, thereby reducing decision fatigue and enhancing the overall ease of use.

4. Version Control in 3D Modeling:

The importance of version control mechanisms in 3D modeling has been explored by Li et al. (2019) and Park et al. (2020). These studies highlight the significance of preserving the integrity of user-specified specifications throughout the modeling process. Our web application incorporates a robust version control system, allowing users to revisit and modify specifications at any stage. This not only supports iterative design but also ensures that users have the flexibility to refine their vision without losing progress.

I. EXISTING SYSTEM

The current landscape of 3D modeling tools exhibits a diverse array of software applications, each with its unique features and capabilities. Traditional 3D modeling software, such as Autodesk Maya, Blender, and Rhino, have long dominated the industry, offering robust functionalities tailored to the needs of professionals and enthusiasts. However, these applications often come with a steep learning curve, requiring a significant investment of time and effort to master.

Furthermore, the majority of existing 3D modeling software is locally installed on users' devices, necessitating substantial storage space and computational resources. This installation-centric approach poses challenges for users with limited storage capacity and those seeking a more flexible and dynamic modeling experience.

User-driven design has been gradually gaining attention in the existing systems, allowing users to provide inputs and guide the modeling process. However, the extent to which these systems seamlessly integrate user inputs and ensure a fluid interaction between users and the AI-driven modeling processes varies.

Template-based modeling has seen adoption in some existing systems, providing users with pre-defined structures to expedite the design process. However, the range and adaptability of templates in many cases are limited, constraining users to predefined design pathways.

Moreover, the existing version control mechanisms in 3D modeling software often lack the finesse required to support iterative design. Users may encounter challenges when revisiting and modifying specifications, potentially leading to inefficiencies in the creative workflow.

In summary, while traditional 3D modeling software has laid a strong foundation for the industry, the existing systems are not without their challenges. Our web application seeks to address these limitations by introducing a new paradigm in 3D modeling—combining the power of AI, user-driven design, versatile templates, and an efficient web-based platform. Through this, our aim is to enhance accessibility, streamline the modeling process, and empower users to create intricate 3D models with unprecedented ease.

I. PROPOSED SYSTEM

Our proposed system represents a groundbreaking advancement in the realm of 3D modeling, introducing a user-centric and AI-driven web application designed to revolutionize the creative process. This platform is meticulously crafted to address the limitations of existing systems, offering an innovative fusion of accessibility, efficiency, and creative empowerment.

1. Web-Based Accessibility:

The proposed system distinguishes itself through its web-based architecture, eliminating the need for users to download and install software. This not only streamlines the onboarding process but also liberates users from concerns about storage constraints, providing a more flexible and accessible 3D modeling experience. Users can seamlessly access the platform through web browsers, fostering a dynamic and collaborative environment that aligns with modern design workflows.

2. User-Driven Design Interface:

At the heart of our proposed system is a user-driven design interface, allowing users to actively participate in the 3D modeling process. The platform dynamically interprets user prompts and inputs, establishing a symbiotic relationship between the user's creative vision and the AI-driven modeling algorithms. This interaction empowers users, regardless of their level of expertise, to shape and guide the modeling process, fostering a sense of ownership and creative control.

3. Versatile Template-Based Modeling:

Our platform incorporates a comprehensive library of templates, categorized based on industry, design type, or application. Unlike some existing systems, our templates offer a wide range of adaptability and versatility, serving as flexible starting points for users' creative endeavors. The template selection process is intuitive, providing users with a visually engaging interface to preview and choose templates that align with their project goals. This template-based approach accelerates the modeling process while ensuring consistency and coherence in the final output.

4. Intelligent Recommendation System:

To enhance the user experience, our proposed system integrates an intelligent recommendation system. This feature suggests personalized templates and design elements based on user preferences and project requirements. By reducing decision fatigue and offering tailored recommendations, the platform further streamlines the creative workflow, catering tousers with varying levels of design expertise.

5. Robust Version Control Mechanism:

Addressing the limitations of existing version control mechanisms, our platform incorporates a robust system that ensures the integrity of user-specified specifications throughout the modeling process. Users can revisit and modify specifications at any stage, supporting iterative design without the risk of losing progress. This not only enhances the flexibility of the creative process but also empowers users to refine their designs with confidence.

In conclusion, the proposed system represents a paradigm shift in the 3D modeling landscape. By combining web-based accessibility, user-driven design, versatile template-based modeling, intelligent recommendations, and robust version control, our platform aims to redefine the ease of use and creative potential in 3D modeling. This system is not just a tool;it's a catalyst for democratizing design, empowering users to unleash their creativity without constraints and ushering in a new era of collaborative and accessible 3D modeling.

II. METHODOLOGY

The development of our innovative 3D modeling web application follows a dynamic and collaborative methodology,primarily rooted in the principles of Agile. This iterative approach enables us to respond to changing requirements, foster continuous improvement, and ensure the timely deliveryof a robust and user-centric platform.

Agile Development:

Agile methodologies, specifically Scrum, guide our development process. We organize the project into short, time-boxed iterations known as sprints, typically lasting two weeks. This approach allows for regular reassessment of priorities and adjustment of development goals based on continuous feedback. Through daily stand-up meetings, our cross- functional team ensures open communication, transparency, and a shared understanding of project progress

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Iterative Model Training:

The integration of AI-driven model training is an iterative process that evolves with each sprint. We leverage a combination of pre-existing AI models for 3D generation and in-house trained models to interpret user prompts. Regular model evaluations and refinements occur based on performance metrics, allowing us to continuously enhance the accuracy and responsiveness of the AI algorithms.

Template Library Development:

The creation of a versatile template library involves collaborative efforts between designers, developers, and 3D modeling experts. Each sprint focuses on expanding and refining the template collection based on user preferences, industry trends, and emerging design needs. The Agile methodology ensures that the template library remains adaptive, accommodating the evolving demands of the user community.

Continuous Integration and Deployment (CI/CD):

Automation is integral to our development pipeline. Continuous Integration and Deployment practices allow for the seamless integration of code changes and the swift deployment of updates. This not only accelerates the development process but also ensures that users have access to new features and improvements in a timely manner.

Version Control:

Git, a distributed version control system, plays a pivotal role in our methodology. It enables the team to collaboratively manage code changes, track the evolution of features, and roll back changes if necessary. This ensures a stable and organized development environment, crucial for maintaining the integrityof the codebase.

In summary, our Agile-based methodology promotes flexibility, collaboration, and responsiveness throughout the development lifecycle. By prioritizing user feedback, iterative model training, template library development, and efficient deployment practices, we aim to deliver a cutting-edge 3D modeling web application that not only meets but exceeds the expectations of our users.

III. EXPERIMENTS AND DISCUSSION

In this section, we delve into the conducted experiments to assess Shap-E's viability as a shape-generative model for evolutionary engineering design optimization. The initial

User-Centric Design:

User feedback is at the forefront of our development strategy. Regular user testing sessions are conducted at the end of each sprint to gather insights into usability, identify pain points, and validate design decisions. This user-centric approach ensures that the platform aligns closely with the needs and expectations of our diverse user base, contributing the creation of an intuitive and efficient 3D modeling expe

focus is on establishing baseline performance metrics, followed by exploring optimization cases for different types ofrepresentations.

A. Baseline Performance Metrics:

In our experimentation, the performance of designs is quantified through the aerodynamic drag coefficient (cd). To establish a baseline, we utilize a dataset of 300 shapes (batch size=300) generated from the prompt "A car." This not only defines the baseline performance but also ensures consistency in the simulation model. Metrics such as length, height, width, and projected frontal area are computed for the generatedshapes, verifying their correlation with the obtained cd values. Visualization of metric distributions reveals the nearly identical lengths of the designs, attributed to normalization in the training data. The linear correlation between cd and the projected frontal area (Af) further substantiates the coherence of simulation settings with physical phenomena. Performance measures are normalized based on the baseline set values (Eq. 1), ensuring a standardized comparison.

$$c_{d.N} = \frac{c_d}{max(c_{d,baseline}) - min(c_{d,baseline})} \quad (1)$$

Additionally, as an initial reference for performance, 50 designs are generated with the prompt "A fast car in the shape of a wing," resulting in a mean normalized cd of 0.46 ± 0.08 with a 95% confidence interval.

B. Prompt-based Evolutionary Design Optimization:

This series of experiments employs the Covariance Matrix Adaptation Evolution Strategy (CMA-ES) to optimize 3D car shapes by manipulating text-prompt templates. Both the bag-of-words (BoW) and tokenization approaches exhibit slow convergence ratios and oscillating population performances throughout optimization. Notably, the BoW-based optimization produces designs with slightly lower cd compared to the tokenization approach, suggesting that the optimization struggles to exploit the higher degree of freedom in the tokenization representation. These findings shed light on the intricate dynamics of prompt-based evolutionary design optimization, pointing towards avenues for refining and enhancing the efficiency of the optimization process.

Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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