Generative AI & Tangible Products
Human-AI Design of 3D-printed Lamps

Abstract

New generative AI systems can make beautiful pictures, but can they help produce functional products? This graduation project investigated the potential for generative AI to aid the design of functional, 3D-printed lamps. In the spotlight was the design of 3D-printed lamps, and through two empirical studies, the effect of AI on design enhancement was evaluated. A software system, leveraging AI, was developed to offer designers a sandbox for lamp design exploration. This system's outputs served as the inputs for generating 3D models, demonstrating human-AI collaboration, then actualized using four different 3D printing technologies. Altogether, this work showcases the potential for AI tin turning human creativity into tangible products. Despite meaningful challenges in the process of 3D printing and 2D to 3D conversions, AI advancements signal a promising future for the design industry—and a need for new approaches to design education.

Generated Image · **Functional Product**

"a symmetric opal glass lamp with very smooth curvatures suitable for 3D printing."

"lamp, modular design, different ways to assemble."

## Can GPT-4 Effectively Optimize Generative AI Outputs to Align with Human Preferences?

In the first study, participants(n=10, for Midjourney n=8) engaged in several rounds of lamp design generation using both optimized and unoptimized prompts. Designs were evaluated on desirability, alignment, and printability, with scores assigned on a scale of zero to 100. The study compared scores between designs based on optimized and unoptimized prompts.

Study1 Rating Interface (0-100)▼
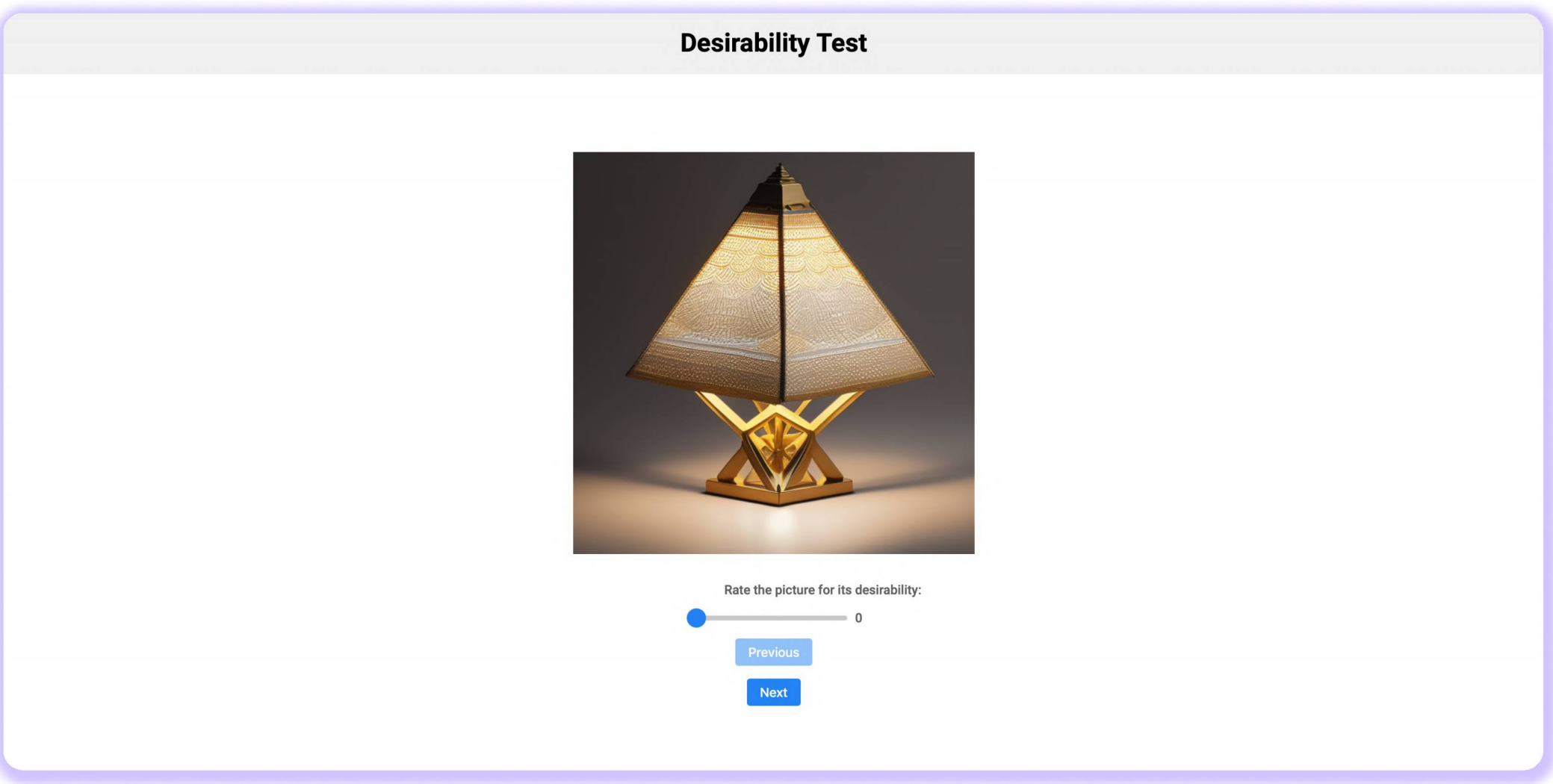
Study1 Results▼

| Model/ Category	Rated Desirability (U-statistic, p-value)	Rated Printability (U-statistic, p-value)	Rated Alignment (U-statistic, p-value)	Significant Improved Dimensions
Midjourney	6520, 0.005*	9262.5, 0.07	8314, 0.84	Desirability
Open Journey	646, 3.16e-05*	1380, 0.37	948.5, 0.036*	Desirability, Alignment
Stable Diffusion	1115, 0.35	1122.5, 0.38	1264.5, 0.92	None
DALL-E 2	1080, 0.24	1357, 0.46	1038.5, 0.15	None
Overall	30789.5, 3.37e-05*	41230.5, 0.17	36227.5, 0.20	Desirability

Can human preference data train AI to generate measurably improved human experiences?

In the second study, 405 images were assessed by participants on a "like" or "dislike" scale, focusing on aesthetics and desirability. This yielded 3451 and 2613 ratings for desirability and visual appeal, respectively. The highest rated images were used to train two separate models using the Low-Rank Adaptation (LoRA) technique. The process was repeated with a different set of 100 images, rated 25-30 times for visual appeal (2753 total ratings) and 28-35 times for desirability (3062 total ratings). The LoRA-enhanced models outperformed the original models in generating liked responses.
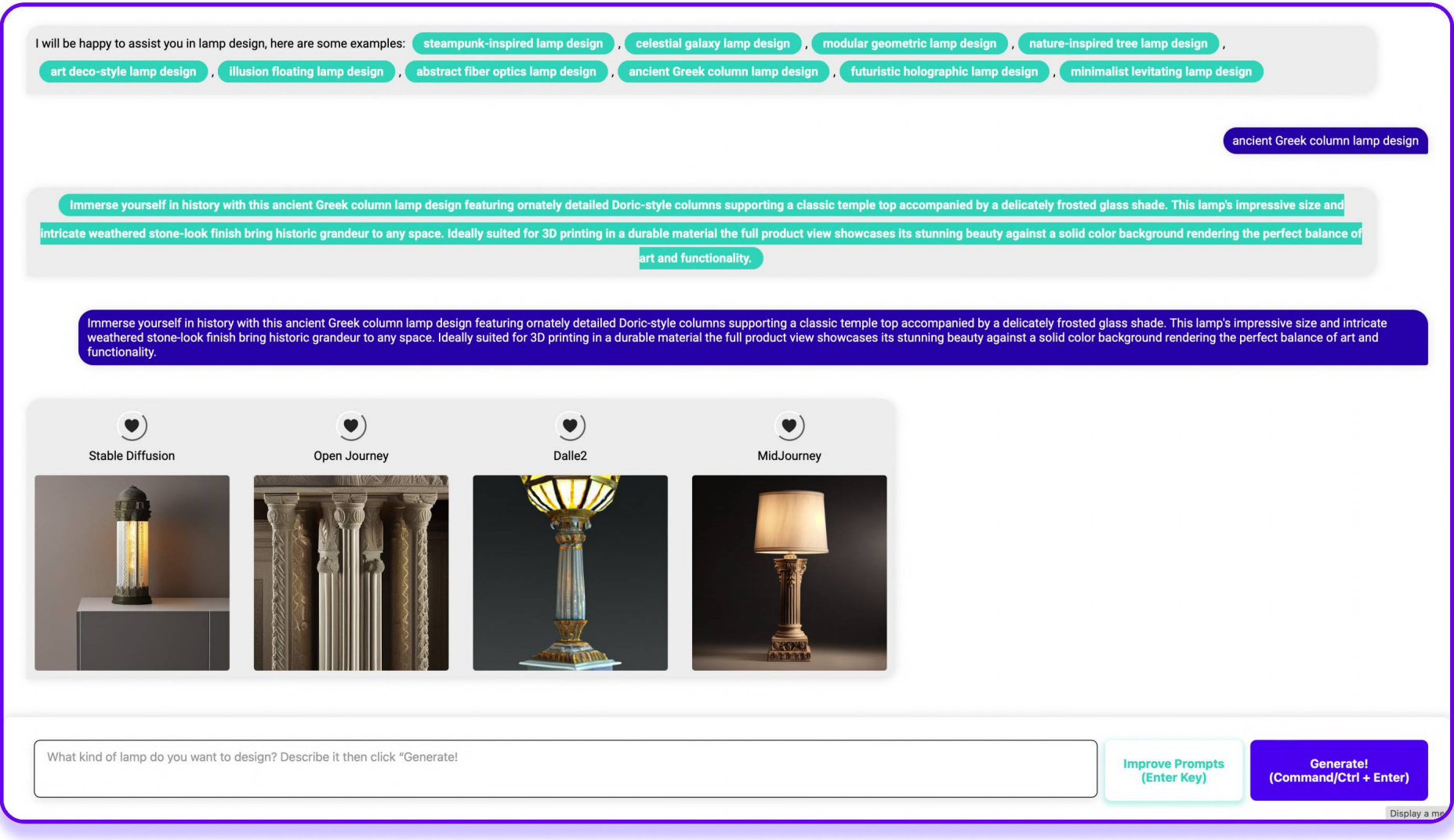
Study2 Rating interface ▼
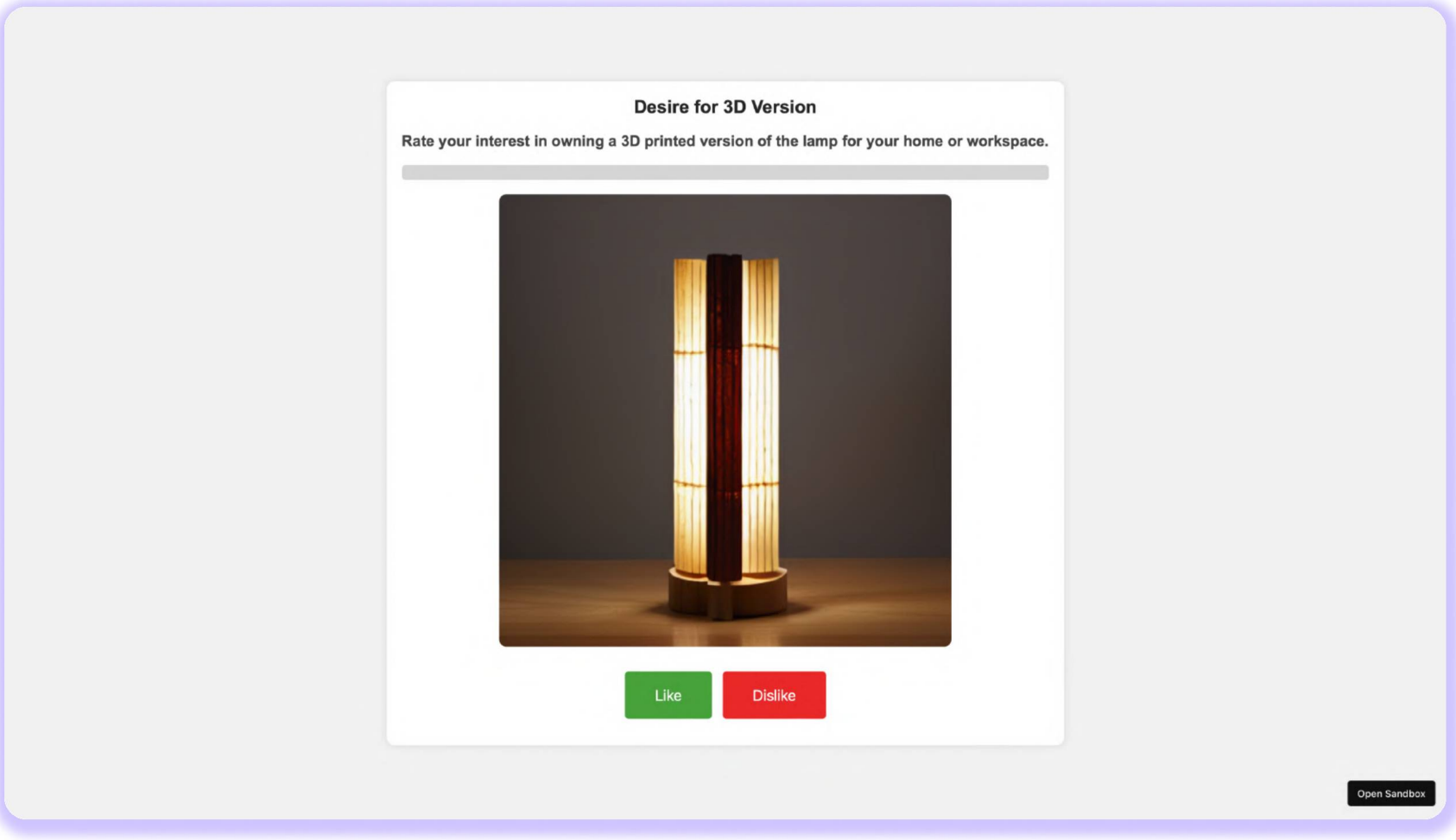
Study2 Results ▼
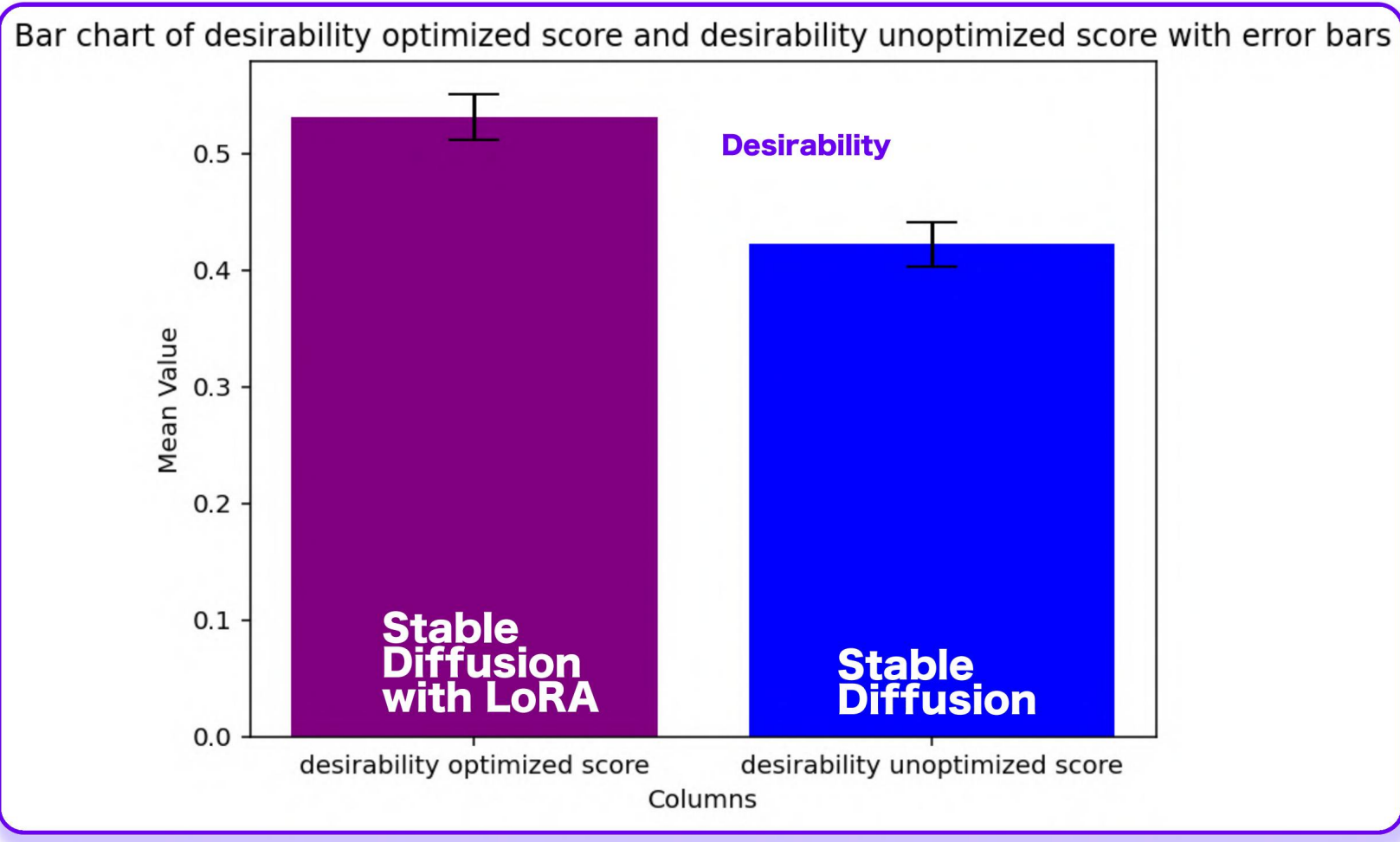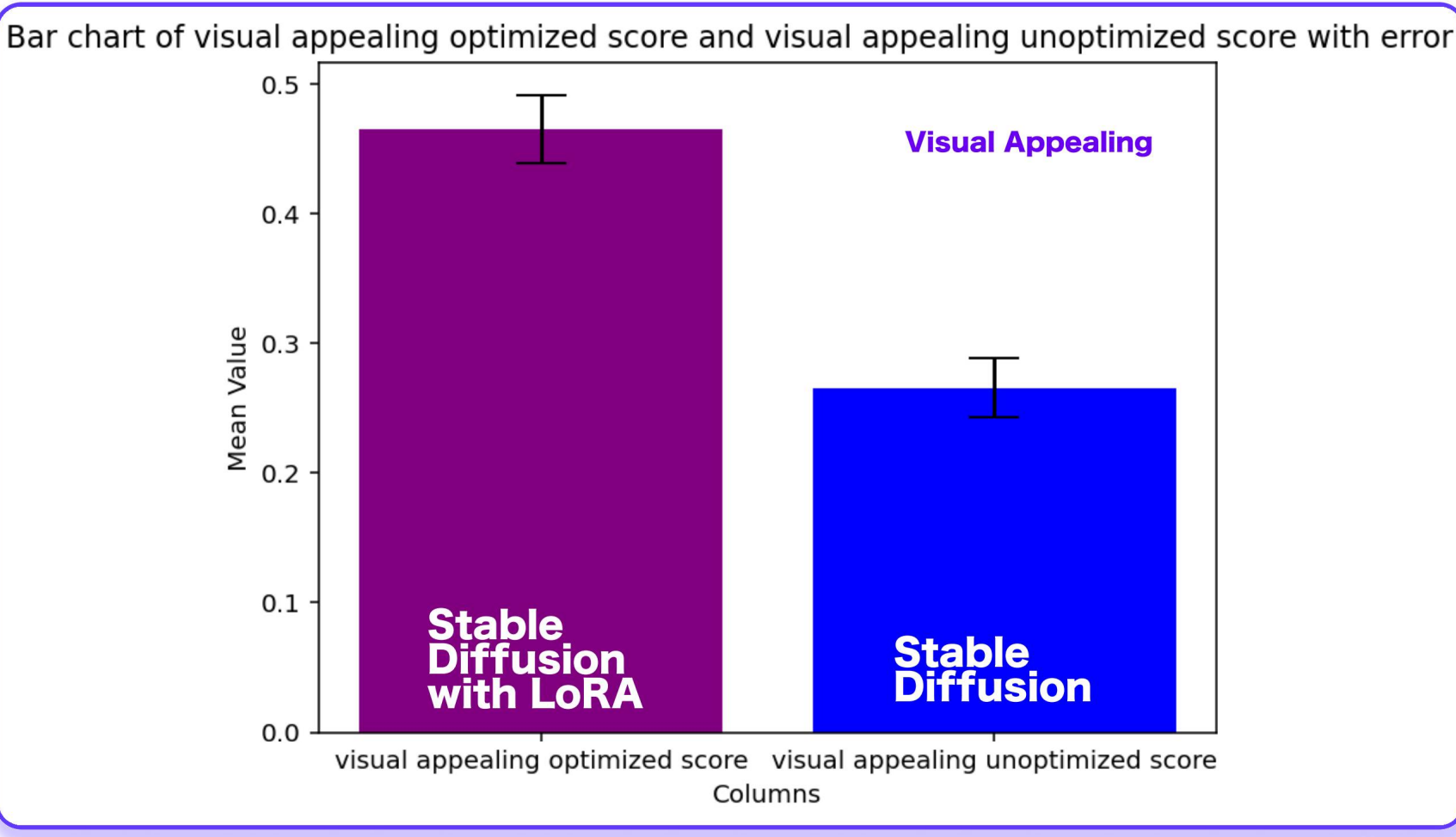
How does the Developed Tool and User Interface Assist Designers?

A user interface, built upon user testing and project studies, was developed to facilitate image generation. It includes an AI function, a GPT4 chat interface, and a generative AI tool, simplifying design preference communication and concept generation.

dinuoliao.com

Conclusion

This project underscores the transformative potential of artificial intelligence in the design process. Through extensive studies, we've demonstrated how AI can improve design desirability and aesthetic appeal, opening the door for a new era of AI-assisted design. Our user interfaces, hosted on dinuoliao.com, have made AI-assisted design more accessible, providing tangible evidence of AI's practical applications in the design process. The insights gained from this project suggest a future where AI is integral to design, reshaping the roles of designers and their education. This fusion of AI and human creativity promises to enhance design efficiency, offering a tantalizing glimpse into the future of design.

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