



# A Study on the Application of Generative Artificial Intelligence Technology in Image Design

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**ABSTRACT.** In order to explore the application process of artificial intelligence in generating image works and further investigate the application of generative AI technology in image design, this study selected the Midjourney platform as the observation object, recruited online users and AI platforms for cooperation, and used participatory observation, questionnaire survey, and data analysis to explore the actual effects and advantages and disadvantages of AI technology in the creation process and evaluate its help and contribution to image creation. Through the study, it was found that generative AI technology can be used in various ways for image design, such as generating images with specific styles, realizing image style conversion, and generating image design materials. At the same time, AI-generated art also has its own creative mechanism, providing new technical tools and creative ideas for artists' creation. In image design, AI technology has a wide range of application prospects, which can help designers to better process and design images, and also provide good technical support for research and application in related fields.

**Keywords:** Generative Artificial Intelligence, Image Design, Algorithmic Generation, Human-Computer Collaboration.

## 1 Introduction

As artificial intelligence technology continues to develop, its applications in various fields are increasingly widespread. Research results related to "artificial intelligence and art" can be broadly divided into two categories: one is to study how artificial intelligence is used to analyze works of art, and the other is to study how artificial intelligence is used to create new works of art. <sup>[1]</sup>The motivation of this article is to explore the process of using artificial intelligence to generate image works, discuss its key technologies, application scenarios, and practical situations, and provide a basis and reference for further exploration of the application of generative artificial intelligence technology in image design. It is hoped that this article can enhance our understanding of the application of artificial intelligence and inspire us to explore how to collaborate with artificial intelligence tools to create images.

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## 2 Application Scenarios of Generative Artificial Intelligence in the Field of Image Design

### 2.1 Representative Technologies and Platforms

Artificial intelligence technology is divided into two categories based on functional value: Analytical Artificial Intelligence and Generative Artificial Intelligence. Generative artificial intelligence, which can independently generate various types of data such as text, images, audio, and video, is used in fields such as writing, painting, music, and dynamic imaging creation. Generative artificial intelligence technology has wide applications in the field of image design, and can automatically output artworks in various styles, improving the efficiency and quality of artistic creation.

Generative Adversarial Networks (GAN) is a type of machine learning model used to generate images, audio, text, or other forms of data. The technical principle of GAN is to train the "generator" and "discriminator" to achieve confrontation. The "generator" model is responsible for generating fake data, while the "discriminator" model is responsible for distinguishing real data from fake data. Neural Style Transfer is a deep learning-based image processing technology that uses convolutional neural networks to process images, separates the content of one image from the style of another image, and merges them together to generate a new image. Artificial Intelligence Creative Adversarial Network (AICAN) is a deep learning-based image creation system that uses the structure and technology of GAN to generate images, and can create new artworks by learning and imitating different artistic styles and creative thinking. DALL·E is an image generation model based on artificial intelligence technology, which was released by OpenAI in 2021. It can generate images based on natural language descriptions. Midjourney is an AI painting chatbot built on Discord, using the technology of GAN to train the model. Users can input text and images in the Discord community to generate a new artwork based on its features and style.

### 2.2 Primary Application Scenarios

The primary application scenarios of generative artificial intelligence technology in the field of image design can be divided into the following three aspects.

First, image style transfer. AI image platforms typically use deep learning techniques to transfer the style of one image to another while preserving the content of the original image. These techniques can capture different features of existing artistic styles and apply them to user-uploaded images to generate images with the target artistic style. Existing AI platforms support multiple style transfers, such as Impressionism, Cubism, Expressionism, Sketch, Pixel, Chinese-style, Japanese manga, and more.

Second, automatic image generation. AI image platforms can use technologies such as GAN and VAE to learn from large amounts of image data and generate new images. Platforms like DeepDream and Midjourney allow users to set various parameters to describe and restrict the content and style of the generated images, resulting in design results that are closer to the user's needs. These generated images can be used in various

applications, such as advertising, packaging design, product design, and creative displays of cultural heritage.

Third, image design assistance. Designers can use images generated by AI as creative inspiration and also use them as raw materials for further creative work. Some AI platforms, such as Canva, provide a wide range of design templates and materials, allowing users to quickly create designs with a professional look through simple drag-and-drop operations.

### **3 Research Design**

In accordance with the research topic of this paper, a mixed research method is adopted, and the specific research steps are as follows:

#### **3.1 Platform Selection and Participant Recruitment.**

As of April 23, 2023, the user base of Midjourney platform has reached 14 million, covering creative designers, industrial designers, Web3 & NFT professionals, and individual enthusiasts. The platform utilizes Discord community to build its product, and the community co-creation model not only helps to improve users' platform usage skills, but also provides a good communication environment, which is conducive to the observation, research, and data acquisition of this study. In accordance with the research objectives and case requirements, a certain number of online users and artificial intelligence platforms will be recruited for cooperation.

#### **3.2 Case Selection and Observation**

Select cases that meet the requirements from the participation results of volunteers and use participatory observation to obtain their collaboration with the AI platform.

#### **3.3 Data Collection and Analysis**

Collect data through methods such as questionnaire surveys, in-depth interviews, and observation, and analyze the actual effects and advantages and disadvantages of AI technology in the creative process, understand the details, problems, and solutions that arise during the collaboration, and evaluate its help and contribution to image creation.

#### **3.4 Inductive Summary**

Analyze and summarize the results of empirical research, and summarize the advantages and limitations of artificial intelligence in image design collaboration, and provide suggestions and future optimization directions.

## 4 Application and Practice of Artificial Intelligence Platforms in Design Projects

### 4.1 Survey on the Application of Artificial Intelligence Technology in Image Design

#### 4.1.1. The Usefulness of Artificial Intelligence Image Generation Tools.

As shown in Table 1, the effectiveness of artificial intelligence image generation tools was mainly divided into three categories among the 203 valid questionnaires collected from the survey: whether they brought inspiration or creativity to your creation, whether they improved your painting skills and knowledge, and whether they made it easier for you to try new painting styles or themes. The percentage of "yes" or "some-what" answers to all questions was 75.37%, indicating that artificial intelligence image generation tools are still quite effective for most users. Even though the mean score for whether it made it easier for users to try new painting styles or themes was the lowest, it still reached 2, indicating that users are still quite satisfied with artificial intelligence image generation tools.

**Table 1.** The effectiveness of artificial intelligence image generation tools.

Classification		Fre- quency	Propor- tion%	Mean
Does it bring inspiration or creativity to your creation?	1Yes	83	40.89	1.99
	2Somewhat	70	34.48	
	3Uncertain	20	9.85	
	4No	30	14.78	
Does it improve your painting skills and knowledge?	1 Yes	76	37.44	1.98
	2 Somewhat	77	37.93	
	3Uncertain	29	14.29	
	4No	21	10.34	
Does it make it easier for you to try new painting styles or themes?	1Yes	78	38.42	2.00
	2Somewhat	75	36.95	
	3Uncertain	23	11.33	
	4No	27	13.30	

#### 4.1.2. Advantages of Artificial Intelligence Image Generation Tools.

According to the results in Table 2, among the 203 valid questionnaires collected from the survey, the advantages of artificial intelligence image generation tools were mainly divided into six categories: improving design efficiency, providing creative inspiration, expanding design styles, enhancing creative quality, obtaining design materials, and optimizing design solutions. The percentage of positive answers for improving design efficiency, providing creative inspiration, expanding design styles,

enhancing creative quality, and obtaining design materials were all over 50%, while the mean score for optimizing design solutions was less than 0.5, indicating that the optimization of design solutions has not yet been widely recognized by most users as an advantage of artificial intelligence image generation tools.

**Table 2.** Advantages of AI image generation tools

Classification		Frequency	Proportion%	Mean
Improve design efficiency	0No	89	43.84	0.56
	1Yes	114	56.16	
Provide creative inspiration	0No	69	33.99	0.66
	1Yes	134	66.01	
Expand design styles	0No	86	42.36	0.58
	1Yes	117	57.64	
Improve creative quality	0No	95	46.80	0.53
	1Yes	108	53.20	
Obtain design materials	0No	100	49.26	0.50
	1Yes	103	50.74	
Optimize design solutions	0No	111	54.68	0.45
	1Yes	92	45.32	

**4.1.3. Shortcomings of Artificial Intelligence Image Generation Tools.**

According to the results in Table 3, among the 203 valid questionnaires collected from the survey, the drawbacks of artificial intelligence image generation tools were mainly divided into five categories: unfriendly user interface, difficult to grasp the usage methods, incomplete functions and lack of customization options, inadequate accuracy leading to unexpected results, low degree of freedom for adjusting and optimizing the platform's output results, and slow platform response speed. The percentage of users who answered "yes" to all questions exceeded 50%, indicating that most users still consider artificial intelligence image generation tools to be insufficiently intelligent. Even though the mean score for slow platform response speed was the lowest, it still reached a level of 0.53, indicating that among the drawbacks of artificial intelligence image generation tools, slow platform response speed is relatively better, but still cannot meet users' needs.

**Table 3.** The limitations of AI image generation tools.

Classification		frequency	proportion%	mean
The interface is not user-friendly and difficult to learn how to use.	0No	70	34.48	0.65
	1Yes	133	65.52	
Not sophisticated enough and lacks customizable options	0No	59	29.06	0.71
	1Yes	144	70.94	
Accuracy is not high, and the generated results do not meet expectations	0No	83	40.89	0.59
	1Yes	120	59.11	
The degree of freedom to adjust and optimize the output results of the platform is not high	0No	65	32.02	0.68
	1Yes	138	67.98	
The platform has a slow response speed	0No	95	46.80	0.53
	1Yes	108	53.20	

**4.1.4 Platform usage frequency is correlated with educational level.**

To investigate the impact of personal characteristics on the frequency of using the Midjourney platform among painting enthusiasts or professionals, the Tobit model was selected in this study, with personal information added as a control factor for regression analysis. Model:

$$y = \alpha_0 + \alpha_1x + \alpha_2c1 + \alpha_2c2 + \alpha_4c3 + \varepsilon \tag{1}$$

As depicted in Table 4, in the Tobit model, y represents the frequency of using the Midjourney platform, x represents whether the user is a painting enthusiast or professional, c1 represents gender, c2 represents age, and c3 represents education.

**Table 4.** Variable definition

Variable	Sym- bol	Problem	Options
Dependent variable	y	What is the frequency of your use of the Midjourney platform?	1.Every day 2.Every week 3.Every month 4.Occasionally
Independent variable	x	Are you an art enthusiast or a professional in the art industry?	0.No 1.Yes
Control variable	c1	Your gender	1.Male 2.Female
	c2	Your age range	1.Under 18 2.18-25 3.26-30 4.31-40 5.41-50 6.51-60 7. 60 and above
	c3	Your current level of education	1.Junior high school or below 2.Senior high school/vocational school/technical school 3.Junior college/Community college 4.Bachelor's degree 5.Master's degree or above

**Table 5.** Descriptive statistics

Variable	Obs	Mean	Std. dev	Min	Max
y	203	2.586	1.097	1	4
x	203	0.542	0.499	0	1
c1	203	1.537	0.500	1	2
c2	203	2.931	0.818	2	4
c3	203	3.084	1.201	1	5

As shown in Table 5, based on the descriptive statistics results: The sample size of  $y$  is 203, with a mean of 2.586, a standard deviation of 1.097, a minimum value of 1, and a maximum value of 4, indicating that the frequency of using the Midjourney platform is relatively low among respondents. The sample size of  $x$  is 203, with a mean of 0.542, a standard deviation of 0.499, a minimum value of 0, and a maximum value of 1, indicating that the number of respondents who are painting enthusiasts or related professionals is relatively high. The sample size of  $c1$  is 203, with a mean of 1.537, a standard deviation of 0.5, a minimum value of 1, and a maximum value of 2, indicating that there are more female respondents than male ones. The sample size of  $c3$  is 203, with a mean of 3.084, a standard deviation of 1.201, a minimum value of 1, and a maximum value of 5, indicating that the educational level of respondents is relatively high.

**Table 6.** Regression analysis

	y				
	coeff	std.err	t	p	Sig
x	0.272	0.153	1.775	0.077	*
c1	0.316	0.152	2.071	0.040	**
c2	-0.039	0.093	-0.421	0.674	
c3	0.034	0.064	0.532	0.595	
cons	1.965	0.423	4.645	0.000	***
N	203				
pseudo R2	0.013				

Standard errors in parentheses

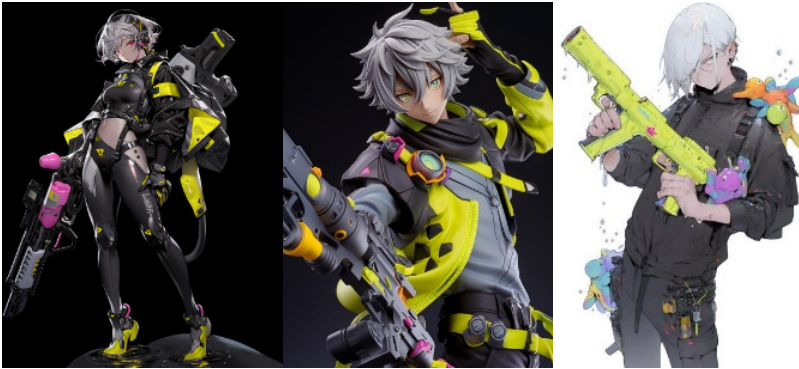
\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

As illustrated in Table 6, according to the regression results, the regression coefficient of  $x$  is 0.272, which indicates that compared to respondents who are not painting enthusiasts or related professionals, the frequency of using the Midjourney platform will increase by 0.272 units when the respondent is a painting enthusiast or related professional, and it is significant at the 10% level. The regression coefficient of  $c1$  is 0.316, which indicates that compared to males, when the user is female, the frequency of using the Midjourney platform will increase by 0.316 units and it is significant at the 5% level. The regression coefficient of  $c2$  is -0.039, which indicates that as the respondent's age stage increases by one unit, the frequency of using the Midjourney platform will decrease by 0.039 units, but it is not significant. The regression coefficient of  $c3$  is 0.034, which indicates that as the respondent's education level increases by one stage, the frequency of using the Midjourney platform will increase by 0.034 units. The regression coefficient of  $\_cons$  is 1.965, which indicates that the constant term of the model is 1.965 and it is significant at the 1% level.  $N$  is 203, which indicates that the sample size of the model is 203, and the pseudo  $R^2$  is 0.013, which indicates that the model fit is 0.013.

## 4.2 Application Analysis of Artificial Intelligence Technology in Image Design

### 4.2.1. Case Studies of Neural Style Transfer.

Neural style transfer in AI painting is a process that uses artificial intelligence algorithms to transform an image from one style to another, allowing artists to output their ideas in different styles and increase their creative efficiency. After upgrading from Midjourney to Niji5, different painting styles can be specified using the same set of vocabulary. As shown in Figure 1, it should be noted that Niji5's image functions are mostly used for depicting anime characters, focusing on character features, and can enrich the expression of images in 2D/3D based on specific requirements. The conversion between styles can help artists explore more artistic styles and create diverse and rich artworks in a short period of time. Traditional painting requires more energy and materials from artists, while AI-based creation enables the combination and transformation of different styles in a short time, providing greater flexibility and efficiency in the creative process. At the same time, expressing different styles for a given topic can help people better understand the differences and similarities between different painting styles. By increasing their understanding of different painting styles, artists can choose to focus on their areas of expertise or preferred styles, thus improving their painting skills in a targeted manner.



**Fig. 1.** Images with styles inspired by "no specific style requirements" "Yoshitaka Amano" and "Takashi Murakami", Other keywords: male doll with a water gun in both hands, black, deep silver, and light purple and yellow, detailed character desing--ar 3:4 --niji 5

### 4.2.2. Case Studies of Automated Image Generation.

AI-generated images have gained prominence in various fields such as character design, TikTok effects, and game company design. As shown in Figure 2, Algorithms can automatically generate different types of character images based on input keywords, helping designers save costs in character design and allowing them to focus more on creative character design, thereby improving the quantity and quality of creations. Additionally, a referenceable overall effect can unify and improve the consistency and realism of character appearances, enhancing visual experiences.





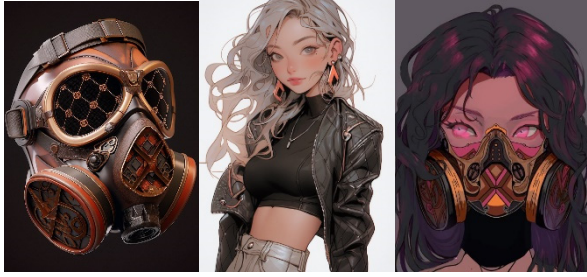
**Fig. 2.** Automatically generated image (left) and re-creation inspired by automatically generated image (right), keywords: A male doll with a water gun in both hands, Takashi Murakami, black, deep silver, and light green, corporate punk, detailed character design, 2D, stand up --ar 3:4 --niji 5

When designers have a certain expected effect for the image, they can refine and input keywords describing the image into the AI interface. However, as textual descriptions may not fully achieve the desired effect in the designer's mind, designers often need to further optimize the generated images based on their requirements. The description provided by the designer plays a crucial role in the entire AI creative process, as the accuracy and precision of the description impacts the output of the AI-generated results.

#### 4.2.3. Design-Assisted Practice Case Studies.

AI-generated images can also serve as important auxiliary tools in the design process. For example, As shown in Figure 3, material images are generated based on input keywords, and suitable concept images are further drawn based on personal interpretation and requirements, increasing the efficiency of the creative process while maintaining the original style of the creator. To accurately represent object structures, creators often use 3D tools for assistance in painting, and the vast database behind AI platforms can help creators quickly and accurately obtain relevant materials with just a precise description.

However, a potential issue with similar descriptions is the possibility of design works becoming homogeneous and consumer aesthetic degradation, as the AI database is limited and such situations are unavoidable. This further emphasizes that creators should not solely rely on AI for design and should have stricter requirements for their own aesthetic abilities.



**Fig. 3.** Automatically generated images (left and middle) and artwork drawn by combining them.

## 5 Research Results and Discussion

### 5.1 Research Results

Through our research, we have found that generative artificial intelligence technology can be used in various ways for image design, such as generating images of specific styles, achieving image style transfer, improving image processing results, and generating image design materials. The medium used in artistic creation can affect the type, form, creative thinking, and technique of art works. AI-generated art also has its own creative mechanism, which not only provides new technical tools for artists but also offers new ways of thinking and creative concepts. [2]

Generative AI technology has a wide range of applications in image design and holds great potential for assisting designers in image processing and design. Furthermore, it provides excellent technical support for research and application in related fields.

### 5.2 Discussion

#### 5.2.1. The role of designers in collaborating with AI platforms.

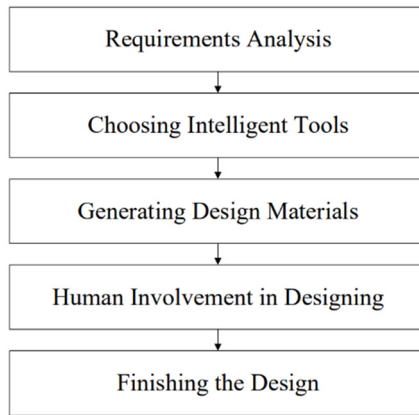
The question of whether artworks generated by artificial intelligence can be considered "art" has been widely discussed since AI technology was applied to art creation. According to Deniz E. Kurt, the power to recognize or evaluate a work as "art" is defined by the audience. Even for works created by humans, whether they are recognized as "art" depends on the audience's perception, not just the creator's intention. [3] In this dimension of thinking, even though AI platforms do not have human emotions and intentions, the works they generate can also be seen as art.

In the current technological environment, artificial intelligence is being used as a new tool for artistic creation, and humans are attempting to collaborate with machines as partners in co-creation. In this study, we practiced the image design process with the participation of artificial intelligence, exploring how designers communicate and interact with AI platforms. Artificial intelligence is a different kind of creative tool, and algorithm upgrades have enabled machines to have a "machine creativity" similar to that of humans. The work is completed through the creative interaction between the designer and the AI platform. [4] The development of AI-generated images has brought

various impacts to the design industry. Artificial intelligence is separating creativity from human agency through technological advancements, thus it is seen as a threat. [5] The low cost of generating images with AI has led to some designers experiencing reduced sense of accomplishment and perception due to less creative input in their collaboration with AI. It has become increasingly important to maintain personal interpretation and uphold creative integrity while collaborating with AI in the design process.

### 5.2.2. Collaboration Process between Designers and AI Platforms.

The process of collaboration between designers and AI platforms to complete a work can be roughly divided into the following steps, as demonstrated in Figure 4.



**Fig. 4.** Collaboration Process between Designers and AI Platforms

Firstly, identify design requirements and goals. Designers need to clarify the requirements and goals of the design, including the content, style, composition, color, and other elements of the desired image. These elements will provide guidance and constraints for using AI tools in the subsequent steps. Secondly, select the appropriate AI platform. Based on the design requirements and goals, the designer needs to choose the AI image generation tool that best fits their needs. Thirdly, run the AI tool to generate design materials. Run the AI image generation platform to generate design materials. If necessary, the designer can run multiple attempts to generate multiple design materials and then choose the most suitable one. Fourthly, use the generated materials to create the design. The designer creates the design based on the generated materials, either to meet the design requirements and goals or to gain inspiration for creative work. The generated materials can also be used as a reference to assist the manual design process. Finally, complete the design when satisfied with the result.

### 5.2.3. Copyright and Ethical Controversies of Artificial Intelligence in Design.

The ethical implications of AI-generated images are a topic worth considering. Japanese artist Mai Yoneyama has explicitly stated on social media that her works are strictly prohibited from being used with AI, yet there are still people who use AI to

learn her style and generate new images that are then shared on social media. Whether the use of AI to learn specific artistic styles without authorization can be constrained should be evaluated by the artists themselves.

In the face of issues brought about by AI-generated images, in addition to research institutions and developers enhancing the development of AI painting techniques, there may be a need to strengthen the transparency and openness of AI painting technologies, allowing users to better understand the potential risks of technology use. At the same time, governments and companies should strengthen regulation of AI painting technologies, improve usage norms, and enhance public trust.

In the era of big data, the use of AI may also lead to copyright disputes, involving issues related to the protection of users' and consumers' personal privacy. Users need clear legal boundaries to safeguard their own and others' legitimate rights and interests. In the future, discussions may arise regarding knowledge payment for AI-generated content.

## **6 CONCLUSION**

The application of generative artificial intelligence technology in image design has brought many new possibilities and opportunities to the fields of image processing and design. It can achieve various applications such as image style transfer, automatic image generation, and image design assistance, which is expected to improve the efficiency and quality of image processing and design. As the application scope of AI generation platforms expands, it is necessary to conduct relevant theoretical research on the basis of artistic practice, to help institutions and individuals understand the reasonable use of AI technology, be aware of the limitations and potential issues of AI technology, and enable AI technology to better serve artistic innovation and development.

## **AUTHORS' CONTRIBUTIONS**

Xiaoyu Ji proposed the research idea. Shanxi Liao conducted research and analyzed case studies. Shanxi Liao wrote the initial draft of the manuscript. Xiaoyu Ji revised the manuscript. All authors approved the final version of the manuscript.

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