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Interactive Enhancement of Tourism Product Design Using Machine Vision and CAD Technology

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Abstract. The interactivity of tourism product design improves the user experience and promotes tourism development. However, it faces challenges in technology realization, user experience, data processing, differentiated design, and innovation. Therefore, it is necessary to study how to use machine vision and CAD (computer-aided design) technology to enhance the interactivity of tourism product design and the attraction and competitiveness of tourism products. This article explores the application of machine vision and CAD technology in enhancing the interactivity of tourism product design and designs a comparative experiment to verify the effect of machine vision and CAD technology in enhancing interactivity. The experiment shows that the interactive enhancement method based on machine vision and CAD technology not only improves the design efficiency and stability at the technical level but, more importantly, optimizes the user experience from the user's point of view so that users can participate in the design process more intuitively and truly, thus significantly improving user satisfaction. Moreover, the interactive enhancement method based on machine vision and CAD technology ensures more accurate and smooth interaction between designers and users by improving the accuracy of image recognition and CAD modeling. This advantage enables designers to realize users' intentions more accurately and improves the overall quality and efficiency of design.

Keywords: Machine Vision; CAD Technology; Tourism Products; Interactive Design; Design Efficiency; User Experience
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1 INTRODUCTION

In the modern tourism industry, the design of tourism products increasingly needs to consider the influence of various factors. These factors include the interests, preferences, and needs of tourists, as well as the characteristics of tourism resources and environment. To solve the problems faced in

tourism product design, Agius et al. [1] proposed a tourism support tool based on machine learning and collaborative knowledge. This tourism support tool adopts machine learning technology, which can automatically learn and update knowledge, thereby continuously improving its understanding of tourist needs and tourism resource characteristics. At the same time, it also adopts collaborative knowledge technology to achieve knowledge sharing and communication among different stakeholders, thereby promoting the design and optimization of tourism products. Through machine learning techniques, this tool can automatically extract useful information from a large amount of data and update its knowledge base. These data include behavioral data of tourists, characteristic data of tourism resources, etc. This tool can provide recommendations for tourism product design and optimization based on the needs and preferences of tourists, as well as the characteristics of tourism resources. These suggestions can include optimizing tourist routes, recommending tourist attractions, and improving tourism services. This tourism support tool is a new type of computational support tool based on machine learning and collaborative knowledge, aimed at solving the problems faced in tourism product design. By automating learning and updating knowledge, promoting tourism product design and optimization, achieving knowledge sharing and communication, and supporting decision-making.

A tourism product design with good interactivity can make tourists more actively participate in planning their own trips and customize their trips according to their personal preferences and needs, thus enhancing their sense of participation and satisfaction. Digital dual-drive supervised machine learning combines the advantages of supervised learning and reinforcement learning to better handle complex and ever-changing tourism data, providing more accurate and personalized services for the tourism industry. By utilizing digital dual drive supervised machine learning, tourism recommendation systems. Alexopoulos et al. [2] analyze the historical behavior and preferences of tourists, predict their future needs and preferences, and recommend the most suitable tourism products or services to them. Digital dual-drive supervised machine learning can help tourism enterprises better manage risks. By analyzing historical data and predictive models, the system can identify potential risk factors and provide early warning for enterprise managers. In addition, the system can provide strategic recommendations for the expansion and development of enterprises by analyzing market trends. Digital dual-drive supervised machine learning can help improve tourism traffic management. By analyzing traffic flow data and prediction models, the system can predict future traffic conditions and provide decision support for traffic management departments. In addition, the system can improve the efficiency and safety of tourism transportation by optimizing route planning and scheduling management. Moreover, through interactive design, tourism products can better display the characteristics, culture, and tourism resources of the destination, stimulate tourists' interest, and further promote the development of tourism.

Machine vision and computer-aided design (CAD) technology have been widely applied in various fields. Especially in the tourism product industry, the combination of machine vision and CAD technology can achieve three-dimensional modeling of tourism products, further promoting innovation and development. Deng et al. [3] explored how to combine machine vision and CAD product CAD. Machine vision technology can achieve automatic recognition and modeling of tourism products through image processing and pattern recognition. Firstly, through machine vision technology, the images of tourism products can be automatically scanned and feature extracted, thereby obtaining the geometric shape and texture information of tourism products. Then, machine learning algorithms are used to learn and model this information, generating a three-dimensional model of tourism products. By using CAD software, a three-dimensional model of tourism products can be established based on the geometric shape and texture information obtained by machine vision technology. The CAD technology can achieve functions such as automatic recognition, modeling, measurement, and optimization of tourism products. This can not only improve the design and production efficiency of tourism products but also further promote innovation and development of the tourism industry.

However, the current interactive situation of tourism product design faces some challenges. On the one hand, traditional tourism product design methods usually lack interactivity and present product information in a linear and static way, which cannot fully reflect tourists' individual needs and

willingness to participate. In the tourism industry, HCI is used to improve the experience of tourists, enhance interactivity, and provide more personalized services. In recent years, the development of advanced tactile sensors and edge machine learning technology has deepened the application of HCI in the field of tourism vision. Advanced tactile sensors can capture and transmit tactile information, including pressure, temperature, vibration, etc. In human-computer interaction, these sensors can be used to recognize and interpret gestures, objects, shapes, textures, etc. Fazio [4] can recognize tourist gestures and objects in real time by running edge machine-learning algorithms on terminal devices. This can improve response speed and privacy protection, avoiding the transmission of sensitive data to the cloud. Through edge machine learning, real-time analysis of tourist behavior and feedback can be conducted on terminal devices, providing more personalized services. For example, the explanation content of a virtual tour guide can be adjusted based on the walking speed and interests of tourists. The use of machine learning design CAD (computer-aided design) concepts to develop tourism recommendation systems has become a trend. This technology that combines artificial intelligence and computer graphics can provide strong support for the development of tourism in landscape areas. CAD can help designers create 3D models of landscapes, thereby better grasping the form and details of the landscape. CAD can use virtual reality and simulation technology to analyze lighting, pedestrian flow, ecology, and other aspects of the landscape, thereby helping designers optimize design solutions. CAD can use technologies such as GIS (Geographic Information System) to carry out spatial planning, land use planning, transportation planning, etc. for landscapes, thereby providing support for tourism development. Gamidullaeva et al. [5] trained and learned the extracted features using machine learning algorithms to obtain a travel recommendation model. Evaluate and optimize the tourism recommendation model through techniques such as cross-validation to ensure its accuracy and reliability. By combining machine learning and CAD technology, precise analysis of user behavior can be achieved, personalized attraction recommendation services can be provided, and tourism route planning schemes can be optimized. Meanwhile, this technology can also provide support for the development planning of landscape areas.

On the other hand, although some tourism products begin to try to introduce interactive elements, there are often problems, such as difficult technical implementation and poor user experience. For example, some interaction designs are too complicated and have high use thresholds, which makes it difficult for tourists to operate and experience. Other designs are not intelligent and personalized enough to provide targeted recommendations and customization according to tourists' preferences and needs. Virtual reality (VR) technology and machine vision have played an increasingly important role in tourism product design. Through these two technologies, designers can better understand the form, function, and aesthetic value of tourism products, creating a more immersive and personalized experience for tourists. Gong et al. [6] explored how to conduct aesthetic analysis of tourism product design based on virtual reality technology and machine vision. Using 3D modeling software, designers can create virtual models of tourism products and observe the shape and details of the products from any angle. This enables designers to more accurately grasp the shape, proportion, and color elements of products, improving the efficiency and accuracy of design. Machine vision technology provides powerful image processing and analysis capabilities for tourism product designers by automatically recognizing and extracting features from images of tourism products, machine vision technology. The aesthetic analysis of tourism product design based on virtual reality technology and machine vision is a comprehensive process that involves multiple aspects such as form, function, and user experience. By utilizing these technological means, the user experience processes and observe user reactions and evaluations, providing guidance for product optimization and improvement. In addition, the interactivity of tourism product design also faces some other challenges. For example, a large number of tourist information and data need to be processed in the design process, and how to effectively manage and utilize these data is an important issue. In virtual reality tourism environments, 3D models, as an important form of representation, have a significant impact on the learning availability of tourists.

Huang and Lee [7] explored the factors that affect the usability of 3D model learning in virtual reality tourism environments. Interactive design is an important part of the virtual reality tourism

environment, which can enhance the interaction and immersion between tourists and 3D models, thereby improving learning effectiveness. Through interactive design, tourists can more conveniently operate and control 3D models and observe and learn about attractions from multiple perspectives. At the same time, good interactive design can also improve the user experience, allowing tourists to immerse themselves more comfortably and naturally in the virtual environment. Interactive design is one of the important factors affecting the usability of 3D model learning in virtual reality tourism environments. By using methods such as natural interaction design, virtual tour guides, and social interaction, it is possible to enhance the interaction and immersion between tourists and 3D models, enhance learning effectiveness, and enhance user experience. In the future, the expansion of application scenarios and interactive design will play an increasingly important role in virtual reality tourism environments. For different types of tourism products, how to carry out differentiated interactive designs according to their respective characteristics and needs is also a problem to be solved. Moreover, with the rapid development of technology, keeping the interactive innovation and timeliness of tourism product design and keeping up with the times are also continuous challenges facing the industry. Therefore, it is necessary to introduce new technologies to enhance the interactivity of tourism product design.

Machine vision is a science that studies how to make machines "see." It can extract, process, and analyze information from images or videos. In the interaction of tourism product design, machine vision can identify and analyze all kinds of tourism-related image information, such as scenic spot photos, maps, and so on. This means that a tourism product design platform can use machine vision technology to automatically extract key information and data from the pictures uploaded by users, such as the location and characteristics of scenic spots, and then provide users with more personalized product recommendations and design suggestions. CAD technology is widely used in various design fields, which can provide designers with powerful modeling, visualization, and simulation tools. Using CAD technology, designers can accurately construct various components of tourism products, such as hotel layouts, scenic spots, and facilities, and visualize them with high quality. This can not only provide visitors with a more realistic and accurate product preview but also enable designers to better interact with users' feedback from users. In this article, machine vision and CAD technology are used to enhance the interactivity of tourism product design.

⊖ Interaction enhancement: In the field of tourism product design, an innovative idea of enhancing interaction by using machine vision and CAD technology is put forward. By integrating these two technologies, the interaction between designers and users becomes more intuitive, accurate, and efficient.

⊜ Technology integration: This article combines machine vision and CAD technology and applies it to the interactive enhancement of tourism product design. This cross-domain technology integration has brought new possibilities for product design and promoted the innovation of design methods.

⊛ Improvement of user participation: Through the intuitive visual feedback provided by machine vision and the high-precision modeling provided by CAD technology, users can participate more deeply in the process of product design, thus improving user satisfaction and product applicability.

This article first analyzes the existing research through a literature review, then puts forward the theoretical framework and implementation method, then verifies the feasibility of the method through simulation experiments, and finally draws a conclusion.

2 RELATED WORK

3D printing technology provides new visual potential for tourism landscape design, allowing designers to present design solutions more intuitively and improve design efficiency and quality. Tourism landscape design involves multiple aspects, including terrain, architecture, vegetation, water bodies, etc. 3D printing technology can use different materials and printing techniques to present complex shapes and details for different design elements. Meanwhile, 3D printing technology can also create models of different proportions according to the needs of designers for analysis and

optimization of solutions. Kim et al. [8] explored the visual potential of 3D printing technology in the process of tourism landscape design. 3D printing technology can transform tourism landscape design schemes into physical models, allowing designers to evaluate and optimize design schemes more intuitively. This intuitive presentation method can help designers better grasp design details and improve design efficiency and quality. 3D printing technology has enormous visual potential in the process of tourism landscape design. 3D printing technology can bring more possibilities and innovations to tourism landscape design through the intuitive presentation of solutions, enhanced communication effects, detailed presentation, and data analysis, as well as innovative design and presentation techniques. The application of robots can help improve information processing efficiency, provide more convenient services, and enhance the experience of tourists. Kondratenko et al. [9] explored how to use machine learning techniques to improve the efficiency of robot sensors and control information processing in tourism information. Machine learning can help analyze the data collected by robot sensors, thereby identifying objects and features in the environment. By using machine learning algorithms to process sensor data, it is possible to automatically recognize the behavior and feedback of tourists, thereby providing more personalized services. Machine learning can help predict tourist behavior and decisions, thereby making corresponding responses in advance. Reinforcement learning is a machine learning method that utilizes trial and error learning. In tourism information processing, reinforcement learning can help robots optimize and improve themselves based on historical data and learning experience. Training and optimizing robot behavior through reinforcement learning algorithms can improve the response speed and service quality of robots.

In tourism product design, mixed reality technology can have a profound impact on the early design process. This environment can include virtual reconstruction of tourist attractions, as well as historical, cultural, natural, and other background information related to the attractions. This enhanced connection between design and the actual environment helps to enhance the realism and user experience of tourism product design. In the tourism industry, mixed reality technology has had a profound impact on interactive tourism vision, providing a more immersive and interactive experience. Maurya et al. [10] explored how mixed reality technology can impact interactive tourism vision. Through mixed-reality technology, tourists can gain a more intuitive and vivid visual experience while visiting scenic spots. At the same time, tourists can also gain a more in-depth travel experience through interaction with scenic spots. Hybrid reality technology has brought innovation to tourism products and services. By combining virtual elements with the real environment, tourist attractions can provide a more innovative and interesting travel experience. In the tourism industry, data-driven tourism recommendation systems are receiving increasing attention. The core of this recommendation system is to analyze and predict a large amount of tourism data through machine learning algorithms in order to provide personalized travel suggestions for tourists. Md et al. [11] reviewed the application of machine learning in data-driven quality prediction in the tourism recommendation process under the background of Industry 4.0. Machine learning is a methodology of artificial intelligence that enables computers to self-learn and improve by analyzing patterns and relationships in data. In tourism recommendation systems, machine learning can be used to predict the preferences, behaviors, and needs of tourists. For the tourism industry, data-driven quality prediction of tourism recommendations is particularly important. Machine learning can help businesses extract valuable information from a large amount of tourism data, thereby providing more personalized services for tourists. Optimization, accurate prediction, and personalized recommendation of tourist behavior can be achieved. This can not only improve tourist satisfaction and loyalty but also help tourism enterprises improve operational efficiency and market competitiveness.

BIM models have become an indispensable part of the design and construction process of building projects. Especially in construction projects of tourist attractions, the application of BIM models can help achieve more efficient, accurate, and sustainable construction. Mulero et al. [12] explored how to use completed BIM models to improve machine learning for tourist attraction construction projects. In construction projects in tourist attractions, machine learning can help achieve more efficient, precise, and sustainable construction. The completed BIM model can provide high-quality

data support for machine learning. The use of completed BIM models to improve machine learning in tourist attraction construction projects is of great significance and value. Through high-quality data support and advanced machine learning algorithms, it plays an important role in improving design efficiency, reducing construction costs, and improving construction accuracy. At the same time, problems in design and construction can be identified, optimization suggestions can be proposed, and the sustainability of buildings can be improved. Therefore, we should further promote and apply BIM technology and machine learning algorithms in tourist attraction construction projects to achieve more efficient, accurate, and sustainable construction. Digital tourism has become an important direction in the tourism industry. Among them, virtual reality technology provides new ideas and implementation methods for the visual system design of tourism landscapes. Poux et al. [13] explored the application of virtual reality technology in the design of tourism landscape visual systems with a user-centered approach. Digital tourism is a product of the combination of tourism industry, digital technology, and internet technology. It provides tourism services through digital technology and internet technology, including online tourism consultation, virtual tourism, and tourism route planning. Virtual reality technology is an important component of digital tourism, which can simulate real tourism landscapes through computers, allowing users to experience the joy of tourism at home. User-centered virtual reality tourism landscape visual system design refers to the design of a visual system that can truly and vividly display the tourism landscape based on the needs and experiences of users.

With the advancement of Industry 4.0, the manufacturing industry is undergoing a revolution led by machine learning and artificial intelligence. In this revolution, CAD 3D modeling of tourism products has also been significantly improved. Rai et al. [14] achieved automatic recognition, modeling, optimization, and production of tourism products. Machine learning technology can automatically identify the characteristics and patterns of tourism products by analyzing a large amount of data, thereby establishing accurate tourism product models. By analyzing a large amount of tourism product images and data, machine learning techniques can identify the geometric shape, texture, and color features of products, thereby establishing a data-based tourism product model. By continuously training and optimizing machine learning models, fine adjustments and improvements can be made to tourism product models, thereby improving product quality and performance. In the context of manufacturing and Industry 4.0, by combining machine learning and CAD technology, we can achieve automatic recognition, modeling, optimization, and production of tourism products. Tamir et al. [15] introduced a machine learning-based method for monitoring and optimizing process parameters of 3D tourism products. In the production of tourism products, machine learning can be used to predict product quality, optimize process parameters, and so on. A certain tourism handicraft enterprise encountered problems such as unstable product quality and low production efficiency during the production process. To address these issues, the company has adopted a machine learning-based method for monitoring and optimizing the process parameters of 3D tourism products. By collecting production data, extracting features, and training models, we have successfully improved product quality and production efficiency while reducing production costs.

Machine learning, as a key component of AM technology, is playing an increasingly important role in the tourism industry. Xames et al. [16] explored the tourism trends of machine learning applications in additive manufacturing. Machine learning can help tourist attractions predict future passenger flow and tourist behavior. By analyzing historical data, machine learning can identify seasonal changes and other influencing factors, providing a basis for scenic spot operations. Customized tourism products can be quickly manufactured through AM technology and machine learning. For example, specific souvenirs or travel supplies can be printed based on the needs and preferences of tourists. Machine learning can help tourist attractions provide more intelligent and personalized services. For example, machine learning can recommend the best travel routes and attractions by analyzing tourist behavior and feedback and provide relevant information and explanations. Machine learning can help tourist attractions make decisions based on data. By analyzing historical data, machine learning can identify seasonal changes and other influencing factors, providing a basis for scenic spot operations. For example, future passenger flow and tourist

behavior can be predicted based on historical data to develop more reasonable operational strategies.

3 A THEORETICAL FRAMEWORK FOR ENHANCING THE INTERACTIVITY OF TOURISM PRODUCT DESIGN

3.1 Machine Vision and CAD Technology Foundation

Machine vision realizes human visual function. Its basic principles include image acquisition, preprocessing, feature extraction, and recognition. This technology includes image processing, image analysis, pattern recognition, and other aspects and is widely used in quality inspection, target tracking, 3D reconstruction, and other fields. CAD technology is a product design technology aided by computer software. Its basic principle is to integrate geometric modeling, graphic processing, and data analysis in the design process to provide efficient and accurate design tools. CAD technology is not only used in traditional design fields such as machinery and architecture but also extended to various industries such as electronics, aerospace, and automobiles. The integration of machine vision and CAD technology can realize the close combination of design and actual production. The integration and application of machine vision and CAD technology are as follows:

Reconstruction of CAD model based on machine vision: Using machine vision technology to obtain image data of actual objects and generating CAD model through 3D reconstruction algorithm. This method can quickly obtain an accurate model of the actual object and carry out subsequent design and optimization in a CAD environment. Machine vision aided CAD design verification: In the process of CAD design, machine vision technology can be used to verify the design in real-time. For example, machine vision can detect problems such as collision and interference in design and provide immediate feedback to designers for modification.

Automatic design and optimization: Combining machine vision and CAD technology, an automatic design and optimization system can be built. Machine vision can provide the input of actual data, while CAD technology is used to model and optimize the design. Through machine learning and other technologies, the system can continue to learn and evolve. The interaction of tourism product design refers to the interaction and communication between designers and users in the process of tourism product design. It emphasizes the importance of user participation and experience and encourages designers to consider users' needs and feedback in product design. The concept of interactivity comes from the fields of human-computer interaction and user experience design, and its purpose is to improve the usability, attractiveness, and user satisfaction of products by designing better interaction methods.

In the design of tourism products, interactivity can be applied to different stages, such as demand research, product planning, design iteration, and so on. By interacting with users, designers can better understand users' needs and preferences so as to design products that are more in line with market demand. Moreover, interactivity can also improve users' sense of participation and satisfaction and enhance users' trust and loyalty to products.

3.2 The Framework Construction of Enhancing the Interactivity of Tourism Product Design

The idea of using machine vision and CAD technology to enhance the interactivity of tourism product design is to introduce these advanced technologies into the product design process and provide better interactive methods and tools to promote cooperation and communication between designers and users. Specific methods include image recognition and analysis: through machine vision technology, identify and analyze image information provided by users, such as photos of tourist attractions, hand-drawn sketches, etc., so as to automatically extract design elements and user needs, and provide designers with more accurate user feedback and design reference. 3D modeling and visualization: Using CAD technology, 3D models of tourism products are established, and high-quality visualization is carried out. They interact with users in real-time to improve the design accuracy and user satisfaction.

The noise generated in the process of image acquisition is mainly influenced by the type and quality of image sensors, and some sensors will inevitably introduce noise when collecting images. Noise is generally random and unpredictable, so we can only study it through some statistical laws, and we can use the probability density function to describe the noise model. Gaussian noise is the most common in practical image processing applications. The probability density distribution function of random variable Z conforming to Gaussian distribution is as follows:

$$P\ z\ = \frac{1}{\sqrt{2\pi}\sigma} e^{\frac{-\ z-\mu\ ^2}{2\sigma^2}} \tag{1}$$

Where Z stands for image noise; V represents the average or expectation of image noise; σ represents the standard deviation of image noise. The variance of image noise is the square σ^2 of the standard deviation of pixel values. For an image $g\ x,y$ contaminated by noise, any pixel x,y in the image, S_{xy} is used to represent the neighborhood of pixel x,y . Therefore, the new pixel values of all pixels can be calculated using the following formula to generate the restored image $\hat{f}$:

$$\hat{f}\ x,y\ = \frac{1}{mn} \sum_{s,t\ \in S_{xy}} g\ s,t \tag{2}$$

Where m,n is the size of S_{xy} .

Combining machine vision and CAD technology, VR and augmented reality environment are constructed so that users can preview and experience tourism products in real-time during the design process. This immersive interaction can enhance the user's sense of participation and realism. To build a framework for enhancing the interactivity of tourism product design, it is necessary to comprehensively consider the interactive design theory, machine vision technology, CAD technology, and other factors. The core of the framework is user-centered, and by introducing machine vision and CAD technology, the interactive methods and tools in the product design process are optimized so as to improve the interactive effect. This framework is shown in Figure 1.

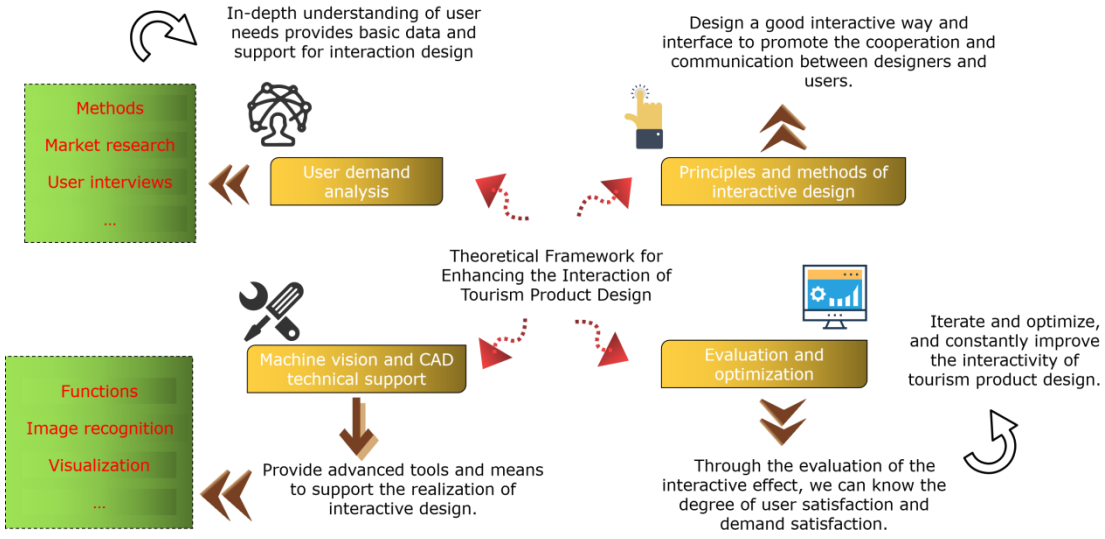


Figure 1: A theoretical framework for enhancing the interactivity of tourism product design.

The framework will provide effective theoretical and methodological guidance for users to participate in tourism product design, and improve the interactive effect and the quality of user experience through the support of machine vision and CAD technology.

4 REALIZATION METHOD OF ENHANCING THE INTERACTION OF TOURISM PRODUCT DESIGN BY USING MACHINE VISION AND CAD TECHNOLOGY

4.1 Interactive Enhancement of Tourism Product Design Based on Machine Vision and CAD Technology

Machine vision can play an important role in enhancing the interactivity of tourism product design. Identify key elements such as tourist attractions and buildings through machine vision technology and understand their spatial relationships and attributes. Designers can quickly construct the preliminary design of tourism products according to the image information and interact intuitively with users. Machine vision can also be used to recognize the user's gestures and actions, thus achieving a more natural and intuitive way of interaction. Designers can use this technology to let users operate and modify the elements and layout of tourism product design through gestures. Moreover, with the help of machine vision technology, the real-time preview function of tourism product design can be realized. Designers and users can instantly check the effect of design modification through cameras or image sensors and get a more real and accurate interactive experience.

Compared with gray images, color images can provide more information. In the interactive design of tourism product design, the target to be analyzed can be easily extracted with the help of a color space model. According to the principle of three primary colors, the color equation of any color is:

$$F = \alpha\ R\ + \beta\ G\ + \gamma\ B \tag{3}$$

Among them, α, β γ are the mixing ratios of red, green, and blue, which are called tricolor coefficients. Read the original color image of tourism products, convert it into a gray image, and adjust its gray image, as shown in Figure 2.

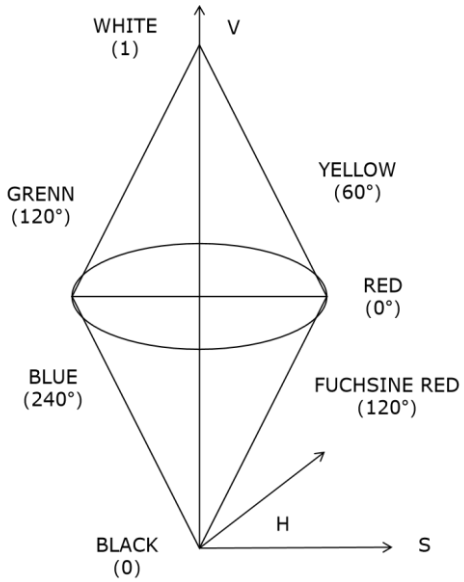


Figure 2: HSV color model.

$$H = \cos^{-1}\left[\frac{R-G\ +\ R-B}{2\sqrt{R-G^{\ 2}+\ R-B\ \ G-B}}\right] \tag{4}$$

$$R \neq B \quad or \quad G \neq B \tag{5}$$

$$S = 1 - \frac{3}{R+G+B}\left[\min\ R,G,B\ \right] \tag{6}$$

$$V = \frac{R+G+B}{3} \tag{7}$$

Set the number of grayscale levels in the input image to L, and the grayscale interval of f to $\left[f_{\min}, f_{\max}\right]$; The grayscale range of g is $\left[g_{\min}, g_{\max}\right]$; $C\ f$ represents the cumulative distribution function of input image grayscale, which is defined as follows:

$$C\ f\ = \sum_{j=0}^{k} P_f\ f_j \tag{8}$$

$$j = 0,1,2,3,\ldots,k,\ldots,L-1 \tag{9}$$

CAD technology provides a powerful modeling and visualization tool for enhancing the interactivity of tourism product design. Using CAD technology, designers can create accurate 3D models of tourism products, including buildings, landscapes, facilities, and other components. Users can intuitively check and explore the details of the design and better understand the product characteristics and design concepts. CAD technology supports parametric design, and designers can set different parameters to control the shape and size of products. By adjusting these parameters, users can observe the design changes in real time and participate in the decision-making process of product design. Moreover, this article uses CAD technology to build a collaborative design environment so that multiple designers and users can access and operate the same design model at the same time. This cooperative work mode can enhance teamwork, accelerate design iteration, and improve design efficiency.

4.2 Advantages of the Combination of Machine Vision and CAD Technology

Machine vision and CAD technology can complement each other and play a greater role in enhancing the interactivity of tourism product design. This article combines machine vision and CAD technology to generate the corresponding 3D model automatically or semi-automatically by identifying the key elements in the image. This method can quickly build a preliminary design and provide users with a more intuitive and easy-to-understand interactive interface. The image data of the real scene is obtained by machine vision technology and fused with the 3D model designed by CAD. In this way, the actual environmental factors can be considered in the design stage, and the accuracy and feasibility of the design can be improved. In addition, machine vision can be used to analyze the interactive data between users and design and combined with CAD technology for intelligent optimization. By analyzing the user's line of sight trajectory and operation behavior, targeted design optimization suggestions are provided to enhance the user experience of the product further. In the next section, the method proposed in this article is simulated, and the results are analyzed.

5 SIMULATION EXPERIMENT AND RESULT ANALYSIS

5.1 Simulation Experiment Design

In this section, in order to verify the effect of machine vision and CAD technology in enhancing the interactivity of tourism product design, a simulation experiment is designed. First of all, the representative tourism product design cases are selected in the experiment, and an interactive

enhancement system based on machine vision and CAD technology is constructed. The system integrates image recognition, 3D modeling, real-time preview, and other functions to support the interactive operation between designers and users. Next, a comparative experiment is designed to compare the traditional tourism product design method with the interactive enhancement method based on machine vision and CAD technology. As shown in Figure 3, the visualization effect of tourism product design with traditional methods is shown, and Figure 4 shows the visualization effect of tourism product design with interactive enhancement methods based on machine vision and CAD technology.

Tourism product design using traditional methods

Figure 3: Visualization effect of traditional method design.

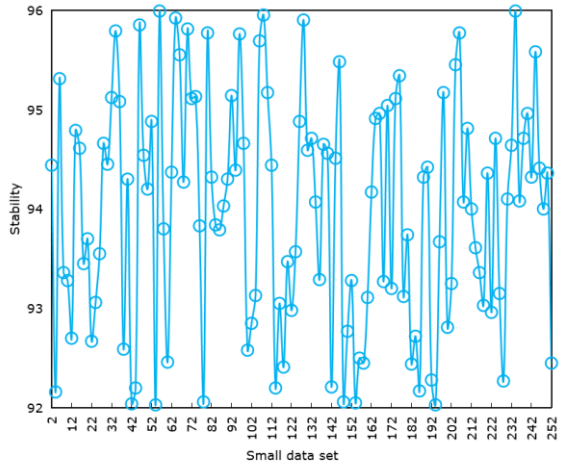
Tourism product design based on interactive enhancement method of machine vision and CAD technology

Figure 4: Visualization effect of this method.

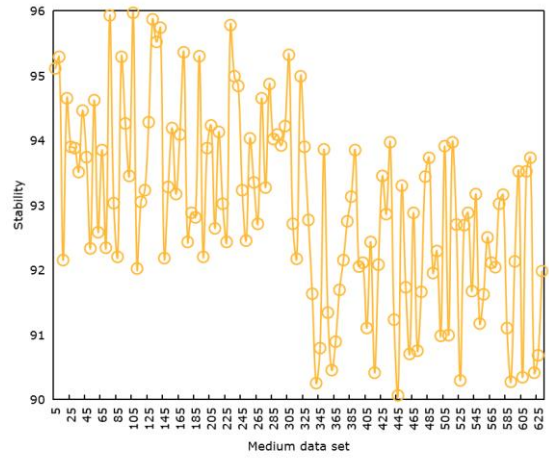
In the experiment, this article invited designers and users to participate and record their design process and interactive experience under the traditional method and enhanced method respectively. In order to objectively evaluate the experimental effect, the evaluation index is set, including design efficiency, user satisfaction, interaction accuracy, and so on. These indicators will be used to quantitatively analyze the experimental results.

5.2 Experimental Results and Data Analysis

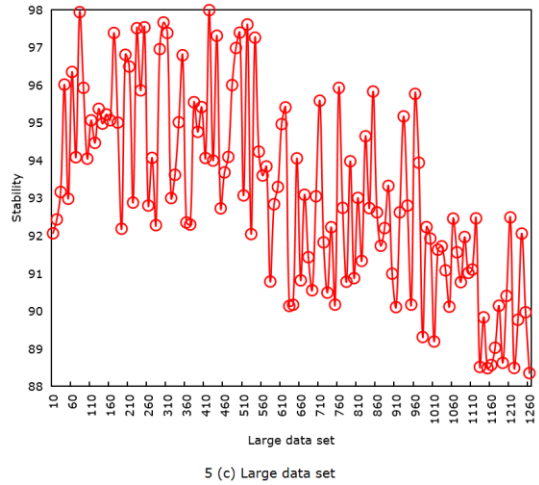
The following experimental data sets are tested with different scales of data sets, including small, medium, and large data sets, to verify the stability of the algorithm under different data volumes. For the machine vision algorithm, this section adjusts the key parameters to obtain the best performance. For CAD technology, this section adopts high-precision modeling and rendering settings to ensure design accuracy. During the experiment, designers and users are required to operate according to the predetermined design tasks, and their design operations, interaction behaviors, and feedback opinions are recorded. Moreover, the operation of the algorithm is monitored, including processing time and memory consumption. The stability of the algorithm is shown in Figure 5.



5 (a) Small data set



5 (b) Medium data set



5 (c) Large data set

Figure 5: Stability test results of the algorithm.

It can be seen from the data in the figure that the interactive enhancement method based on machine vision and CAD technology has obvious advantages in stability. In large data sets, the algorithm in this article can still maintain about 90% stability, which shows that the algorithm has good robustness when dealing with a large amount of data. This is because the algorithm in this article makes full use of the processing power of the computer and realizes parallel processing. This processing method can handle multiple tasks, which improves the overall stability and efficiency of the algorithm.

In order to compare the difference in design efficiency between the interactive enhancement method based on machine vision and CAD technology and the traditional method, this section sets the same design task, requiring designers to complete the design of a tourism product within a specified time. The task includes the acquisition of design references and the completion of the final design scheme. For the interactive enhancement method based on machine vision and CAD technology, corresponding tools and environments are provided, including image recognition, 3D modeling, real-time preview, and other functions. For the traditional method, conventional design tools, such as hand-drawn board and design software, are provided. During the experiment, the time spent by designers in each design stage is accurately recorded, and the quality and efficiency of their designs are evaluated. The design efficiency of different methods is shown in Figure 6.

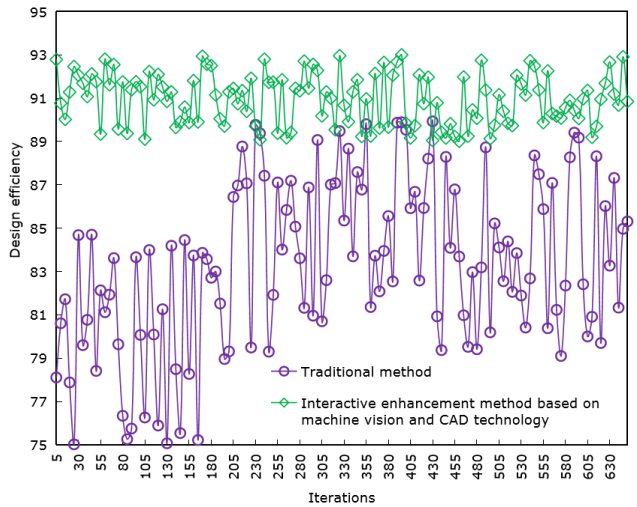


Figure 6: Comparison of design efficiency of different methods.

It can be seen from the data in the figure that the interactive enhancement method based on machine vision and CAD technology is obviously higher than the traditional method in design efficiency. This is mainly because machine vision technology can quickly identify and extract the key information in the image and provide accurate design references for designers. This makes it unnecessary for designers to spend a lot of time manually collecting and sorting out reference materials. Moreover, through CAD technology, designers can use accurate geometric modeling tools to quickly build product prototypes and make detailed adjustments. Compared with traditional hand-drawn or modeling methods, this modeling method is more accurate and efficient. In addition, the interactive enhancement method based on machine vision and CAD technology also provides a real-time preview function. Designers can immediately check the design effect and adjust it during the design process. This kind of real-time feedback greatly improves the flexibility and efficiency of design. Designers can get the design reference more quickly, and model accurately in real-time preview.

In order to compare the differences in user satisfaction between the traditional tourism product design method and the interactive enhancement method based on machine vision and CAD technology, this section invited two groups of users to participate in the experiment, and the number

of users in each group was equal. One group uses traditional design methods, and the other group uses interactive enhancement methods based on machine vision and CAD technology. The same design task is set for two groups of users, that is, designing a tourism product. The task clearly puts forward the design objectives and requirements. After the experiment, users are asked to evaluate the satisfaction of the design method used. In order to collect more comprehensive data, this section uses a variety of evaluation tools, including questionnaires, user interviews, and observation records. The specific user satisfaction is shown in Figure 7.

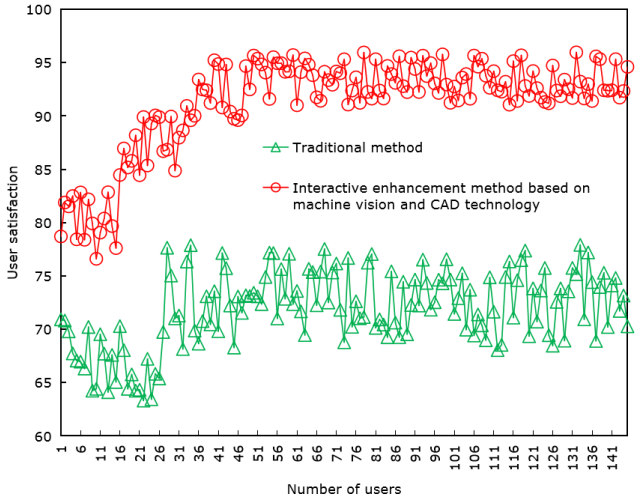


Figure 7: User satisfaction.

It can be seen from the data in the figure that the interactive enhancement method based on machine vision and CAD technology surpasses the traditional method in user satisfaction. This is because, through machine vision technology, users can see the initial effect of the design more directly, so as to understand the designer's intention more quickly. This intuition greatly improves the communication efficiency between users and designers. Moreover, the real-time preview and adjustment function makes users no longer passive recipients, but can actively participate in design decisions. Users can immediately put forward their own suggestions and see the implementation effect of the suggestions in the design. This sense of participation greatly improves the satisfaction of users. Therefore, users' satisfaction with the enhanced method is obviously higher than that of the traditional method.

In order to compare the differences in interaction accuracy between different methods, several groups of images of tourism product design are selected as experimental samples to ensure that the samples are representative in content, complexity, and diversity. For the interactive enhancement method based on machine vision and CAD technology, designers use machine vision technology to identify product images, extract key features, and use CAD technology to accurately model. For traditional methods, designers rely on manual measurement, drawing, and modeling. The experiment established the evaluation standard of interaction accuracy, which was based on modeling accuracy, feature matching degree, and design modification times. By comparing the modeling results of designers with the needs of users, the interaction accuracy of different methods can be quantitatively evaluated. The interactive accuracy of different methods is shown in Figure 8.

It can be seen from the data in the figure that the interactive enhancement method based on machine vision and CAD technology is significantly better than the traditional method in interactive accuracy. This is because machine vision technology can accurately identify the key information in the image, such as shape, size, color, and so on, through advanced image algorithms.

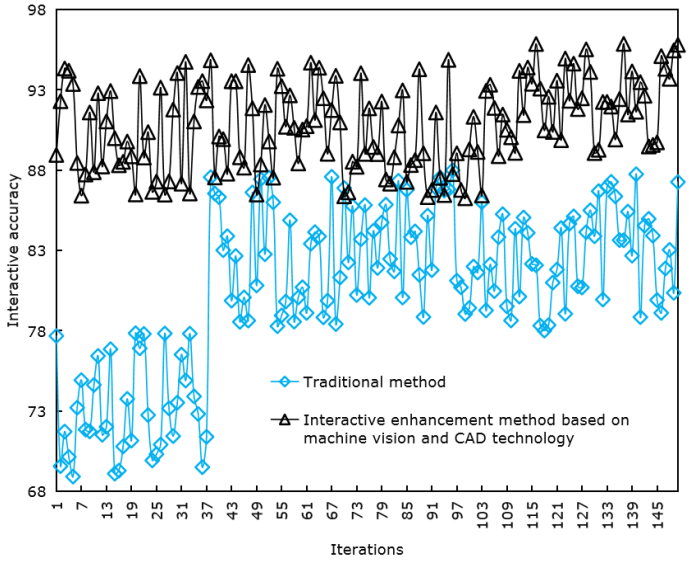


Figure 8: Comparison of interactive accuracy of different methods.

This provides accurate basic data for subsequent modeling. Moreover, combined with the data provided by machine vision technology, CAD technology can accurately build 3D models and ensure that the designer's intentions are accurately realized. In addition, CAD technology also provides a powerful tool for modification and adjustment, which enables designers to adjust quickly and accurately according to users' needs.

6 CONCLUSIONS

Both machine vision and CAD technology enhance the interactivity of tourism product design. They can not only provide designers and users with more intelligent and intuitive design tools and methods but also greatly enhance the interactivity and user experience of tourism product design, thus promoting the development and innovation of tourism. This provides sufficient background and motivation for this study and proves the value and significance of using machine vision and CAD technology to solve the interactive challenge of tourism product design. Through research, the following conclusions can be drawn:

⊖ The integration of machine vision and CAD technology can significantly improve the interactivity and user experience of tourism product design. This enhancement method is helpful in improving design efficiency, reducing the number of design iterations, and increasing user participation and satisfaction.

⊜ The effectiveness and feasibility of the interactive enhancement method based on machine vision and CAD technology in tourism product design are proved by simulation experiments. This brings new opportunities and challenges to the field of tourism product design.

⊛ The experiment verifies the advantages of the interactive enhancement method based on machine vision and CAD technology in stability. This method can still maintain good stability when dealing with a large number of data, which provides reliable technical support for enhancing the interactivity of tourism product design.

④ The application of machine vision and CAD technology alone or in combination can effectively enhance the interactivity of tourism product design and improve the user experience and design accuracy. These technologies bring innovative methods and tools to the field of tourism product design and are expected to promote the further development of this field.

In the future, we can further explore the deep integration of machine vision and CAD technology, optimize algorithms and tools, and improve the intelligence and adaptability of the system to better meet the needs of designers and users.

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