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Computer-Aided Design AND APPLICATIONS

Innovation of Computer Aided Design of Tourism Cultural Products with Service Design Concept

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Abstract. With the continuous development of image emotion recognition technology, computer vision technology and artificial intelligence algorithm can be used to analyze the emotion of images, and then emotional computer-aided design (CAD) of tourism products can be realized. In this paper, the concept of service design is combined with virtual reality (VR) technology, and the emotion identification technology based on convolutional neural network (CNN) is used for emotion analysis, so as to better understand and meet the needs and emotional state of tourists, provide more accurate services and solutions, and promote the innovative development of tourism. The simulation test shows that CNN model performs best in both accuracy and recall. This may be because CNN model has natural advantages in processing image data, which can better capture the characteristics of images and has good spatial perception ability. The CAD design method in this paper can improve the user experience of ICH tourism cultural products, make users understand and feel the cultural connotation of tourism products more deeply, and also enhance the interaction between users and tourism products.

Keywords: Service Design Concept; Virtual Reality; Intangible Cultural Heritage; Tourism Products; Computer Aided Design
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1 INTRODUCTION

With the rapid development of science and technology, CAD has been widely used in many fields, especially in service design and tourism product design. The service design concept is a user-centered design idea, which emphasizes the organic combination of service, product, communication and environment through systematic methods from the user's needs, so as to

improve the user experience and service quality. With the advancement of technology, Boboc et al. [1] entered a new era of digitization and informatization. This era has brought unprecedented convenience to our lives and also had a profound impact on various industries. In the field of cultural heritage management and protection, augmented reality (AR) technology is changing the way we work. By overlaying information, we can gain a deeper and more comprehensive understanding and protection of these precious cultural heritage. Through augmented reality technology, we can achieve high-precision digital recording of cultural heritage. For cultural heritage that has disappeared or been damaged, we can use augmented reality technology for virtual restoration. By simulating historical buildings, objects, etc., we can enable people to more intuitively experience the original appearance of these cultural heritage sites. During the process of visiting cultural heritage, tourists can directly see relevant historical and cultural information in front of their eyes through AR devices, making the visiting experience more in-depth and interesting. In service design, designers need to pay attention to users' needs and pain points, and solve problems through design thinking and methods to improve users' experience and service quality. At the same time, service design can also help enterprises better understand user needs and market trends, so as to make more accurate decisions. Chang et al. [2] explored the spatial and temporal distribution pattern of intangible cultural heritage resources in the Yellow River Basin, as well as their potential for tourism utilization, in order to provide theoretical support and practical guidance for relevant departments. The intangible cultural heritage resources in the Yellow River Basin have high potential for tourism utilization. On the one hand, the unique spatial and temporal distribution pattern makes the intangible cultural heritage resources in the Yellow River Basin highly attractive for tourism. On the other hand, the degree to which tourism utilization potential can be fully utilized also affects the protection and inheritance of intangible cultural heritage resources. Therefore, when formulating tourism resource development strategies, the characteristics of spatial and temporal distribution patterns should be fully considered to achieve effective utilization and sustainable protection of intangible cultural heritage resources. This article reveals the interrelationship between the spatiotemporal distribution pattern of intangible cultural heritage resources and tourism utilization potential in the Yellow River Basin. The unique spatiotemporal characteristics of these cultural heritage resources endow them with high tourism attractiveness, and the degree of utilization potential of tourism is constrained by the protection and inheritance of these resources. Tourism product design needs to consider how to integrate the culture, history, natural landscape and other elements of the destination into the product to attract tourists and enhance the tourism experience. As a computer technology, VR technology has the characteristics of immersion, interaction and imagination, and can provide users with immersive feelings. In recent years, with the continuous development of image emotion recognition technology, computer vision technology and artificial intelligence algorithm can be used to analyze the emotion of images, and then emotional service design can be realized.

With the continuous development of technology, the tourism industry is also seeking innovation and breakthroughs. Among them, the tourism augmented reality system based on image recognition has become a new research hotspot. Chiu et al. [3] introduced the basic principles, system design, implementation methods, and application scenarios of this technology, and finally provided prospects for future development. Tourism augmented reality system is a technology that combines virtual information with the real world, providing tourists with a richer interactive experience through devices such as mobile phones and tablets. The tourism augmented reality system based on image recognition has taken this field to a new level, providing personalized recommendations and services for tourists by recognizing image information. However, this field also faces some challenges, such as image recognition accuracy, data processing speed, and user experience issues. Image recognition technology plays a core role in tourism augmented reality systems. The tourism augmented reality system utilizes these recognition results to provide tourists with corresponding guidance, explanations, and other services. Emotional service design is a design idea centered on users' emotional experience, which emphasizes starting from users' emotional needs and improving users' experience and service quality through emotional design methods. Emotional service design can help enterprises better

understand the emotional needs and pain points of users, thus providing more accurate services and solutions. Image emotion recognition technology is a technology to analyze the emotion of images through computer vision technology and artificial intelligence algorithm. Through the emotional analysis of the image, we can judge whether the emotional tendency expressed in the image is positive or negative, thus providing support for emotional service design and tourism product design. In emotional service design, image emotion recognition technology can help designers better understand users' needs and emotional states by identifying and analyzing users' expressions and emotions, and then provide more accurate services and solutions. This paper mainly discusses the innovation of the combination of service design concept and VR technology in the design of ICH tourism cultural products. Through this combination, we can make use of the immersive, interactive and imaginative characteristics of VR technology and the emotional analysis ability of image emotion recognition technology to realize tourism product design and service experience that is more in line with users' needs. Ding et al. [4] explored a digital transformation engineering framework that integrates BIM and reverse engineering technology, aiming to improve the efficiency and quality of construction projects. Building Information Modeling (BIM) is an information technology based on three-dimensional digital technology that simulates the performance of buildings, infrastructure, and the environment. It achieves full lifecycle management of building design, construction, operation, and other aspects by establishing digital building models. Reverse engineering technology is a digital technology that extracts design information from physical objects or data for product or model reconstruction. Combining BIM with reverse engineering technology can provide more comprehensive and accurate design and renovation solutions for construction projects. Firstly, BIM can provide a comprehensive digital building model, providing accurate basic data for reverse engineering. Meanwhile, the introduction of reverse engineering technology can help BIM models better match the actual construction environment and achieve precise control of the construction process. Utilize BIM technology to process point cloud data and generate digital building models. At this stage, in-depth optimization and analysis of the model can be carried out to improve the quality and efficiency of architectural design.

With the advancement of technology and the popularization of the Internet, digital tourism has gradually become a new trend in the modern tourism industry. In this context, the intangible cultural heritage of Tavira in Portugal has also been affected. Gonçalves et al. [5] explored the relationship between digital tourism and sustainable development, the intangible cultural heritage of Tavira, Portugal, and how to protect and inherit this intangible cultural heritage in digital tourism. Digital tourism refers to a new form of tourism activities achieved through digital technologies such as the Internet and mobile devices. The rapid development of digital tourism has greatly changed traditional tourism methods and brought new opportunities and challenges to the tourism industry. Digital tourism can improve tourism efficiency, facilitate tourists' access to tourism information, optimize tourism experience, and also provide new means for the management and marketing of tourism destinations. By combining the service design concept with VR technology, it can provide new solutions and ideas for the design of ICH tourism cultural products, promote the integration and development of the two, and further expand the application field of CAD. By introducing VR technology and image emotion recognition technology, designers can better understand the needs and emotional state of tourists, thus providing more accurate tourism product design and service experience. The design of ICH tourism cultural products needs to fully consider the needs and emotional experiences of tourists, and at the same time, it also needs to effectively inherit and display the uniqueness and value of ICH culture. The innovative methods proposed in this paper can provide new ways and means for the inheritance and development of ICH culture and promote the sustainable development of ICH culture. The research includes the following innovations:

(1) This paper combines the concept of service design with VR technology, introduces knowledge and technology from different disciplines, breaks the limitation of traditional design methods of tourism products, and puts forward a brand-new CAD method of ICH tourism cultural products.

(2) This paper also puts forward a presentation method of ICH tourism cultural products based on VR technology, which realizes the digital reproduction and interactive experience of traditional culture.

(3) Put forward a design method and service strategy of tourism products based on emotional experience, which provides new ideas and support for the innovative development of tourism.

This paper aims to explore the innovation of VR technology embedded in ICH tourism cultural product CAD under the service design concept. Firstly, this paper introduces the concept of service design and the concept and characteristics of VR technology, and analyzes its application and present situation in tourism product design. Then, combined with the image emotion recognition technology, this paper discusses how to realize the innovative methods and processes of emotional service design and emotional tourism product design Finally, this paper summarizes the innovation of VR technology embedded in ICH tourism culture product CAD under the service design concept, and looks forward to the future research direction.

2 RELATED WORK

Nikolakopoulou et al. [6] explored the application of interactive stories and projection mapping in museums to enhance audience awareness and interest in intangible cultural heritage. The application of interactive stories in museums provides viewers with a brand-new visiting experience. By incorporating multimedia elements and interactive elements into the story, museums can showcase intangible cultural heritage in a fun and educational manner. Projection mapping is a way of vividly showcasing intangible cultural heritage through modern technology. By using projection technology, the details and effects of intangible cultural heritage can be presented in a realistic and three-dimensional form to the audience. In addition, projection mapping can also be used to display the original appearance and production process of cultural relics, enabling the audience to have a deeper understanding of cultural heritage. In practical applications, the combination of interactive stories and projection mapping can produce better results. With the rapid development of virtual reality (VR) technology, users' demand for VR experience is also constantly increasing. In VR applications, 3D modeling and design are one of the key factors affecting user experience. Therefore, understanding users' preferences for 3D modeling and design is of great significance for improving the quality of VR applications. Nysetvold and Salmon [7] introduced how to evaluate users' preferences for 3D modeling and design in virtual reality. User experience analysis is a method of evaluating users by observing and analyzing their behavior, expressions, and feedback when using VR applications. By recording data such as user operations and line of sight trajectories in VR applications, combined with user interviews and survey results, users' preferences for 3D modeling and design can be deeply explored. UNESCO World Heritage Sites are important cultural heritage sites protected globally. In order to effectively control and manage changes to these heritage sites, the use of advanced digital technology has become crucial. The workflow of obtaining and integrating point clouds, triangular meshes, and parameter models is called HBIM, which can provide efficient and accurate means for the protection, restoration, and management of heritage sites. Plata et al. [8] focused on the protocol development for point cloud, triangular mesh, and parameter model acquisition and integration in the HBIM workflow. Use equipment such as laser scanners to scan heritage sites and generate point cloud data. Require high accuracy and moderate density of point cloud data, which can reflect the detailed structure of heritage sites. Convert point cloud data into triangular mesh models through software to express the surface morphology of heritage sites.

The triangular mesh model should ensure consistency with point cloud data and meet certain accuracy requirements. Integrate point clouds, triangular meshes, and parameter models to form a complete HBIM model. It is required that the data of each model have a high degree of matching and can complement and confirm each other. Rinaldi et al. [9] aim to explore the design and implementation methods of this system and evaluate them. The current situation of digital access to cultural heritage highlights the urgent need for more efficient and intelligent retrieval and

management methods. Traditional retrieval methods are often cumbersome and inefficient, unable to meet the management needs of large-scale cultural heritage data. Therefore, developing an augmented reality CBIR system based on multimedia knowledge maps and deep learning technology can improve the efficiency and accuracy of digital access to cultural heritage. In terms of system design, we first need to construct a multimedia knowledge map to multi-dimensionally associate and index various information of cultural heritage, such as graphics, text, audio, etc. This knowledge map also needs to be trained through deep learning techniques to identify and extract key features of cultural heritage. At the same time, we need to use augmented reality technology to integrate real scenes and virtual information of cultural heritage, so that users can intuitively observe and understand cultural heritage in the real world. With the continuous development of technology, structural health monitoring has become an important means to ensure the safety of buildings and infrastructure. In order to further improve the efficiency and accuracy of monitoring, Building Information Modeling (BIM) and Virtual or Augmented Reality (VR/AR) technologies have been widely applied in the field of structural health monitoring in recent years. Sadhu et al. [10] explored how to use BIM and VR/AR technology for data management and visualization of structural health monitoring. The introduction of BIM technology enables us to better manage and utilize this data. Through the BIM model, we can associate monitoring data with geometric information, material properties, etc. of buildings, achieving visual presentation and deep mining of data. At the same time, BIM models can also provide more accurate model data for structural health monitoring, effectively improving the accuracy of monitoring. Virtual reality technology, with its unique interactivity and immersion, provides new possibilities for the protection of intangible cultural heritage. Firstly, through the construction of a digital museum, Selmanović et al. [11] digitize intangible cultural heritage and present it to the audience in the form of virtual exhibits. In addition, virtual scenic area display is also an important application method, which allows tourists to visit various cultural heritage sites through virtual reality technology, thereby more intuitively experiencing the charm of intangible cultural heritage. The application of virtual reality technology can significantly improve the accessibility of intangible cultural heritage protection. Firstly, through virtual reality technology, we can liberate cultural heritage from fixed locations, allowing viewers to appreciate them at home. In this way, it can effectively expand the audience and provide more people with opportunities to access intangible cultural heritage. Secondly, virtual reality technology can also improve the efficiency of cultural inheritance. By simulating traditional cultural activities or reproducing historical scenes, virtual reality technology can stimulate audience interest in intangible cultural heritage, making it easier to inherit this cultural heritage.

In the ship driving sub module, Shen et al. [12] created a 3D ship model using the Unity3D engine and controlled the movement and action of the ship through a program. In the engineering design submodule, we provide various engineering design cases and use the Unity3D GUI system to create a friendly interactive interface for students to carry out design operations. Since the launch of this training system, thousands of students have used our services. Through continuous optimization and improvement, students generally believe that the training system has high practicality and interactivity, which can help them better master the skills and knowledge of marine engineering positions. Taking an emergency response case as an example, students need to handle various emergency situations in a simulated marine environment, such as ship oil leakage and maritime rescue. Through this practical exercise, students can better understand theoretical knowledge and improve their ability to handle practical problems. Eye tracking technology, also known as eye movement tracking technology, has been widely applied in the fields of computer vision and human-computer interaction in recent years. As a new type of interaction, eye tracking can provide a more natural and intuitive human-computer interaction experience. Szekely et al. [13] evaluated the usability of eye tracking in the application of mobile augmented reality (AR) in urban cultural heritage historical images, and explored its practical application value and limitations. The research aims to evaluate the usability of eye tracking in mobile augmented reality applications of urban cultural heritage historical images. Through real user testing, investigate whether eye tracking technology can improve user experience and the

level of acceptance of this interaction method by users. A certain number of historical images of urban cultural heritage were selected and developed using eye tracking technology for mobile augmented reality. The experimental results indicate that eye tracking technology has high availability in mobile augmented reality applications of urban cultural heritage historical images. Tastan et al. [14] conducted architectural modeling using handheld user interfaces and direct manipulation in immersive virtual reality. In immersive VR, handheld user interface usually refers to interaction through devices such as a joystick, remote control, or touch screen. These devices are often equipped with input devices such as touchpads, buttons, and joysticks, allowing users to interact more naturally with the virtual environment. The main advantages of handheld user interfaces are their intuitiveness and flexibility. Due to people's habit of using their hands to manipulate objects, virtual operations through handheld user interfaces can enhance users' immersion and engagement. In addition, due to its portability, the handheld user interface is also easy to use in various environments. In architectural modeling, handheld user interfaces can be used for various tasks, such as model creation, editing, and rendering. In addition, the handheld user interface can also be used for selecting, moving, deleting, and other operations to improve modeling efficiency.

Theodoropoulos and Antonio [15] systematically review the application of virtual reality (VR) games in the field of cultural heritage. Through a comprehensive review and evaluation of history, culture, art, education, and other aspects, the article showcases the enormous potential of VR games in protecting, inheriting, and promoting cultural heritage. At the same time, in response to the shortcomings of existing research, it has put forward some forward-looking suggestions to provide certain guidance for future research. With the advancement of technology, virtual reality (VR) games, as an emerging form of cultural entertainment, are receiving increasing attention. As a treasure of human civilization, the protection and inheritance of cultural heritage are particularly important. The immersive experience and interactivity of VR games undoubtedly open up new avenues for the inheritance and promotion of cultural heritage. Explored the application of VR games in the field of cultural heritage and conducted a systematic review of relevant research. With the advancement of technology, the application of mobile augmented reality (AR) technology in the fields of heritage protection and tourism is gradually receiving attention. By combining virtual information with real scenes, mobile augmented reality heritage applications provide unprecedented interactive experiences and information services for heritage tourists. Yin et al. [16] explored the concept, background, requirement analysis, application scenarios, and practical operations of mobile augmented reality heritage applications, with the aim of providing reference for research and practice in related fields. Mobile augmented reality heritage application is an application based on mobile devices and augmented reality technology that combines virtual information with real scenes. Through this approach, tourists can gain rich content and interactive experiences while visiting heritage sites, thereby better understanding and appreciating cultural heritage. Mobile augmented reality heritage applications are of great significance in improving tourist satisfaction, promoting cultural dissemination, and protecting precious heritage. As an intangible cultural heritage (ICH) with profound historical heritage and a broad public foundation, the application of VR technology provides new perspectives and methods for its protection, inheritance, and sustainable research. Zhang et al. [17] explored how to use virtual reality technology to create a bamboo weaving virtual experience system and analyzed its importance in the sustainable research of intangible cultural heritage. Utilize professional photography equipment to capture high-definition images of bamboo weaving crafts, and generate realistic 3D models through 3D modeling software. Create an immersive virtual environment that simulates the on-site atmosphere of bamboo weaving technology. In order to enable users to perform bamboo weaving operations in a virtual environment, it is necessary to carefully design the interaction mode. For example, operating through a handle or wearable device, while incorporating a force feedback mechanism, allows users to feel the texture of bamboo weaving. Users can freely choose bamboo weaving materials, tools, and styles in a virtual environment, and experience the charm of bamboo weaving through practical operations. Based on user feedback and actual application results, evaluate and optimize the virtual experience system to improve its practicality and usability.

3 METHODOLOGY

3.1 Image Emotion Recognition

Service design is a user-centered design idea, which emphasizes the organic combination of service, products, communication and environment through systematic methods from the user's needs, so as to improve the user experience and service quality. The application of service design in tourism can help us better understand the needs and experiences of tourists and provide more accurate services and solutions. Specifically, service design can achieve innovation in tourism product design through the following aspects:

(1) Understanding user needs: The service design concept focuses on understanding and meeting their needs from the user's point of view. In the design process of ICH tourism cultural products, designers can develop tourism products that are more in line with the needs of users by deeply understanding the needs and preferences of tourists.

(2) Systematic design: The service design concept emphasizes looking at services from a holistic perspective, and combining elements such as services, products, communication and environment to carry out systematic design and optimization. In the design of ICH tourism cultural products, designers can organically integrate the culture, history, natural landscape and other elements of tourist destinations through systematic design methods to create more attractive tourism products.

VR technology is a computer technology, which creates an immersive feeling by simulating a three-dimensional environment. VR technology has the characteristics of immersion, interaction and imagination, which can provide users with an immersive experience. In the design of tourism products, VR technology can help designers organically combine the culture, history, natural landscape and other elements of tourism destinations, thus creating more attractive tourism products. Specifically, VR technology can achieve innovation in tourism product design through the following aspects:

(1) Immersive experience: VR technology can create an immersive experience environment, enabling users to feel the various elements of a tourist destination. This immersive experience can greatly improve the user's experience and enhance the attractiveness of tourism products.

(2) Interactive experience: VR technology can provide an interactive experience way, which enables users to interact with the virtual environment and deeply understand and feel the culture, history and natural landscape of tourist destinations. This interactive experience can greatly improve user participation and enhance the interest of tourism products.

CAD is widely used in the design of ICH tourism cultural products, which can help designers to design and draw with high efficiency and high quality. Specifically, CAD can achieve innovation through the following aspects:

(1) Accurate drawing: CAD can help designers to draw accurately and draw various elements of tourist destinations in a more detailed way, so as to better show their characteristics and values.

(2) Three-dimensional modeling: CAD can help designers to carry out three-dimensional modeling, and show various elements of tourist destinations in a three-dimensional way, so as to restore their shapes and characteristics more truly.

(3) Animation exhibition: CAD can help designers to make animation exhibitions, and show various elements of tourist destinations in a dynamic way, so as to show their charm and characteristics more vividly.

Image emotion recognition technology is a technology to analyze the emotion of images through computer vision technology and artificial intelligence algorithm. Through the emotional analysis of images, we can judge whether the emotional tendency expressed by images is positive or negative, thus providing support for emotional service design and tourism product design.

Specifically, the image emotion recognition technology can achieve innovation in tourism product design through the following aspects:

(1) Emotional design: Through the image emotion recognition technology, designers can understand the emotional needs and emotional state of users, so as to carry out emotional service design and tourism product design.

(2) Personalized service: Through image emotion recognition technology, designers can provide personalized service according to the emotional state of users.

Based on the service design concept, VR technology and image emotion recognition technology, this paper will discuss the innovation of ICH tourism cultural product design, aiming at improving tourists' experience and satisfaction and promoting the innovative development of tourism. By combining the service design concept with VR technology, and using the image emotion recognition technology for emotion analysis, we can better understand and meet the needs and emotional state of tourists, provide more accurate services and solutions, and promote the innovative development of tourism. CNN is a common choice for the task of image emotion recognition. Input the preprocessed data into the model for training. In this process, the model will learn how to extract features from images and how to predict emotions according to these features. In the process of training, it is necessary to constantly adjust the parameters of the model to minimize the loss function. This process is usually completed by using the back propagation algorithm. In the process of training, it is necessary to check the performance of the model regularly, for example, after each epoch, or after training several EPOCHs. You can use the validation set to evaluate the performance of the model and adjust it according to the results. If the performance of the model is poor, you may need to adjust the parameters of the model, or try a different model or optimization strategy. The CNN model is shown in Figure 1.

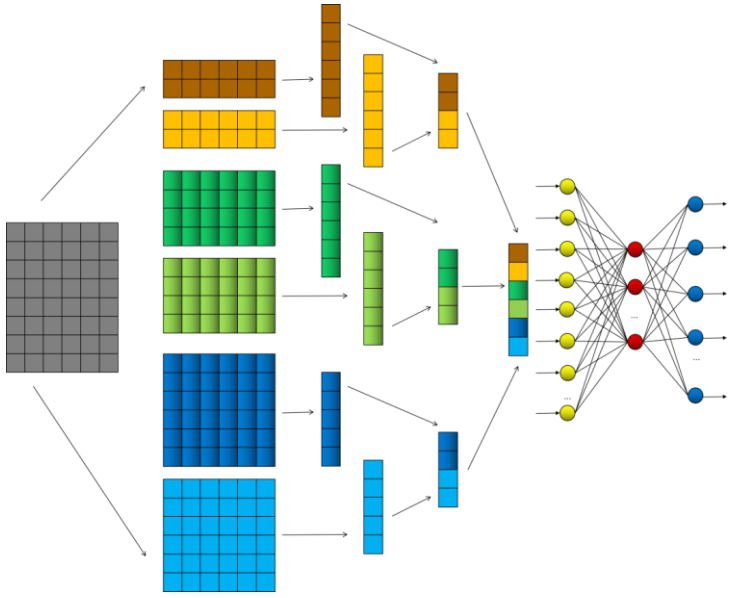

Figure 1: CNN structure.

Data collection needs to consider the diversity, quantity and quality of data to ensure the effectiveness and stability of the model. Generally speaking, data collection can be achieved by tagging, downloading and crawling. Through data preprocessing, the original data can be cleaned, transformed and standardized to meet the requirements of model training. Data preprocessing includes data cleaning (eliminating erroneous, invalid and redundant data), data transformation

(transforming original data into a trainable format, such as transforming a picture into a pixel matrix), feature extraction (extracting features in an image through image processing technology) and other steps. According to the existing image data set, a model that can automatically identify and classify images is constructed by using machine learning algorithm. This step needs to select a suitable model according to the characteristics of the data set, train the model and adjust the model parameters to minimize the loss function.

Based on this, this paper assumes that opinion leader i attitude towards this activity or this movement is x_i, where $x_i \in [-1,1]$. The emotional inclination of an ordinary user v who participates in forwarding the event e_j to the event is shown in formula (12).

$$q_v^{e_j} = \sum_{i=1}^{m} \frac{N_{v_i}^{e_j}}{\sum_{k=1}^{m} N_{v_k}^{e_j}} x_i \tag{1}$$

$N_{v_i}^{e_j}$ indicates the amount of tweets forwarded by ordinary user v from opinion leader i in event e_j. Forwarding behavior is the embodiment of the user's subjective thoughts, which is manifested by the user's approval of the forwarder's views or thoughts, and it is different from social media users' comments and replies.

Because each word makes a different contribution to a sentence, and the overall emotional tendency of a sentence may be determined by a few particularly critical words, an attention mechanism is needed to find the contribution value of each word to the sentence. This model applies text attention mechanism, which is mainly used for feature extraction of target words, and is used to distinguish the different importance degrees of the multiple words that make up the target words. The formula of this process is expressed as follows:

$$A_t = O_B \times W_A \tag{2}$$

$$A_m A_t^T + mask \tag{3}$$

$$A_a = soft\max(A_m) \tag{4}$$

W_A represents the randomly initialized parameter matrix that can be trained and adjusted in the model, and T represents the transposition of the vector. For a given image, it can be classified and recognized by extracting its features and using the trained model.

3.2 User Emotion Classification

User sentiment classification is a key innovation point in the application of service design and VR technology to the design of ICH tourism cultural products. Through this combination, we can make use of the advantages of VR technology and the emotional analysis ability of image emotion recognition technology to better understand the needs of users and provide more personalized service experience. In the aspect of user emotion classification, deep learning and natural language processing technology are used to construct a classification model. This model can automatically identify and analyze the emotions expressed by users in social media or online comments. Firstly, user comments are transformed into a format suitable for model input through data acquisition and preprocessing technology. Then, word embedding technology is used to capture semantic information in the text, and CNN is used to capture emotional information in the text.

This paper studies a user emotion recognition method in social media based on DL, and the flow of user emotion classification algorithm is shown in Figure 2.

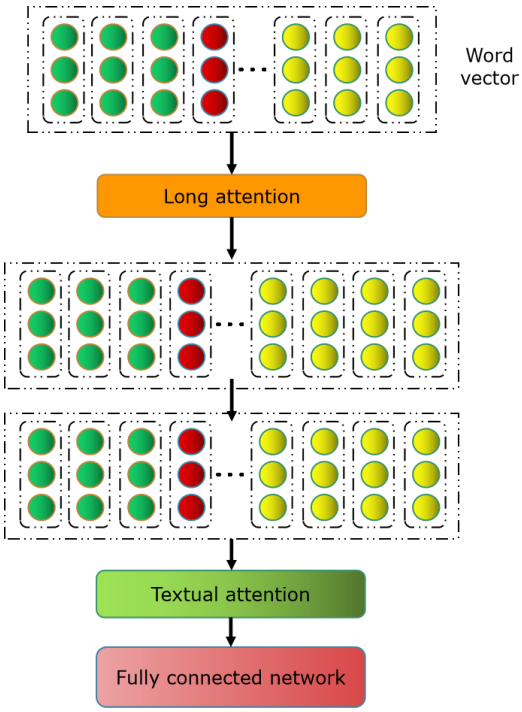

Figure 2: Algorithm flow of user emotion classification.

By combining the service design concept with VR technology in the design of ICH tourism cultural products, we can use the characteristics of VR technology such as immersion, interaction and imagination and the emotional analysis ability of image emotion recognition technology to provide users with tourism product design and service experience that is more in line with their needs. For example, through VR technology, three-dimensional scenes of ICH tourism cultural products are presented, allowing users to have an immersive experience in a virtual environment. At the same time, the emotion of users can be analyzed by image emotion recognition technology, so as to provide them with more personalized service experience.

In order to classify users' emotions more accurately, it is necessary to make as many comments as possible and extract more accurate emotional features by using context dependence. The simplified GRU model of can be expressed as:

$$h_t = GRU\left(x_t, h_{t-1}\right) \tag{5}$$

When the context $X = \{x_1, x_2, \cdots, x_n\}$ of the comment is input, the hidden layer state $\vec{h}_t$ is output to GRU:

$$\vec{h}_t = GRU\left(x_t, \vec{h}_{t-1}\right) \tag{6}$$

Through LDA (Latent Dirichlet Allocation) topic model output, the result is n topics, and each topic has m words closely related to it. Definition w_{ij} stands for the j th word related to the i th topic. Expressed in matrix form as follows:

$$\begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1m} \\ w_{21} & w_{22} & \cdots & w_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ w_{n1} & w_{n2} & \cdots & w_{nm} \end{bmatrix} \tag{7}$$

After paying attention to memory for many times and extracting information, the output vector y_i^t of the last calculation layer is the final emotion feature y_o, which can be interpreted as a conditional probability, and it is input into a SoftMax classifier for emotion classification:

$$p_c = \frac{\exp\left(W_s \cdot y_o + b_s\right)}{\sum_{c=1}^{c} \exp\left(W_c \cdot y_o + b_c\right)} \tag{8}$$

Where, C is the number of categories, and p_c is the probability of being predicted as category c.

Over-fitting is a common model training problem, which occurs when the model fits the training data too much, resulting in poor performance on new and unknown data. In order to avoid over-fitting, many strategies can be adopted, one of which is to introduce regularization term into feature fusion algorithm:

$$\max_{v} \frac{v^T Z_b v}{v^T Z_t v + \gamma_1 v^T v + \gamma_2 G(v)} \tag{9}$$

Among them, Z_b and Z_t are used to describe the inter-class divergence and overall divergence of the sample set in turn, and the formulas are as follows:

$$Z_b = \frac{\sum_{i=1}^{c} (m_i - m)(m_i - m)^T}{n} \tag{10}$$

$$Z_t = \frac{\sum_{i=1}^{c} (x_i - m)(x_i - m)^T}{n} \tag{11}$$

In the formula, m_i and m are used to describe the mean value of the samples of class i and all samples in turn; $v^T v$ is used to describe the regular term; $G(v)$ is used to describe the prior knowledge, and γ_1 and γ_2 are both constants higher than 0.

This classification model can automatically identify and analyze users' emotions, thus helping enterprises to better understand users' needs and feedback. Secondly, the model has a high generalization performance and can adapt to different fields and scenarios, thus providing a more personalized service experience for the design of ICH tourism cultural products. Finally, the model can be adaptively adjusted and optimized according to user feedback to continuously improve its performance and accuracy.

4 RESULT ANALYSIS AND DISCUSSION

Accuracy and recall reflect two aspects of classifier performance. This paper compares and tests the long-term and short-term memory (LSTM) model, the deep belief network (DBN) model and the CNN model in this paper. The accuracy results of different methods are shown in Figure 3. The recall results of different methods are shown in Figure 4.

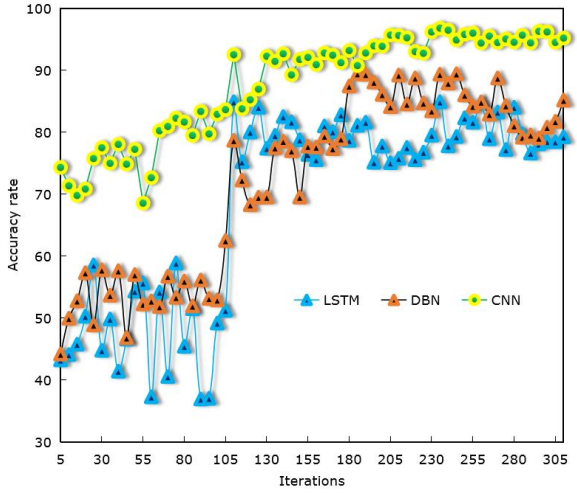

Figure 3: Accuracy test results of different algorithms.

In all cases, the accuracy of CNN model is higher than that of LSTM and DBN. In some cases, the improvement of accuracy may be significant. This shows that CNN has a strong ability to distinguish between positive and negative samples and can effectively reduce misjudgment. The accuracy of LSTM and DBN is not much different, and the performance gap between them on different data sets is small. Among them, the accuracy of LSTM is slightly higher than that of DBN in training set and verification set, but the accuracy of DBN is higher than LSTM in test set. This may be related to the data distribution during model training.

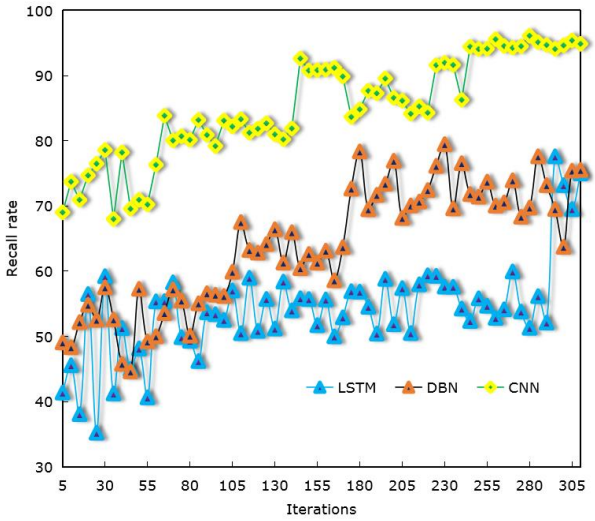

Figure 4: Test results of recall rate of different algorithms.

CNN also performed best in recall rate. This shows that CNN has a strong ability to identify positive samples and can find all positive samples well. There is little difference between LSTM and DBN in recall rate, but compared with the performance of accuracy, there is a bigger gap between them in recall rate. This may mean that the two models have the same ability to identify positive samples, but there is a gap in their ability to identify negative samples. CNN model performs best in both accuracy and recall. This may be because CNN model has natural advantages in processing image data, which can better capture the characteristics of images and has good spatial perception ability. In addition, by introducing regularization term, CNN model avoids the problem of over-fitting to a certain extent, so it also performs well on the test set.

Adding 100 examples of the most uncertain samples to the training set in each iteration can be regarded as increasing the learning content and challenges of the model, which is helpful to enhance the model's ability to deal with uncertainty and generalization performance. From the experimental results, adding the samples with the highest uncertainty is helpful to improve the performance of the classifier (see Figure 5).

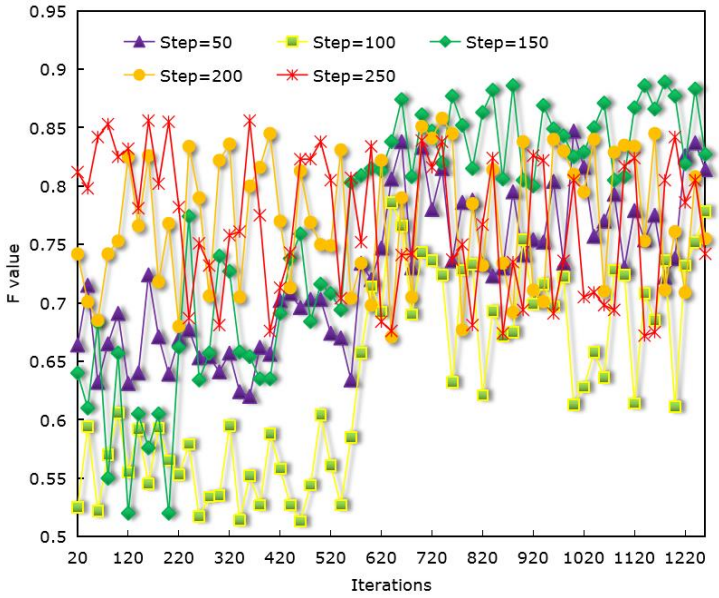

Figure 5: Relationship between expansion method and performance of active learning training set.

For unlabeled samples with the highest confidence, the experimental results show that adding these samples to the training set can also improve the performance of the classifier. This may be because these unlabeled samples are similar to labeled samples in some respects. Adding them to the training set will help the model to learn and understand these similar data features better, thus improving the classification performance. With the increase of the number of unlabeled samples added in the iterative process, the performance of the classifier has not been continuously improved. In the 30th iteration, the performance of adding 150 and 200 unlabeled samples is even lower than that when the step size is 0. This may be because the model is over-fitted in some iterations, that is to say, the model has over-learned some noises or irregularities in the training data, resulting in poor performance on new and unseen data.

The scatter plot of predicted value and actual value using LSTM model is shown in Figure 6. The scatter plot between the predicted value and the actual value using CNN model is shown in Figure 7. It can be seen that the prediction result of CNN model is more accurate than that of LSTM model.

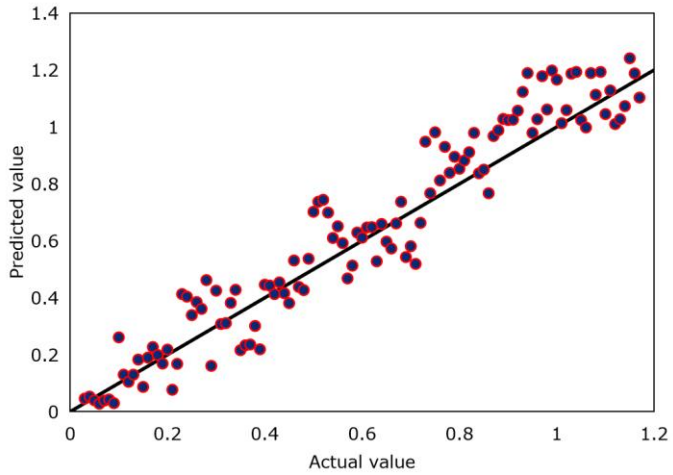

Figure 6: Scatter chart of actual value and predicted value of LSTM.

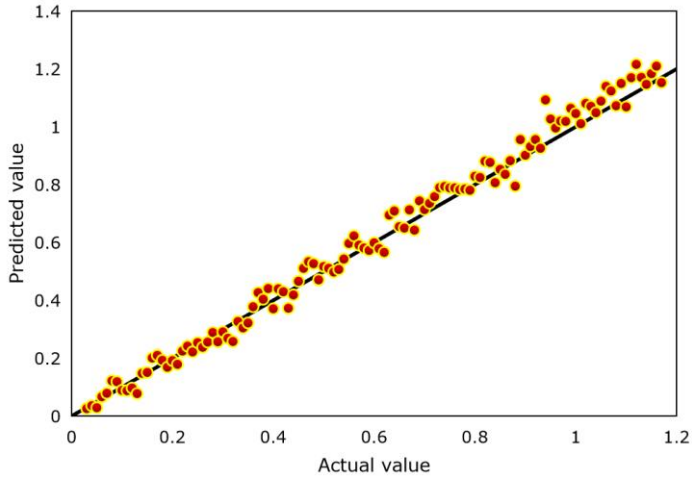

Figure 7: Scatter chart of actual value and predicted value of CNN.

LSTM is a neural network model especially suitable for processing time series data, because it can capture long-term dependencies in data. CNN is a model suitable for processing two-dimensional data such as images and texts, but it may not be as good as LSTM for processing time series data. But on this particular issue, CNN even surpassed LSTM. In complex tasks, such as digital protection of cultural heritage, it may be necessary to capture more complex patterns, such as spatial relationship and image structure. The characteristic of CNN model is that it can effectively capture the spatial structure information in images, which may play a key role in this problem.

5 CONCLUSIONS

Emotional service design is a design idea centered on users' emotional experience, which emphasizes starting from users' emotional needs and improving user experience and service quality through emotional design methods. The design of tourism products needs to consider how to integrate the culture, history, natural landscape and other elements of tourism destinations into the products to attract tourists and enhance the tourism experience. The work of this paper mainly

focuses on the application of service design and VR technology in the design of ICH tourism cultural products. Through experimental verification, it is found that this design method can improve the user experience of ICH tourism cultural products, make users understand and feel the cultural connotation of tourism products more deeply, and enhance the interaction between users and tourism products. In this paper, the service design concept and VR technology are applied to the CAD design of ICH tourism cultural products, and a new design method and application approach are put forward.

In the future, it is necessary to further expand the sample size and conduct in-depth research and analysis on more ICH tourism cultural products. At the same time, try to use different VR technology to carry out experiments to verify the applicability and superiority of the design method in more cases.

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