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Computer-Aided Design AND APPLICATIONS

Brand Marketing Strategy Based on User Emotion Recognition Model of Consumer

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Abstract. Using computer aided design (CAD) technology, brands can quickly create accurate product models. Consumers can browse and customize these models online through virtual reality (VR) devices to realize personalized product customization and improve brand loyalty. In this paper, a user emotion recognition model based on constrained clustering algorithm is proposed, and the user portrait is constructed to predict the consumer's consumption tendency in VR platform and realize accurate marketing. The accuracy and recall of the algorithm in this paper are better than the decision tree algorithm in the prediction of consumer consumption tendency on VR platform, and the accuracy is improved by 22.11%. Constrained clustering algorithm groups consumer data by clustering, which can better capture the characteristics and laws in each group and has strong robustness to the interference of outliers and noise data in the group. This model can analyze the user behavior and consumption tendency in VR platform, thus providing valuable consumer insight for the brand. Through this user emotion recognition model, brands can better understand consumers' needs, predict their buying behavior and formulate accurate marketing strategies.

Keywords: Computer Aided Design; Virtual Reality; Digital Marketing; Emotional Recognition; User Portrait
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1 INTRODUCTION

In the current digital era, brand marketing strategies are constantly seeking innovation to attract and retain consumers. With the rapid development of science and technology, CAD and VR technology are increasingly becoming important tools for brand marketing. Jordan, a country full of history and cultural heritage, has many desirable tourist destinations. However, with the advancement of technology and the intensification of market competition, Jordan's tourism route marketing needs to seek innovation to attract more tourists. Alkurdi et al. [1] aim to explore the

impact and role of interactive media technology in virtual reality on Jordan's tourism route marketing. In tourism route marketing, the application of VR technology allows tourists to understand the situation of tourism routes by simulating the real tourism environment before experiencing Jordan's tourism routes. In addition, VR technology can also be used to produce historical and cultural promotional videos of Jordan, allowing tourists to have a more intuitive understanding of Jordan's history and culture. The application of interactive media technology in virtual reality has become an important trend in Jordan's tourism route marketing. Through innovation in digital marketing, online marketing, and community marketing, Jordan can better showcase its rich tourism resources and unique cultural charm to global tourists. In product design and brand promotion, these two technologies provide unprecedented innovation opportunities for brands. CAD technology makes the creation of product model faster and more accurate, while VR technology provides consumers with an immersive and interactive online experience. Asghar et al. [2] explored an EEG based multimodal emotion recognition method using Deep Feature Extraction (DFE). And study the optimal feature selection strategy. Emotional recognition is of great significance in business and society. In the proposed method, we first preprocess the EEG data, including noise removal, baseline correction, and filtering. Then, we input the preprocessed EEG data into the deep feature bag model, which can automatically learn the feature representations in the data. The time, frequency, and spatial information of EEG signals are used to improve the accuracy of emotion recognition. In order to evaluate the effectiveness of the proposed method, we conducted experimental comparative analysis. In the experiment, we collected EEG data from multiple subjects while watching different types of emotion inducing videos, and used the proposed method for emotion recognition. The experimental results show that using deep feature bags for EEG based multimodal emotion recognition can effectively improve the accuracy of emotion recognition. Specifically, our proposed method outperforms traditional machine learning methods in terms of classification accuracy and recall. By combining the two, brands can better understand the needs of consumers and provide them with personalized products and services, thus improving brand loyalty. With the rapid development of technology, virtual reality technology has gradually integrated into every aspect of our lives. Barreto et al. [3] explored how to design virtual reality environments through CAD floor plan based creative systems, with the aim of providing useful references for creative and practical applications in related fields. In the design process of virtual reality environment, it is first necessary to clarify the scene style, character settings, and task design. The scene style determines the visual performance of the entire virtual environment, character setting affects the user's immersion and interaction experience, and task design is related to the user's gaming experience and learning effectiveness. In virtual environments, character setting needs to balance realism and artistry. Create a character model using 3D modeling software, ensuring the physiological characteristics of the character by adjusting body proportions, muscle lines, etc. At the same time, design rich actions and expressions for the characters to increase interactivity and immersion. Task design is an important aspect in virtual reality environments. In this creative system, we have designed a series of main and branch tasks aimed at improving user engagement and immersion by completing the tasks. CAD technology enables brands to quickly create accurate product models, which can be used as the basis for online display and customization. Through VR devices, consumers can browse and customize products in the virtual environment, thus gaining a brand-new shopping experience. This experience not only helps to improve consumer satisfaction, but also helps to cultivate consumer loyalty.

With the continuous development and progress of technology, people's consumption behavior and habits are also undergoing tremendous changes. Traditional marketing methods are no longer able to meet the development needs of the hotel industry, and digital marketing has gradually become the main means of electronic marketing in the hotel industry. Starting from the transition from traditional marketing to digital marketing, Kapoor and Kapoor [4] explore the evolution of electronic marketing in the hotel industry. In the past few decades, the traditional marketing methods used by the hotel industry mainly include advertising, promotion, and customer service. Although these methods have certain effects, there are also many problems. The emergence of

digital marketing has provided new ideas for the Indian hotel industry. By sending personalized hotel introductions, booking information, and promotional activities to customers via email, we aim to increase their attention and return to the hotel. From the evolution of electronic marketing in the hotel industry, the application of digital marketing has achieved significant results. In addition, digital marketing has also improved customer satisfaction and return rates, enhancing the hotel's brand image. In traditional product design, designers usually rely on handicrafts, experience and imagination to create the appearance and structure of products. However, the emergence of CAD technology enables designers to design products through computers, which not only improves the efficiency and accuracy of design, but also reduces the cost of product design. With the continuous development of technology, the impact of computer-aided technology on visual aesthetics in graphic design is becoming increasingly profound. Lin and Liu [5] explored the application of computer-aided technology in visual aesthetics of graphic design, with the aim of helping readers better understand the development of this field. Computer assisted technology can help designers achieve more precise control in color matching, contrast, harmony, and other aspects. Computer assisted technology can use tools such as vector graphics software to help designers create more accurate and vivid graphics. This software typically have powerful drawing and editing functions, allowing designers to easily complete the production of complex graphics. Computer assisted technology can improve the efficiency and quality of typesetting design. By using typesetting software, designers can quickly adjust content such as text format, layout, and layout, making the entire layout more beautiful and readable. Computer assisted technology can enhance the visual impact of works by precisely controlling elements such as color, graphics, and text. For example, using image processing software, designers can perform operations such as trimming and filtering on images, making the entire work more vivid and interesting. In addition, with the introduction of VR technology, consumers can experience and customize products in a virtual environment, so as to better meet the individual needs of consumers. In brand marketing, traditional marketing strategies are often based on market research, consumer surveys and empirical judgments. However, these methods often fail to accurately grasp the real needs and consumption tendency of consumers. In recent years, the development of data mining and machine learning technology provides a new solution for brand marketing. Through these technologies, consumers' behaviors, preferences and needs can be deeply analyzed, so as to formulate more accurate marketing strategies.

With the continuous development of technology, virtual reality (VR) and gamified learning are gradually penetrating into the field of higher education, bringing new opportunities and challenges for marketing higher education. Loureiro et al. [6] explored the advantages and methods of virtual reality and gamification, as well as their application and value in higher education in marketing. Virtual reality technology can provide students with a real learning environment, enabling them to learn more practical skills through simulated practice, thereby improving their practical operation ability and better mastering marketing related knowledge. Virtual reality technology can simulate real marketing environments, avoid risks and waste caused by practical operations, and thus reduce educational costs. Through students' performance in virtual environments, teachers can timely evaluate their learning outcomes in order to better guide their learning. This paper puts forward a brand marketing strategy of digital image based on CAD and VR technology. First, accurate product models are created by using CAD technology, and then these models are presented to consumers by VR technology. Consumers can experience and customize products in the virtual environment, thus realizing personalized product customization. In addition, a user emotion recognition model based on constrained clustering algorithm will be constructed to identify consumers' emotional reactions to products and build user portraits. Through the analysis of users' portraits, we can predict consumers' consumption tendency, and thus formulate more accurate marketing strategies. In order to ensure its successful implementation, brands need to deeply understand the needs and behaviors of consumers. This requires a powerful tool that can identify and analyze consumer data in real time. The purpose of this study is to improve brand loyalty through CAD and VR technology, and to conduct accurate marketing through the user emotion recognition model based on constrained clustering algorithm. This model can be used to

understand and predict consumers' propensity to consume, thus achieving precise marketing. The implementation of this strategy can help brands improve consumer satisfaction and loyalty, and then succeed in the fierce competitive market. The research includes the following innovations:

(1) This paper combines CAD and VR technology for the first time, and puts forward a brand-new brand marketing strategy. By using the rapid product model creation ability of CAD technology and the immersive and interactive experience of VR technology, consumers can be better attracted and retained, and brand loyalty can be improved.

(2) This paper introduces the user emotion recognition model, which is a model based on constrained clustering algorithm, and can identify and analyze consumer data in real time, and understand and predict consumers' consumption tendency. Through this model, brands can better understand consumers' needs and formulate accurate marketing strategies.

(3) Through the combination of the above two technologies and the application of user emotion recognition model, this paper puts forward a precise marketing strategy. This strategy can provide consumers with personalized products and services on the basis of in-depth understanding of consumers' needs and behaviors, and further improve brand loyalty.

This paper first introduces the significance of CAD and VR in brand marketing; Then, on the basis of analyzing the existing research, the research content of this paper is put forward; Combining the constrained clustering algorithm to build a brand marketing model based on emotion recognition; Finally, the performance of the model is simulated and tested.

2 RELATED WORK

In today's digital age, digital marketing and virtual reality technology are constantly developing and becoming increasingly popular. In this context, alternative tactile effects are becoming a new research hotspot. Luangrath et al. [7] explored the alternative tactile effects in digital marketing and virtual reality, and analyzed their current status and development trends. Alternative tactile effect refers to the use of technical means to simulate the tactile experience of physical objects, enabling users to experience sensory experiences such as texture, shape, temperature, and texture of physical objects in the digital world. This technology has broad application prospects in the fields of digital marketing and virtual reality. In terms of shopping, alternative tactile effects can help users try on clothes in virtual fitting rooms, feeling the texture and comfort of the clothes. In terms of entertainment, replacing tactile effects can bring users a more realistic gaming experience, improve the attractiveness and immersion of the game. In the medical field, alternative tactile effects can help doctors and patients better understand the condition and treatment plan, and improve medical effectiveness. With the continuous development of technology, the application of 3D Content Augmented Reality (AR) technology in the field of military training is becoming increasingly widespread. Among them, the military's universal combat image training system, as an important means of improving combat capabilities, has attracted widespread attention. Mao and Chen [8] discussed the application and important value of 3D content augmented reality in military general combat image training systems. 3D content augmented reality technology is a technology that combines virtual information with the real environment to achieve perception and cognition of the real world. In the military general combat image training system, 3D content augmented reality technology can improve training efficiency. Enable trainees to train in simulated real environments, thereby improving their adaptability and combat skills to combat environments. The application scenarios of 3D content augmented reality in military general combat image training systems are very extensive. In the training of the Marine Corps, augmented reality technology can be used to simulate maritime combat scenarios, including waves, wind direction, ships, and other situations, enabling trainees to better adapt to the maritime combat environment.

With the continuous development of technology, augmented reality (AR) technology has increasingly become a hot topic in the advertising industry. Augmented reality adaptive advertising, as an innovative form of advertising, can combine virtual elements with real scenes

through technological means, providing users with an immersive advertising experience. Moreno et al. [9] explored the concept, advantages, practical cases, and future development trends of augmented reality adaptive advertising based on deep learning. Compared to traditional advertising forms, augmented reality adaptive advertising has significant advantages. Through augmented reality technology, advertisements can interact with the real environment, making it easier for users to generate a sense of immersion, thereby improving the attention and memory effect of advertisements. Augmented reality advertising based on deep learning can automatically adapt to different devices and screen sizes, saving advertisers a lot of time and money. However, augmented reality adaptive advertising also has some shortcomings, such as high technical barriers and high development costs. With the advancement of technology, virtual reality (VR) technology has increasingly become a hot topic in the field of digital entrepreneurship. More and more enterprises are starting to utilize virtual reality technology to provide unique and attractive digital entrepreneurial experiences. In this context, the emergence of virtual agents has brought new possibilities for digital entrepreneurship. Saad and Choura [10] aim to explore the effectiveness of two types of virtual agents in digital entrepreneurship, and conduct comparative research through case analysis and questionnaire surveys. The research will also provide practical guidance and theoretical basis for entrepreneurs and relevant scholars on the application of virtual reality technology. We found that the advantage of social virtual agents lies in their ability to enhance user experience and loyalty through interaction with users. However, due to its relatively single function, its assistance in improving entrepreneurial performance is limited. Relatively speaking, task-based virtual agents exhibit high efficiency in completing specific tasks, thus having great potential in improving entrepreneurial performance. With the rapid development of technology, digital factories have become an important tool for industrial training and maintenance. The digital factory utilizes virtual reality (VR) technology to provide employees in the industrial field with an immersive learning and work environment, helping them better understand and master various skills. Shamsuzzoha et al. [11] provided a detailed introduction to the virtual reality and interactive environments of digital factories. The core of digital factory virtual reality environment is to establish a highly simulated and immersive learning environment. This environment includes various aspects of the factory, such as machinery, equipment, tools, and materials. Employees can enter this virtual environment through headsets or other devices to experience various situations that may be encountered in actual work. When designing virtual reality environments, digital factories need to follow certain design concepts and technical architectures. Firstly, the modeling of virtual environments must be as close as possible to the actual environment, so that employees can better understand and operate. Secondly, digital factories need to adopt advanced graphics rendering technologies, such as real-time 3D graphics rendering, to improve the realism and immersion of virtual environments. In the virtual environment of a digital factory, employees can not only perform various operations and experiments, but also conduct activities such as troubleshooting and maintenance simulation. This interactive environment can greatly improve employees' work skills and efficiency, and reduce risks in actual work.

Subawa et al. [12] started with the practice of virtual reality technology in the tourism industry of Bali, Indonesia, and explored the current application status of virtual reality technology in the tourism industry and methods to solve current problems in the tourism industry through case studies. Many tourist attractions in Bali, Indonesia have used virtual reality technology for simulation and display. For example, a famous scenic spot in Bali utilizes virtual reality technology to provide tourists with an immersive tropical rainforest experience, allowing them to more deeply experience the essence of natural beauty. Bali's tourism companies have used virtual reality technology to create exquisite tourism promotional videos, which are promoted through social media and other channels. In addition, some tourism companies also provide virtual tourism experience services, allowing tourists to experience the charm of the tourist destination before traveling. Szajna et al. [13] explored the application background, related research, specific methods and materials, as well as experimental results and analysis of augmented reality assessment of mobile AR glasses in the production process of artificial wiring. Mobile AR glasses

have broad application prospects in augmented reality assessment of artificial wiring production processes. By combining virtual information with actual scenes, mobile AR glasses can provide real-time guidance for manual wiring production. This information can include production line status, troubleshooting, tool usage, etc. Mobile AR glasses can be used for training and education in manual wiring production. By simulating actual scenarios, learners can better understand the wiring production process and improve their skill levels. Mobile AR glasses can assist in quality inspection during the production process of manual wiring. By comparing actual wiring with virtual models, wiring errors or quality issues can be detected. Although mobile AR glasses have broad application prospects in the production process of manual wiring, there are still some challenges and limitations. The interactive virtual reality (IVR) in interior design is gradually changing our way of life and bringing new opportunities and challenges to digital marketing. Tang et al. [14] explored the impact of IVR on digital marketing and how it affects customer satisfaction and behavioral intention. Firstly, the application of IVR in the field of digital marketing is becoming increasingly widespread. Compared to traditional marketing methods, IVR has many advantages. For example, it can provide an immersive experience, allowing users to better understand products or services. In addition, IVR can provide personalized marketing tailored to user behavior and preferences, in order to better meet their needs. However, IVR also has some shortcomings, such as high technical barriers and high costs. Secondly, explore the impact of IVR on customer satisfaction and behavioral intention. Firstly, IVR can improve customer satisfaction by enhancing the customer experience. By simulating a real interior design environment, customers can preview the appearance and layout of the product before purchasing, thereby better selecting the product that suits them. In addition, IVR can also improve customer satisfaction by providing personalized services and advice.

In today's highly competitive market environment, how to make brands stand out among numerous competitors has become an urgent problem for enterprises to solve. The rapid development of artificial intelligence technology has provided new solutions for brand marketing communication. Timokhovich et al. [15] explored how to use artificial intelligence to achieve personalized brand marketing communication. The development of these technologies provides new opportunities for brand marketing communication. By analyzing consumer behavior, purchasing history, needs, and preferences, enterprises can more accurately understand consumer needs, provide customized products and services for each customer, and thereby improve brand awareness and customer loyalty. To achieve personalized brand marketing communication, enterprises need to use artificial intelligence technology to process and analyze a large amount of data. In practical applications, personalized brand marketing communication driven by artificial intelligence has significant advantages. The personalized recommendation of artificial intelligence can greatly improve customer satisfaction and loyalty, thus laying a solid foundation for the long-term development of enterprises. With the continuous development of technology, virtual reality (VR) technology has brought new possibilities for tourism marketing with its unique interactivity and immersion. Yung et al. [16] explored the relationship between virtual reality and tourism marketing and analyzed it from three conceptualized perspectives: existence, emotion, and intention framework. Virtual reality technology is a computer technology that can create and experience virtual worlds. It uses simulators to generate three-dimensional environments, providing users with immersive and immersive experiences. In the field of tourism, the main application forms of virtual reality technology include virtual tourism, virtual scenic spots, virtual museums, etc. Virtual reality technology simulates the real environment, allowing users to fully immerse themselves in virtual scenes and create an immersive feeling. Virtual reality technology can achieve interaction in virtual scenes, where users can interact with the scene through devices such as controllers and touch screens, increasing their sense of participation and fun. With the rapid development of digital technology, digital marketing research is becoming an increasingly important field. Virtual reality (VR), as a part of digital technology, is gradually gaining popularity in digital marketing research. Zaki et al. [17] aim to explore the knowledge structure of virtual reality in digital marketing research, in order to provide reference for related research. Virtual reality is a computer technology that allows users to immerse themselves in a highly realistic

three-dimensional virtual environment by simulating human auditory, visual, and tactile senses. The virtual reality technology in digital marketing is mainly applied in fields such as product display, market research, and customer experience. The basic principle of virtual reality technology is to use computers to generate a virtual environment that simulates the real environment. Users can interact with this virtual environment through various devices (such as headsets, controllers, etc.), thereby obtaining an immersive experience. In digital marketing, virtual reality technology can be used to create product prototypes, showcase product features and functions, and simulate sales scenarios.

In traditional research, the research on brand marketing strategy mainly focuses on traditional marketing means and tools, such as advertising, promotion, public relations and so on. These means and tools can achieve certain results in some cases, but in the current digital age, they often lack interaction with consumers. This may lead consumers to lose interest in brands and fail to effectively attract and retain consumers. This paper puts forward a brand marketing strategy based on CAD and VR digital images. This strategy can better adapt to the market demand in the digital age, improve brand loyalty, cultivate consumers' personalized needs, and help brands better understand consumers' needs and behaviors, thus achieving accurate marketing.

3 BRAND MARKETING MODEL BASED ON EMOTION RECOGNITION

CAD is a tool and method for designing and creating by using computer technology. In brand marketing, CAD technology is often used in product design and model making, helping brands to create various product models quickly and accurately, and providing consumers with an intuitive and interactive experience. At the same time, CAD technology also helps to reduce production costs and improve production efficiency, providing more business opportunities for brands.

VR technology is a computer technology that can create and experience virtual worlds. In brand marketing, VR technology can be used to build virtual scenes and product models, so that users can browse and experience products in an unrestricted environment. For example, car brands can use VR technology to provide a virtual test drive experience to help consumers better understand the performance and characteristics of products. At the same time, VR technology can also achieve personalized customization, meet the individual needs of consumers, and further enhance brand loyalty.

Emotion recognition is a technology to recognize and understand users' emotions by analyzing users' behaviors, languages, expressions and other data. In brand marketing, emotion recognition can help brands better understand consumers' emotional needs and reactions, so as to formulate more accurate marketing strategies. For example, by analyzing users' evaluation of brands on social media, we can understand consumers' emotional tendencies and feedback, and then adjust and optimize products and marketing strategies.

Applying CAD, VR and emotion recognition technology to brand marketing can further improve the interaction and communication between brands and consumers. For example, in the virtual environment, consumers can observe and try the product model in an all-round way, at the same time, accept the brand information and marketing promotion, so as to better understand and feel the value of the brand. At the same time, the application of emotion recognition technology can help brands better perceive the needs and feedback of consumers, further optimize products and services, and improve consumer satisfaction and loyalty.

The application of CAD and VR technology in brand marketing, and the importance of user emotion recognition model in VR platform are discussed. Next, a brand marketing model based on emotion recognition will be introduced, which combines the advantages of CAD, VR and user emotion recognition technology to provide a new perspective and method for brand marketing. In the digital age, the interaction between consumers and brands has undergone profound changes. Traditional brand marketing methods often only pay attention to the functions and characteristics of products, but ignore the emotional needs of consumers. Therefore, the core idea of brand marketing model based on emotion recognition is: centering on consumers' emotion, using CAD

and VR technology to meet consumers' needs in function and emotion. By collecting consumer behavior data and consumption records in VR platform, we can understand consumers' shopping habits, needs and preferences. These data will become the input of subsequent emotion recognition. The constraint clustering algorithm is used to identify the emotion of the collected consumer data. By analyzing the data of consumers' behavior, language and expression, we can identify consumers' emotional tendencies in real time, and further form user portraits according to consumers' consumption tendencies.

User Portrait refers to the user's personalized label system based on the user's behavior, language, expression and other data, and then accurate user analysis is carried out through machine learning and other technologies. Collect user behavior data from various channels, including but not limited to purchase records, browsing records, search records, speeches on social media, etc. At the same time, it is also necessary to collect basic information of users, such as gender, age, occupation, etc. The collected data may have problems such as noise and missing values, so it is necessary to clean and preprocess the data. For example, the quality of data can be improved by data deduplication, abnormal value processing and missing value filling. Feature extraction is carried out on the preprocessed data to extract features that can reflect the user's behavior and preferences. The construction process of user portrait is shown in Figure 1.

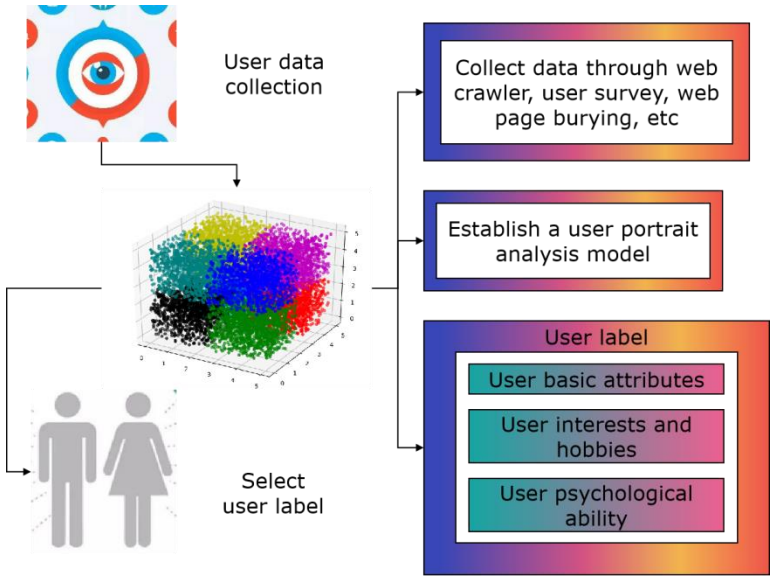

Figure 1: User portrait construction process.

According to the clustering results, each user is given a corresponding label to form a user portrait. Tags can be user preferences, behavioral characteristics, etc. After the construction is completed, the user portrait needs to be evaluated and optimized. We can adjust and optimize the construction process of user portrait by comparing the coincidence degree between user portrait and actual situation.

In the clustering analysis of user emotion recognition, it is necessary to collect user behavior data in the virtual environment, including user browsing records, clicking behaviors, purchasing behaviors, comments and so on. These data can be obtained through the API of VR platform or crawler technology. For the collected original data, some pre-processing work is needed, such as data cleaning, removing abnormal values, normalization, etc., to improve the accuracy and reliability of the data. The preprocessed data are transformed into feature vectors suitable for clustering. In this process, some techniques can be used to extract features that can reflect users'

emotions and consumption behaviors, such as text analysis and image recognition. For the user data in each cluster, emotion dictionary and text analysis technology are used to identify the user's emotional tendency. In this process, it is necessary to choose appropriate emotional dictionaries and algorithms to obtain more accurate results. The user data in each cluster are summarized into corresponding user portraits, including the characteristics of users' age, gender, interests, preferences and so on. These user portraits can be used as a reference for subsequent precision marketing. The clustering results and user portraits need to be evaluated and optimized to ensure their accuracy and effectiveness. The clustering analysis process of user emotion recognition is shown in Figure 2.

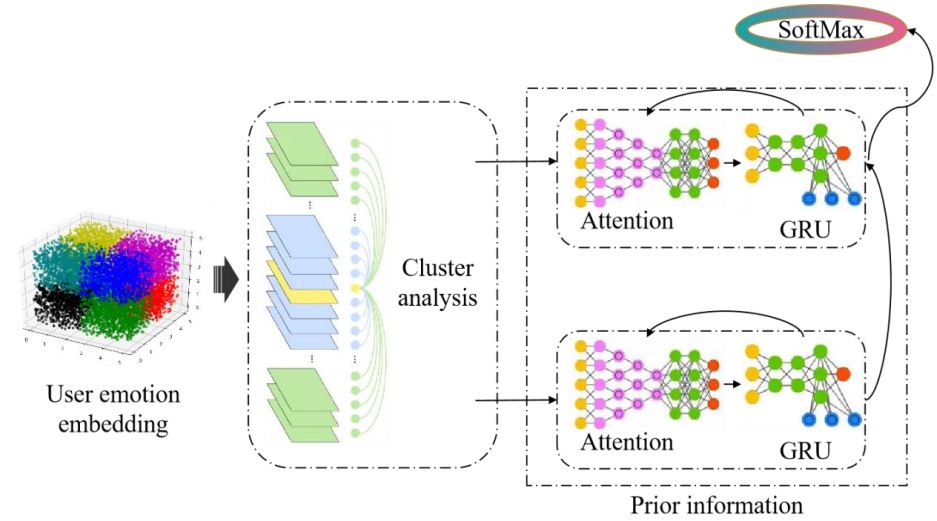

Figure 2: Cluster analysis of user emotion recognition.

The observation units in the sample set usually have certain homogeneity or similarity, that is, they have common characteristics or attributes in some aspects. This is to facilitate the research and observation of the sample set, as well as the inference and analysis of the population. Set sample set:

$$S = \{s_1, s_2, \ldots, s_m\} \tag{1}$$

The sample categories are:

$$C = \{c_1, c_2, \ldots, c_k\} \tag{2}$$

The information entropy is:

$$H(S) = \sum_{j=1}^{k} \sum_{i=1}^{m} p(s_{ij}) \log \frac{1}{p(s_{ij})} \tag{3}$$

It can be further deduced as:

$$H(S) = -\sum_{j=1}^{k} \sum_{i=1}^{m} p(s_{ij}) \log p(s_{ij}) \tag{4}$$

Where $p(s_{ij})$ represents the probability that the sample point in the sample set belongs to the category c_j. Let the sample attribute set:

$$A = \{a_1, a_2, \ldots, a_t\}^T \tag{5}$$

There are t different values. The information entropy of the sample set is as follows:

$$H(S|A)=-\sum_{j=1}^{k}\sum_{i=1}^{t}p(a_{ij})\log p(a_{ij}) \tag{6}$$

Among them, $p(a_{ij})$ represents the probability that the sample point belongs to the category c_i when the attribute A is a_i.

Given the parameter weight W and the deviation b, the probability that the transaction x belongs to the category i is:

$$P(Y=i|x,W,b)=soft\max_i(Wx+b)=\frac{e^{W_i x+b_i}}{\sum_j e^{W_j x+b_j}} \tag{7}$$

Negative logarithmic likelihood function is used as the loss function in supervised fine tuning. Assuming that y^i is the true classification of input x^i, the loss function has the following form:

$$L(W,b,x)=-\sum_{i=1}^{N}\log\left(P\left(Y=y^i\middle|x^i,W,b\right)\right) \tag{8}$$

According to consumers' behaviors and user portraits in the VR platform, the recommendation algorithm is used to recommend personalized products or services for consumers. For example, if consumers show a preference for a certain type of product or brand in the VR platform, they can recommend similar products or services to them. By monitoring consumers' behavior and emotional changes in the VR platform in real time, marketing strategies can be adjusted in time to make brand marketing more accurate and efficient. For example, if consumers' attention to a certain product decreases within a certain period of time, the promotion strategy of the product can be adjusted in time. By comparing the effect of brand marketing model based on emotion recognition with that of traditional marketing methods, we can evaluate the advantages and disadvantages of the model. At the same time, the design and implementation steps of the model can be further optimized to make it more in line with the actual brand marketing needs.

4 RESULT ANALYSIS AND DISCUSSION

This paper aims to verify the effectiveness and superiority of user emotion recognition model based on deep learning in user emotion recognition and purchase behavior prediction in VR platform. Collect user behavior data from VR platform, including user's interactive behavior, comments, purchase records, etc. in VR environment; Pre-processing text data, including word segmentation, stop words removal and stem extraction, to obtain a series of emotional expression words; The text preprocessing method based on bag-of-words model is used to transform emotional expression words into numerical feature vectors. Using word embedding technology to map feature vectors to high-dimensional vector space to capture word meaning information; The test set is used to evaluate the model and calculate the confusion matrix, accuracy and recall rate of the model. By comparing the experimental results, the emotion recognition model based on constraint clustering proposed in this paper is obviously superior to the decision tree method in VR platform, with higher accuracy and stability. At the same time, by analyzing the recognition effect of different types of emotions, it is found that the model is also ideal for the recognition effect of different types of emotions. These findings provide valuable reference for the design and optimization of VR platform.

In order to avoid the loss of important information caused by the elimination of special consumer data, the consumer characteristic data with large difference in data distribution interval is discretized. This processing method can effectively avoid the problem of over-fitting or under-

fitting of the model caused by uneven data distribution or improper handling of abnormal values, so as to obtain a more accurate and reliable emotion recognition model, as shown in Figure 3.

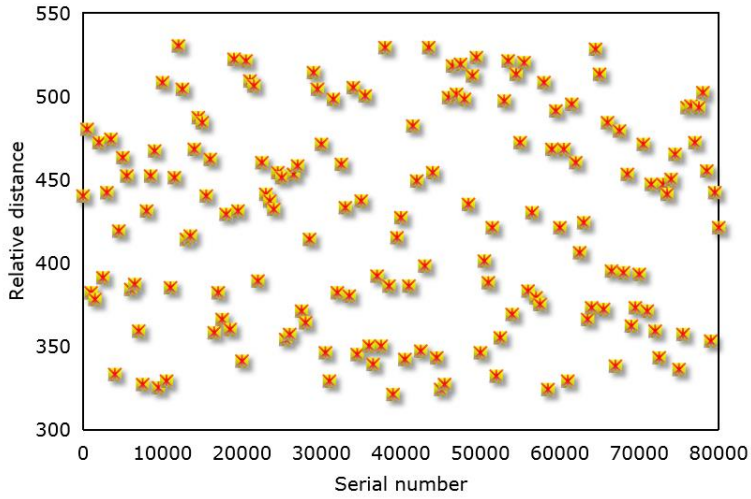

Figure 3: Data outlier removal processing.

Consumer characteristic data with large differences in data distribution intervals may lead to uneven data distribution. For example, the value range of some feature data may be too large or too small, which makes the data unable to be fully utilized when training the model. In order to solve this problem, these characteristic data can be discretized in intervals, and continuous data values can be mapped into discrete intervals, thus making the data distribution more uniform. Some abnormal values may have a negative impact on the training of the model, leading to over-fitting or under-fitting of the model. In order to solve this problem, these abnormal values can be properly processed, such as filling, deleting or adjusting weights, so as to make the data smoother and more accurate. Using these data to train the designed emotion recognition model, we can get better network weight. These network weights can reflect the importance attached by the emotion recognition model to different characteristic data, thus helping us to better understand consumers' buying behavior and emotional needs. By training the emotion recognition model, we can get a set of optimal network weights, which can make the model achieve minimum error and maximum accuracy in predicting VR purchase behavior.

Comparing the output data of emotion recognition model with the real VR purchase behavior data is an important step to verify the effectiveness and accuracy of emotion recognition model. The results shown in Figure 4 show that the learning result of emotion recognition model is convergent, which can approximate the original data well and has the basis for predicting VR purchase behavior.

The convergence of emotion recognition model shows the effectiveness of the model. This means that the emotion recognition model can learn the characteristics of consumers' emotional needs and buying behavior from the data, and with the training, the accuracy and stability of the model prediction are constantly improved. This convergence enables the emotion recognition model to accurately identify different consumers' emotions and predict their purchase behavior. This highly accurate emotion recognition model can better capture the emotional needs and purchasing behavior characteristics of consumers, thus helping brands to better understand consumers and provide more accurate personalized services.

From the comparison results of Figure 5 and Figure 6, it can be seen that the accuracy and recall rate of the algorithm in this paper are better than the decision tree algorithm in the

prediction of consumer consumption tendency on VR platform, and the accuracy rate is improved by 22.11%.

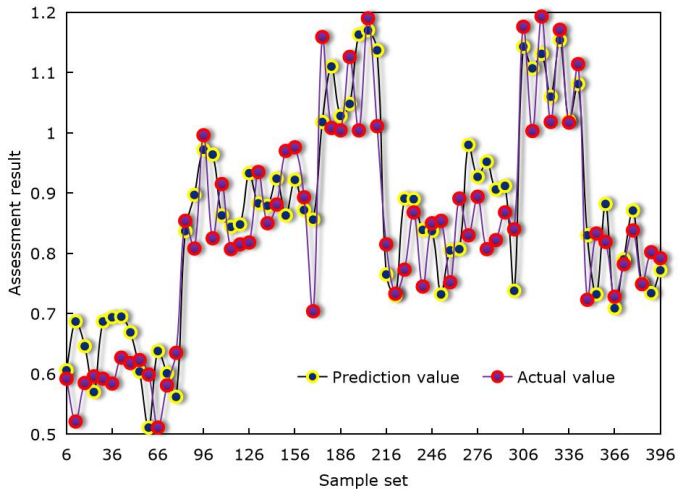

Figure 4: Learning results of emotion recognition model.

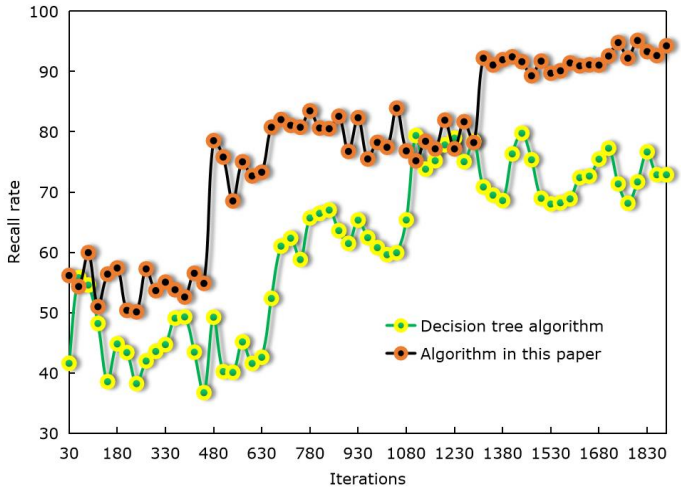

Figure 5: Comparison of recall rate of consumption tendency prediction.

In the prediction of consumers' consumption tendency on VR platform, decision tree algorithm can be used to classify consumers' buying behaviors, such as dividing consumers into two categories: high consumption tendency and low consumption tendency. However, the decision tree algorithm is easily affected by the quality of data sets and feature selection, and its ability to deal with nonlinear relationships is weak. In this paper, the algorithm learns consumers' emotional needs and buying behavior by establishing an emotional recognition model. Because deep learning can automatically learn features, the algorithm in this paper has strong feature capture ability, and can better deal with nonlinear relations and high-dimensional data. The accuracy of this algorithm in the prediction of consumers' consumption tendency on VR platform is improved by 22.11%. This shows that the algorithm in this paper can predict consumers' consumption tendency more accurately, thus helping brands to formulate marketing strategies more accurately.

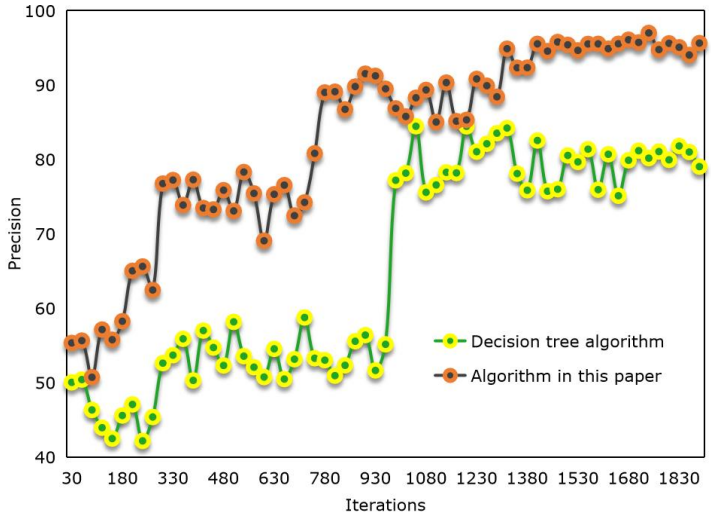

Figure 6: Comparison of prediction accuracy.

Stability is one of the important indexes to evaluate the performance of machine learning model. For emotion recognition model, stability means that the model can maintain relatively consistent prediction results and performance in the face of different input data or parameter settings. In VR platform, consumers' emotions and buying behaviors are complex and changeable, so the stability of emotion recognition model has important practical application value for real-time prediction and decision-making. According to the experimental results shown in Figure 7, it can be found that the constrained clustering algorithm in this paper is obviously superior to the decision tree algorithm in stability.

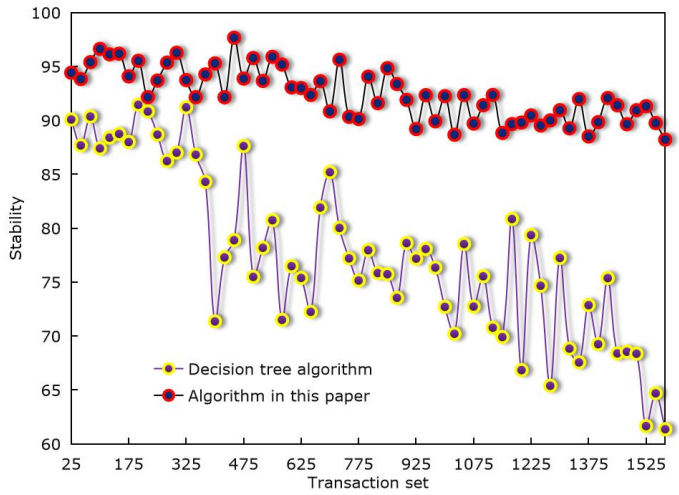

Figure 7: Stability comparison of models.

Constrained clustering algorithm groups consumer data by clustering, which can better capture the characteristics and laws in each group and has strong robustness to the interference of outliers and noise data in the group. This enables the algorithm to maintain relatively consistent prediction

results and performance in the face of different input data or parameter settings. In contrast, decision tree algorithm is poor in dealing with group characteristics and outliers.

The brand marketing model based on emotion recognition not only pays attention to the functions and characteristics of products, but also pays more attention to consumers' emotional needs and consumption tendencies. By combining CAD and VR technology, the model can realize the personalized customization of consumers' shopping experience and improve brand loyalty and consumer satisfaction. At the same time, user portraits based on emotion recognition can help brands better understand consumers' needs and reactions, so as to formulate more accurate marketing strategies. The implementation of this model requires the brand to have certain technical strength and data collection and analysis ability, and it is suggested that qualified brands try and use it. This digital image brand marketing strategy can not only improve the brand competitiveness and market share, but also provide consumers with better products and services.

5 CONCLUSION

In traditional product design, designers usually rely on handicrafts, experience and imagination to create the appearance and structure of products. With the emergence of CAD technology, designers can design products through computers, which not only improves the design efficiency and accuracy. With the introduction of VR technology, consumers can experience and customize products in virtual environment. In this paper, two fields of consumer emotion recognition and purchase behavior prediction in VR platform are studied, and an emotion recognition model based on constrained clustering algorithm is proposed. The experimental results show that the model is superior to the decision tree algorithm in accuracy and stability. The research in this paper not only provides a new perspective for understanding consumers' behavior patterns in VR platform, but also helps to improve the marketing effect and user satisfaction of VR platform. Through the emotion recognition model, we can better understand consumers' emotional needs and buying behaviors in the VR platform, which helps brands to accurately formulate marketing strategies and improve product sales. The proposed emotion recognition model can capture the emotional changes of consumers in real time, so as to predict the purchase behavior more accurately and improve the prediction accuracy.

In the future, we will continue to study the correlation between consumer emotion and purchase behavior in VR platform, and the application of emotion recognition model in various fields. In addition, we will pay attention to the development trend of VR technology, and constantly improve and optimize the emotion recognition model with new technical means to meet the actual needs of more fields.

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