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Automatic Clothing Style Identification and Mining Based on Computer Vision Algorithm

Yuan Wang[1] and Feng Cao[2]

[1]Department of Fashion, Shaanxi Fashion Engineering University, Shaanxi 712046, China, 100861@yzpc.edu.cn
[2]Department of Fashion, Shaanxi Fashion Engineering University, Shaanxi 712046, China, wangyuangzs@163.com

Corresponding author: Yuan Wang, 100861@yzpc.edu.cn

Abstract. This article mainly studies the use of computer-aided design (CAD) technology in clothing style identification and explores how to combine CAD technology with a computer vision algorithm to improve the accuracy and efficiency of identification. In this article, an automatic clothing style recognition system is developed, including image preprocessing, feature detection, classifier design, and other modules. Moreover, data mining (DM) technology is used to analyze the identified clothing style data deeply and extract valuable information. In order to verify the performance and effect of the automatic clothing style recognition system, a series of experiments are designed in this article. After analyzing and comparing the experimental results, it has been discovered that the system excels in terms of recognition accuracy, MAE, and processing speed. These excellent performances make this system have high value and potential in practical application. Moreover, the system has been highly evaluated by users in terms of usability, functional satisfaction, response speed, interface aesthetics, stability, and reliability. Users think that the system interface is intuitive, easy to operate, fully functional, and stable, and at the same time, the system responds quickly, the visual experience is pleasant, and the performance is excellent. The findings confirm the system's efficacy and practicality, laying the groundwork for future enhancements and optimizations.

Keywords: Computer Vision; Computer-Aided Design; Clothing; Automatic Identification; Convolutional Neural Network; Data Mining; Association Rule Mining
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1 INTRODUCTION

With the sustained development of the global economy and the constant changes in consumers' aesthetics, the clothing industry is facing unprecedented challenges and opportunities. Traditional clothing selection methods often fail to meet the needs of consumers with asymmetrical bodies, leading to discomfort when wearing certain clothing. In recent years, with the rapid development of

3D visualization technology, this field has begun to demonstrate enormous potential and value. Annett et al. [1] explored the clothing experience of consumers with asymmetric bodies and how to use 3D visualization technology to improve their shopping experience. The traditional fitting method cannot fully simulate the actual wearing effect, resulting in consumers only realizing that the clothing does not fit or looks asymmetrical after purchase. On the other hand, asymmetrical body shape may cause discomfort for consumers during fitting. Through this technology, consumers can try on clothing in a virtual environment, preview the effect in advance, and better choose clothing that suits their body shape. In addition, 3D visualization technology can help designers better understand consumer needs, optimize product design, and improve the adaptability and comfort of clothing. In this highly competitive and ever-changing industry, it is very important to identify clothing styles quickly and accurately to meet consumer demand, grasp market trends, and enhance brand competitiveness. 3D digital clothing technology has become a major highlight in the field of clothing design. Especially based on three-dimensional digital clothing technology, virtual upper garment loop clothing design not only simplifies the design process and improves design efficiency but also provides designers with infinite creative space. Chen et al. [2] explored the development and impact of virtual upper loop clothing design based on three-dimensional digital clothing technology. Through 3D digital technology, designers can quickly create and modify designs in a virtual environment, preview design effects in real time, and greatly shorten the design cycle. Based on three-dimensional human body measurement data, the wearing effect of clothing on the human body can be accurately simulated, improving the adaptability and comfort of clothing. By adjusting parameters, designers can quickly generate a series of clothing styles to meet the needs of different markets. By combining artificial intelligence technology, suitable top styles can be intelligently recommended based on consumer preferences and needs. However, the traditional clothing style identification method mainly relies on manual work, which is not only inefficient but also easily influenced by subjective factors. Traditional pattern-making often relies on manual drawing or printing techniques, and designers need to repeatedly modify and experiment to achieve satisfactory results. This method is inefficient and makes it difficult to achieve complex and refined pattern design. However, traditional pattern-making has its unique charm and artistic value, especially in the application of some special techniques and materials. The 3D virtual pattern production technology has been widely applied in the clothing industry. This technology provides designers with a new way of creating, allowing them to design and present patterns more intuitively and flexibly. Habib and Alam [3] compared 3D virtual patterns with traditional pattern-making to reveal their advantages and limitations, as well as how to combine the two to achieve the best design effect. Using computer software, designers can create and modify patterns in three-dimensional space. This technology allows designers to preview the final effect of patterns in a virtual environment and make real-time adjustments, greatly improving design efficiency and accuracy. In addition, the production of 3D virtual patterns can also achieve more complex pattern designs and finer detail processing.

Hoque et al. [4] explored the application and research directions of visual algorithms and CAD in data recognition technology in the clothing industry. Through machine learning and computer vision technology, visual algorithms can quickly and accurately measure human body dimensions, such as shoulder width, waist circumference, etc. This measurement method not only improves the accuracy of measurement but also reduces human error, providing strong support for personalized clothing design and customization. Visual algorithms can be used to identify and analyze information such as clothing styles, colors, patterns, etc. Through image processing and feature extraction techniques, algorithms can automatically recognize and analyze clothing styles, providing a data foundation for applications such as clothing classification, recommendation, and search. CAD technology can help designers quickly create and modify three-dimensional models of clothing. Through precise 3D modeling, designers can better understand the structure and design elements of clothing, improving design efficiency and effectiveness. Meanwhile, simulation technology can help designers preview the effect of clothing in actual wear, providing a basis for design optimization. The design and implementation of a component-based intelligent clothing modeling CAD system is of great significance for improving the efficiency and accuracy of clothing design. Hu [5] introduces the design and implementation of a component-based intelligent clothing modeling CAD system. By selecting

and combining components from the component library, a complete clothing style is formed. The system should support free splicing and modification of components to meet different design requirements. The system should have a parameterized design function, where designers can adjust parameters to change the size, shape, and other attributes of clothing to adapt to different body types and wearing requirements. The system should have automatic optimization and adjustment functions and automatically adjust the position, size, and other properties of components based on the parameters and requirements provided by the designer to achieve the best clothing styling effect. By using 3D graphics technology, the designed clothing is displayed on a virtual model and supports virtual fitting functions, making it easier for designers and consumers to understand the clothing effect better.

In the process of building a 3D virtual human model, body shape analysis is a crucial step. By collecting actual human body data and analyzing body shape, various physiological parameters of the human body can be obtained, such as height, weight, body fat percentage, etc. These data are input into a computer-aided design (CAD) system, processed, and modeled to generate a realistic 3D virtual human model ultimately. The deformation research of 3D virtual human models has wide applications in fields such as clothing design, animation production, and medical simulation. Through deformation technology, various postures and movements of the human body can be simulated, and the wearing effect and movement performance of clothing on the human body can be predicted. In addition, in the medical field, 3D virtual human models can also be used for surgical simulation and rehabilitation training to improve medical effectiveness. In the field of fashion design, designers can use 3D virtual human models for fashion design and fitting simulations, improving design efficiency and accuracy. In the field of sports science, researchers can use three-dimensional virtual human models for sports biomechanical analysis and athlete training. In the field of healthcare, doctors can use 3D virtual human models for surgical simulation and rehabilitation training [6]. Clothing style recognition is an important research direction in the field of computer vision. In recent years, the rapid development of computer vision technology has provided a new solution for clothing style recognition. Computer vision algorithms can automatically extract the feature information of clothing by learning and analyzing a large quantity of image data so as to accurately identify clothing styles. Moreover, in the field of fashion design, CAD technology has experienced decades of development, from the initial simple drawing tool to a comprehensive design platform that integrates many functions, such as printing, grading, and layout [8]. As CAD technology gains widespread usage in the realm of clothing design, the integration of computer vision algorithms with CAD is anticipated to enhance the efficacy and precision of recognizing clothing styles even further.

The research objectives of this article are as follows:

⊖ Develop an efficient and accurate automatic clothing style identification system, which can automatically extract and analyze the feature information in clothing images and identify clothing styles.

⊖ Using DM technology, the identified clothing style data are deeply analyzed, and valuable market information and consumer behavior patterns are extracted to provide support for clothing enterprises' decision-making.

The innovation of this article is mainly reflected in the following aspects: first, the design of system architecture realizes the automatic processing of the whole process from image uploading to result display; Secondly, the optimization of feature detection and recognition algorithm improves the accuracy and efficiency of recognition; Thirdly, the application of DM technology provides a new perspective and means for market analysis and trend prediction of clothing industry.

Firstly, this article introduces the present situation of the clothing industry, the importance of clothing style recognition, and the application of computer vision in related fields. Moreover, it is explained that the purpose of this study is to realize automatic identification and data mining of clothing styles by combining computer vision algorithms with CAD technology so as to improve the intelligence level of the industry. Then, the design of the automatic clothing style recognition system is discussed, including analyzing the functional requirements and performance requirements of the system and designing the overall architecture of the system. Moreover, data mining algorithms

suitable for clothing style recognition, such as association rule mining and cluster analysis, are introduced. And analyze the mining results to extract valuable information, such as fashion trends, consumer preferences, and so on. Finally, the system and algorithm are tested comprehensively, and the recognition accuracy and efficiency of the system are evaluated. The successful implementation of this study will show the great potential of computer vision and CAD in the clothing industry, and it is expected to attract more researchers and enterprises to invest in the research development and application of related technologies.

2 RELATED WORK

CAD methods play an important role in three-dimensional clothing design, providing designers with more intuitive and convenient design tools while also bringing consumers a more realistic shopping experience. 3D clothing design has emerged in recent years with the development of computer graphics and virtual reality technology. Although traditional two-dimensional clothing design can meet basic production needs, there are limitations in the efficiency and effectiveness of the design process. Designers are unable to fully present three-dimensional clothing effects on a two-dimensional plane, resulting in the need for repeated modifications and adjustments during the design process. The introduction of CAD methods provides strong support for 3D clothing design. Through CAD software, designers can add various materials and textures to clothing models, such as the luster, texture, and softness of the fabric, making the design more realistic. With the help of animation features, designers can simulate the dynamic effects of clothing on the human body in order to better observe the actual effects of the design and optimize it further [7]. The ways of clothing design and fitting are also constantly evolving. The combination of visual algorithms and computer-aided design (CAD) technology has brought revolutionary changes to this field. Through this technology, designers can design and try on clothing more quickly and accurately, improve work efficiency, and meet the needs of consumers for personalized customization. Jeong and Sohn [8] discussed the development and application of this technology in detail. By using advanced image processing algorithms, clothing images are segmented into different parts, such as necklines, sleeves, body panels, etc. This segmentation method helps designers to individually design and modify various parts of clothing, improving design flexibility and efficiency. By using CAD technology, the segmented clothing images are 3D modeled, and the effect of wearing the garment on the human body is simulated. Designers can preview design effects in a virtual environment, make real-time adjustments, and reduce the cost and time of sample production. Through image segmentation and 3D modeling techniques, the wearing effect of clothing on the human body can be accurately simulated, improving the accuracy of design. No need to make physical samples, reducing material and sample production costs. At the same time, it also reduces the number of attempts and modifications and lowers labor costs.

In order to meet this market demand, rapid customization of clothing has become an important development direction in the clothing industry. The combination of visual algorithms and CAD technology provides strong support for the rapid customization of clothing. Jiang et al. [9] explored the importance and application of visual algorithms and CAD technology in rapid custom clothing design and simulation. In clothing customization, visual algorithms can be used for image recognition and processing to achieve fast and accurate measurement and design. For example, through machine learning and computer vision technology, it is possible to automatically recognize and measure key parts of the human body, such as shoulder width, waist circumference, etc., providing accurate data support for customized design. Through visual algorithms and CAD technology, designers can customize personalized products based on consumer body shape, preferences, and needs. During the design process, clothing styles, colors, materials, etc., can be quickly adjusted to meet the unique requirements of consumers. Through virtual reality or augmented reality technology, consumers can try on customized clothing in a virtual environment. This virtual fitting method can provide consumers with a more realistic experience and help improve the accuracy of purchasing decisions. With the advent of the digital age, three-dimensional pattern design is increasingly valued in the clothing industry. Through three-dimensional pattern design, unique visual

effects can be created, enhancing the beauty and design sense of clothing. However, the difficulty of 3D pattern design is significant and requires the use of advanced technological means to achieve it. Kang and Kim [10] introduced a clothing 3D pattern design method based on a progressive mesh cropping algorithm to improve design efficiency and accuracy. The progressive grid clipping algorithm is a grid-based image processing technique that achieves efficient image processing by gradually refining images. In clothing 3D pattern design, the progressive mesh cropping algorithm can gradually refine complex patterns and generate more refined 3D models. Meanwhile, the algorithm can also crop and adjust patterns according to design requirements to meet different design requirements. It uses a progressive grid clipping algorithm to process two-dimensional patterns and generate three-dimensional models. During the model construction process, operations such as rotation, scaling, and translation can be performed on the model to adjust the design effect better.

The application of computer-aided design (CAD) in the field of clothing design is becoming increasingly widespread. Among them, the CAD pattern system, as an efficient design tool, plays an important role in improving students' learning effectiveness and ability. Kulsum [11] explored how to use CAD pattern systems to classify women's clothing patterns in order to enhance students' learning effectiveness and abilities. CAD pattern systems can provide high-precision drawing tools to ensure the accuracy and precision of design patterns. At the same time, the system simplifies the design process and improves design efficiency. The CAD pattern system has a rich material library, including various women's clothing patterns, textures, colors, etc., making it convenient for students to choose and edit. The use of CAD pattern systems to classify women's clothing patterns is an important means to improve the design effect and ability of students. The implementation of basic training, advanced learning, theme creation, practical project practice, and evaluation system construction can effectively enhance the learning effectiveness and ability of students. Murasaki et al. [12] explored how to use a quantitative analysis method of back surface deformation based on three-dimensional measurement to evaluate the aesthetic appearance of the back when wearing a bra. The quantitative analysis method of back surface deformation based on three-dimensional measurement is an advanced technical means for evaluating the appearance and comfort of the back when wearing bras. This method mainly obtains surface data of the back of the subjects before and after wearing bras through high-precision 3D scanners. I also use professional software for data analysis, including surface deformation, contour line changes, etc. It selected female volunteers of different body sizes and ensured that they did not wear bras before the experiment. Then, volunteers were asked to wear bras of different styles and sizes, and a 3D scanner was used to obtain surface data of their backs before and after wearing them. Next, we will import the data into professional software for processing and analysis and calculate the deformation and contour line changes of the back. The experimental results show that through the quantitative analysis method of back surface deformation based on three-dimensional measurement, we can accurately evaluate the aesthetics of the back after wearing a bra. Specifically, this method can reflect the degree of deformation of the back, the smoothness of the contour lines, and the fit between the bra and the back.

Especially in the field of customized clothing, with the help of visual algorithms and CAD (computer-aided design) technology, people can highly customize according to their personal preferences and needs. However, these technologies have also brought new problems, especially customized solutions to the bias of capable individuals. Paganelli [13] explores how to use visual algorithms and CAD to eliminate these biases and provide consumers with more fair and objective customized solutions. Visual algorithms combined with 3D scanning technology can accurately obtain consumer body data, including size, body shape, curves, etc. These data provide a foundation for precise clothing production. There are also some issues with the application of visual algorithms and CAD in clothing customization. The most important issue among them is the problem of prejudice against capable individuals. Talent bias refers to the phenomenon where the characteristics of certain groups are overly emphasized or glorified, leading to the neglect or discrimination of the characteristics of other groups. This is manifested in clothing customization as certain body types or features are considered more beautiful and attractive, leading to unfair treatment of consumers with other body types or features when customizing clothing. With the continuous progress of technology, 3D scanning and CAD/CAM (computer-aided design/manufacturing) technology have been widely

applied in the textile industry. These digital technologies have brought tremendous changes to the design, production, and quality control of textiles. Špelic [14] explored the application of 3D scanning and CAD/CAM in textile research and their impact on the industry. By using 3D scanning technology, it is possible to obtain three-dimensional structural data of fabrics, including yarn direction, texture, thickness, etc. These data are helpful in analyzing the mechanical properties, breathability, warmth retention, and other characteristics of fabrics, providing an important reference basis for design. Through 3D scanning technology, it is possible to obtain three-dimensional data of the human body surface and establish a human body model. By combining CAD technology, it is possible to simulate the wearing effect of clothing on the human body, conduct ergonomic analysis, optimize design, and improve the comfort and fit of clothing. For some precious historical textile artifacts, 3D scanning technology can be used for digital archiving and replication. By performing high-precision 3D scanning on cultural relics, surface details and structural data can be obtained, providing important information for subsequent research and protection.

Clothing printing technology is also constantly developing and innovating. Traditional printing techniques are mainly limited to two-dimensional surfaces, making it difficult to meet people's pursuit of three-dimensional and layered feelings. To address this issue, Wu et al. [15] proposed a two-dimensional weaving method based on cotton-printed threads for the three-dimensional printing of clothing. Two-dimensional weaving is a method of interweaving different materials according to certain rules, which can create rich textures and patterns. Cotton-containing printing thread combines printing technology with textile technology and prints patterns on the surface of cotton thread through specific processes. This technology can form various fine and three-dimensional patterns on online materials, providing the possibility for three-dimensional printing of clothing. Through experimental verification, the two-dimensional weaving method based on cotton printing thread can be successfully applied to the three-dimensional printing of clothing. The experimental results indicate that this method can create a rich sense of dimensionality and hierarchy while also having high practicality and market prospects. In addition, this method can also customize production according to different needs and styles, meeting the needs of consumers for personalized clothing. With the development of technology and the increasing demands of consumers for product comfort and fit, dynamic fit optimization in the clothing industry has become a hot research topic. Especially in the design of diving suits, the fit directly affects the comfort and safety of the user. Wu et al. [16] explored how to optimize the dynamic fit of women's diving suits using virtual technology and evaluated its effectiveness. Use 3D scanning technology to finely scan the human body and obtain three-dimensional data of the female body. These data include body shape, curves, muscle structure, etc., providing a foundation for subsequent model building. Design diving suits on virtual models and optimize dynamic fit through simulation techniques. This includes adjusting the size, shape, and materials of clothing to achieve the best fit. By using real-time simulation technology, observe the fit of diving suits in various motion states. Based on simulation results, make real-time adjustments to the design to meet the requirements of dynamic fit. Through this method, we can quickly and accurately evaluate the feasibility and effectiveness of the design, improving the comfort and safety of the product.

3 DESIGN OF AUTOMATIC CLOTHING STYLE IDENTIFICATION SYSTEM

3.1 System Requirements Analysis and Architecture Design

Before building an automatic identification system of clothing styles, we should first analyze the requirements of the system. In terms of functional requirements, the system needs to be able to receive clothing images uploaded by users, automatically preprocess and extract features, then identify the clothing styles of the images and show the results to users. In terms of performance requirements, the system needs high accuracy, high efficiency, and good user experience. Based on these requirements, this article designs the overall architecture of the system. The image input module is responsible for receiving images uploaded by users; The preprocessing module is responsible for denoising and enhancing the image to improve the accuracy of subsequent

processing; The feature detection module is responsible for extracting key features in the image; The style identification module is responsible for identifying the style of clothing according to the extracted features; The result display module is responsible for displaying the recognition result to the user.

3.2 Clothing Style Recognition Algorithm

In the aspect of clothing style recognition algorithm, by comparing the performance of different algorithms, this article chooses the DL algorithm, which is the most suitable algorithm for this system, as the main research algorithm. DL algorithm has a strong ability for feature learning and classification, which can automatically learn and extract deep-seated features in images and realize accurate style recognition. CNN is adopted as the main DL model, and it is improved and optimized to improve the accuracy and efficiency of recognition. In order to identify clothing styles, we first choose an appropriate depth CNN architecture -ResNet. The input layer of the network is usually defined as a four-dimensional tensor, which covers the image data processed in batches, including its height, width, and quantity of color channels (3 for color images). Then, by constructing a convolution layer to extract image features, using a pooling layer to reduce data dimension and a fully connecting layer to integrate feature information, a deep network architecture is formed. Finally, the output layer is set at the end of the network, and the quantity of neurons is consistent with the quantity of clothing styles to be identified, and the softmax activation function is used to output the probability distribution of each category to realize the effective classification of styles. Figure 1 shows the convolution process.

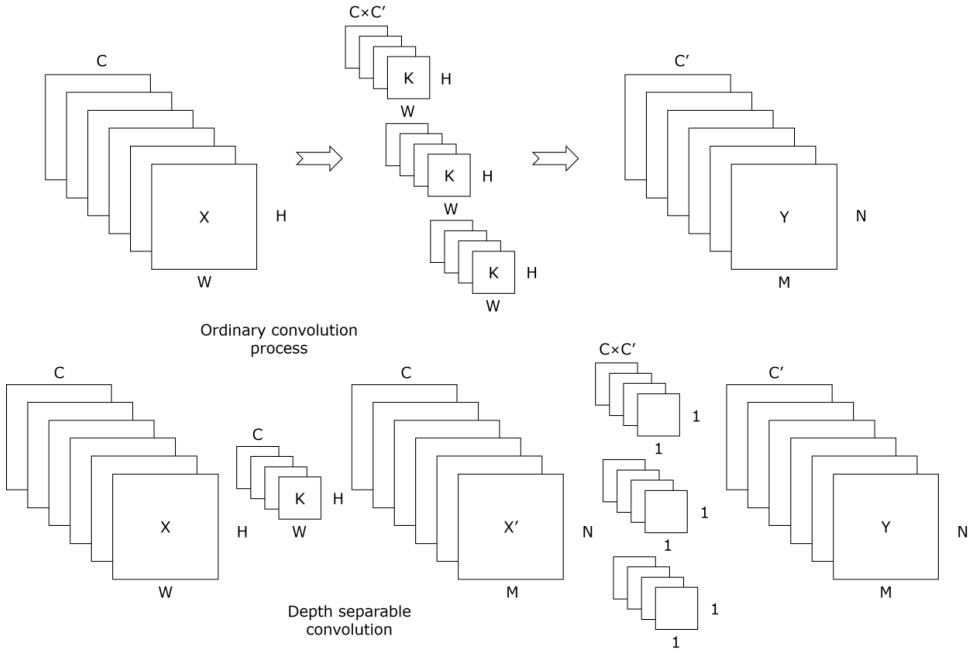

Figure 1: schematic diagram of the convolution process.

During preparation for deep learning training, the labeled image dataset undergoes an initial division into separate training and verification sets. Subsequently, either random initialization or the utilization of pre-trained weights is employed. The cross-entropy loss function is chosen to measure the discrepancy between the network's predictions and the actual labels. Moreover, the optimizer is selected to update the network weights iteratively, thus minimizing the loss function. In the training

process, the loss value is calculated by forward propagation, and then the network weight is adjusted by the reverse propagation algorithm. Regularly evaluate the performance index of the model on the verification set to monitor the over-fitting phenomenon and select the best model. Convolution is the most important part of CNN, which is used to extract feature information from data. The general formula of discrete convolution is as follows:

$$H\ x,y\ = A \otimes k\ x,y\ = \sum_{M,N} A\ m,n\ k\ x-m,y-n \tag{1}$$

Assuming that the l layer is a fully connected layer, the weight matrix is W^l , and the offset is b^l , the calculation process of the fully connected layer is as follows:

$$Z_j^l = f\ W^l X^{l-1} + b^l \tag{2}$$

ResNet has a "shortcut" from input to output and many branches, which have a highly modular topology and high portability. The block output of ResNet is:

$$F\ x\ = \sum_{i=1}^{C} T_i\ x \tag{3}$$

Where $T_i\ x$ can be any function and C is the quantity of branches. ResNet simplifies $T_i\ x$, and all $T_i\ x$ have the same topology, so C it can be extended to any size. 1×1 convolution in the network plays the role of dimensionality reduction. After the model training is completed, an independent test set is used to evaluate the performance of the model to ensure the objectivity and generalization ability of the assessment results. Based on the assessment results of the test set, targeted model optimization is carried out, which involves adjusting the structural design of the network, modifying the super-parameter configuration, or adopting more complex data enhancement strategies to enhance the robustness of the model.

In addition, image preprocessing is an important step in the automatic clothing style recognition system, and its purpose is to remove noise from the image and enhance useful information for subsequent feature detection and style recognition. In this article, a variety of preprocessing methods are adopted, including graying, filtering and denoising, contrast enhancement, and so on. These preprocessing methods can effectively improve the image quality and lay the foundation for subsequent style recognition. Moreover, feature detection is the key step of clothing style recognition, and its purpose is to extract the key features that can represent clothing styles from the preprocessed images. This article also selects a variety of feature detection algorithms, such as SIFT and HOG, and optimizes and selects them according to the experimental results. These feature detection algorithms can effectively extract the shape, texture, and other features in the image, which provides strong support for the subsequent style recognition.

4 APPLICATION OF DM IN CLOTHING STYLE RECOGNITION

4.1 DM Algorithm Selection and Data Processing

DM is a process of extracting hidden information from a large quantity of data, and its algorithms are numerous and have their own characteristics. Among them, association rule mining is a method to find the interesting relationship between data items, which can help us find the collocation law or sales association between different clothing styles. Cluster analysis is an unsupervised learning method that can automatically group similar clothing styles and help us understand market segmentation and consumer classification preferences. In the field of clothing style recognition, this article chooses some algorithms that are particularly suitable for processing this kind of data. The selection of these algorithms is based on their efficiency and accuracy in processing clothing style data and the practical value of the results they provide for clothing enterprises.

Data classification is an important task in DM, which can help us extract useful information from a large quantity of data. The process of data classification usually includes two main stages: the learning stage (constructing a classification model) and the classification stage (using this model to predict the class label of given data). During the learning phase, the classification algorithm builds the classification model through an analysis of the training dataset. Once the model is established, the classification stage commences, where the test dataset is employed to assess the precision of the classification rule. If the determined accuracy is satisfactory, the rule is then applied to classify new data tuples. As shown in Figure 2.

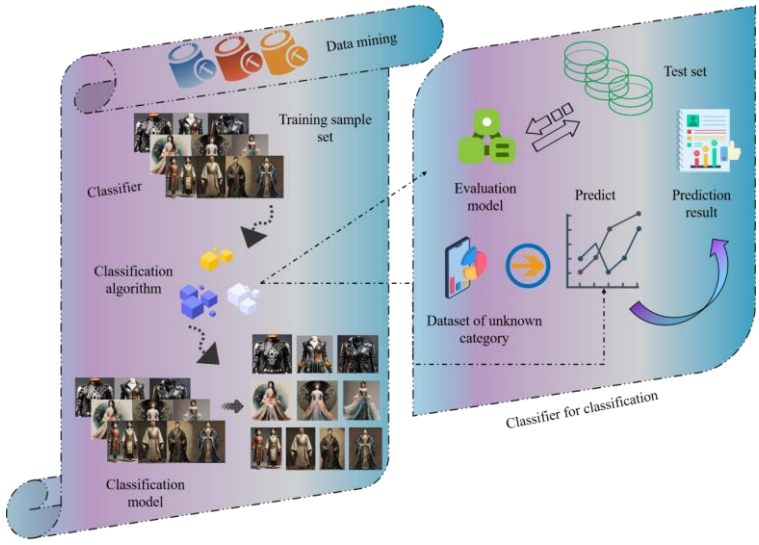

Figure 2: Steps of data classification.

By mining association rules, enterprises can optimize product mix and display mode and improve sales efficiency. In the association rule mining algorithm, the support degree can be expressed as:

$$support\ \ X \Rightarrow Y \tag{4}$$

$$support\ \ X \Rightarrow Y\ \ = supportX \cup Y = P\ \ X,Y \tag{5}$$

Its meaning is the proportion of clothing products contained X,Y in the whole clothing product set. Suppose:

$$I_1, I_2 \subseteq I; I_1 \cap I_2 = \varnothing \tag{6}$$

Then, the credibility can be expressed as:

$$Confidence\ \ I_1 \Rightarrow I_2\ \ = \frac{support\ \ I_1 \cup I_2}{support\ \ I_1} \tag{7}$$

It refers to the ratio of the quantity of things contained to the quantity of things contained I_1. Confidence is the quantity of clothing products including both X and Y and the ratio of all clothing products to clothing products including X, namely:

$$Confidence(X \Rightarrow Y) \tag{8}$$

It can be further expressed as:

$$Confidence(X \Rightarrow Y) = \frac{support\ \ X \cup Y}{support\ \ X} = P\ \ Y \middle| X \tag{9}$$

The main function of confidence is to describe the probability of Y a transaction X .

In addition, it is very important to preprocess the clothing style data before DM. First of all, data cleaning is an essential step, which involves removing duplicate, invalid, or wrong data items to ensure the quality and consistency of data. Secondly, data conversion is also a key step. This article needs to convert data of different formats or types into a format suitable for mining. This includes converting the style information described in the text into a numerical representation so that the algorithm can handle it. Finally, data standardization is also an important part of preprocessing, which can eliminate dimensional differences between data and make different features comparable in value.

These preprocessing steps are very important to ensure the accuracy and effectiveness of DM results. Only the thoroughly cleaned, correctly converted, and standardized data can provide true and reliable information and support the subsequent mining analysis.

4.2 Analysis and Interpretation of DM Results

After DM algorithm processing, a series of hidden information and knowledge about clothing styles are obtained. In order to turn these results into valuable insights for clothing enterprises, in-depth analysis and interpretation of the results are needed. First of all, we can find out which clothing styles are often bought together or worn together through the mining results of association rules so as to infer consumers' collocation habits and purchasing preferences. This information is of great significance for enterprises to optimize product mix, design package products, or formulate bundled sales strategies. Secondly, the results of cluster analysis reveal the existence of different consumer groups in the market and their preferences for different clothing styles. By identifying these market segments, enterprises can design products more pertinently, formulate marketing strategies, and carry out promotional activities to meet the needs of different groups and increase market share.

To sum up, the application of DM in clothing style identification provides valuable market insight and consumer behavior information for clothing enterprises. By choosing the appropriate algorithm, carrying out the necessary data preprocessing, and in-depth analysis and interpretation of the results, enterprises can more accurately grasp the market trends and consumer demand, thus enhancing their competitiveness and profitability.

5 SYSTEM IMPLEMENTATION AND TESTING

5.1 System Development Environment and System Function Realization

In the process of building an automatic identification system for clothing styles, this article first selects a suitable environment and technology stack for system development. Considering the stability and expansibility of the system and the technical proficiency of the team, Python is chosen as the main programming language because it has extensive application library support in image processing, machine learning, and other fields, and its grammar is concise and easy to develop quickly. In the aspect of development tools, the integrated development environment -PyCharm is adopted, which provides one-stop functions such as code editing, debugging, and version control, which greatly improves development efficiency. In addition, in order to support the operation of the DL algorithm, a high-performance GPU computing environment, such as NVIDIA's CUDA platform, is also configured. During the experiment, the experiment was carried out according to the preset experimental scheme, and the experimental data and results were recorded.

The system's function realization revolves around the core modules such as image uploading, preprocessing, feature detection, style recognition, and result display. For the image upload module, this article designs a user-friendly interface that allows users to upload clothing images by dragging

or selecting files. After uploading, the image enters the preprocessing module, where we apply filtering, denoising, contrast enhancement, and other algorithms to improve the image quality and improve the accuracy of subsequent recognition. The feature detection module is the key part of the system. In this article, a variety of feature detection algorithms are implemented, and the most suitable feature set for clothing style recognition is selected through experimental comparison. The DL model is used in the style identification module. By training a large quantity of clothing style image data, the model can accurately identify the style category of the uploaded image. Finally, the result display module presents the recognition results to users in an intuitive way, including the name of the style, the recommendation of similar styles, and other information, and also provides a user feedback mechanism to collect users' opinions and suggestions and continuously optimize the system performance.

5.2 System Testing and Performance Assessment

In order to ensure the stability and reliability of the system, this section has carried out a comprehensive system test. The function test verifies whether the functions of the system meet the design requirements, including the compatibility of image uploading, the effectiveness of the preprocessing algorithm, the accuracy of style recognition, and so on. Table 1 shows the system's function test results.

Test item	*Test content*	*Expected result*	*Net effect*	*Conclusion*
Image upload compatibility	Test image uploads of different formats and sizes.	Successfully uploaded and processed all images.	All images were uploaded and processed successfully.	Pass
Effectiveness of the preprocessing algorithm	Verify image preprocessing algorithms (scaling, cropping, denoising, etc.)	The algorithm should effectively improve the image quality and facilitate the subsequent processing.	The image quality is obviously improved, which meets the requirements of subsequent processing.	Pass
Accuracy of style recognition	Test the system's ability to identify different clothing styles.	The system should accurately identify various clothing styles.	The recognition accuracy meets the design requirements (about 95%).	Pass
System response time	Test the speed at which the system processes images and returns results.	The system should respond to the request within a reasonable time.	The average response time is within the acceptable range (< 2 seconds).	Pass
Exception handling	Test the performance of the system when it encounters abnormal conditions.	The system should be able to properly handle abnormal situations and avoid crashes or data loss.	The system successfully handled all abnormal situations without any crash or data loss.	Pass

Table 1: Functional test results of the system.

Performance testing mainly focuses on the response time and resource consumption of the system and tests whether the system can maintain stable performance during peak hours and multi-user concurrent access scenarios. Figure 3 shows the system's response time.

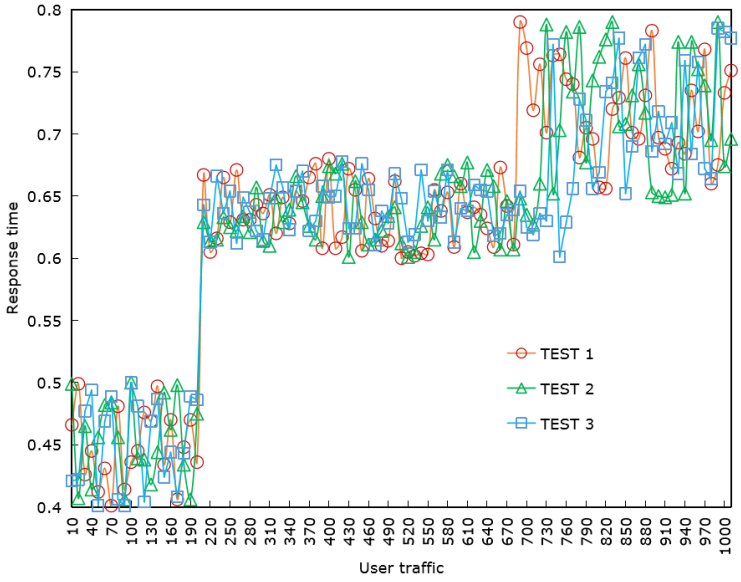

Figure 3: Response time of the system.

Observations indicate that the system boasts a brief average response time, highlighting its ability to swiftly handle requests and deliver outcomes. This rapid processing is crucial for ensuring an optimal user experience and maintaining system efficiency. Figure 4 shows the system's resource consumption.

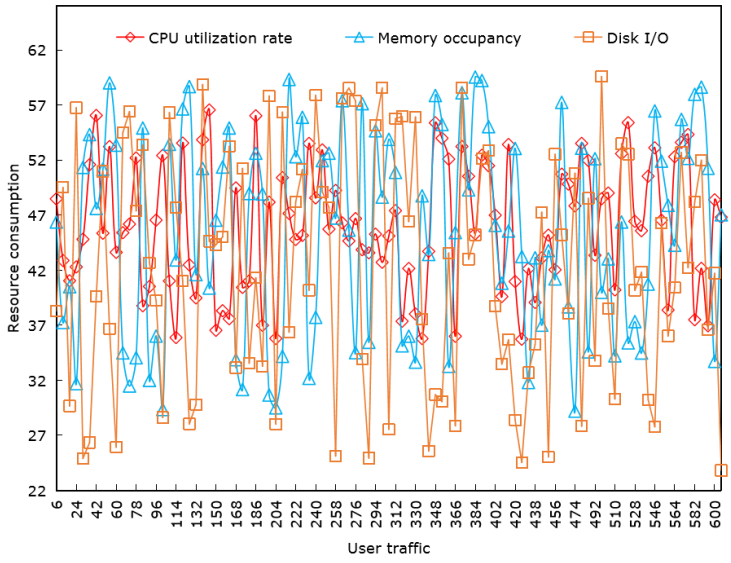

Figure 4: Resource consumption of the system.

CPU utilization rate: If the CPU utilization rate is too high, it may mean that the system has computation-intensive tasks or insufficient code optimization. Excessive CPU utilization may lead to system performance degradation and even stability problems. Memory usage: Observing the memory usage of the system can help us to know whether there is memory leakage or unnecessary

memory allocation in the system. If memory usage continues to increase without releasing, you may need to optimize your code to reduce memory consumption. Disk I/O: Disk I/O is an important performance indicator for systems involving a large quantity of file reads and writes or database operations. Excessive disk I/O may lead to slow system response and affect the user experience. As can be seen from Figure 4, when the system runs for a long time, the CPU utilization rate and memory utilization rate are at a low level, and the disk I/O is not high.

In addition, this section also conducted a user experience test, invited real users to participate in the use of the system, and collected their feedback so as to optimize the operation process and interface design of the system from the user's point of view. The user experience test is shown in Figure 5.

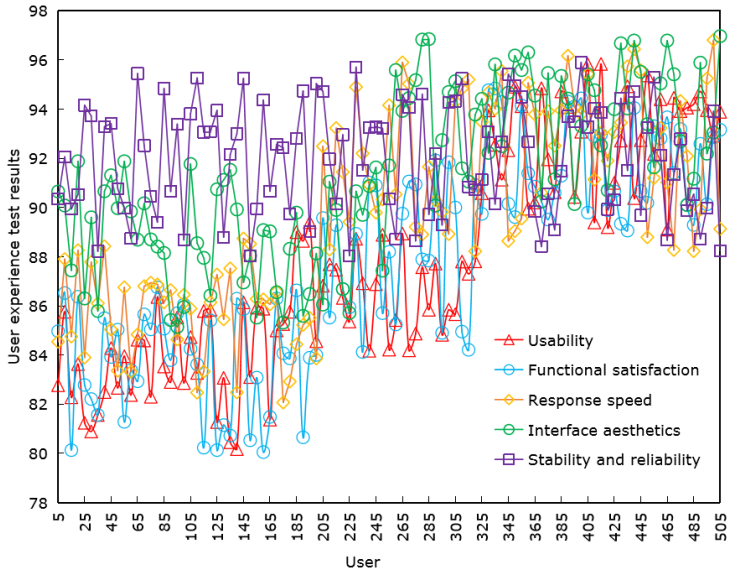

Figure 5: User experience test situation.

To assess the system's recognition accuracy and efficiency, this section utilizes standard evaluation metrics: accuracy, MAE, and information processing speed. A comparative analysis with other comparable systems is conducted, revealing that the system presented in this article excels in recognition accuracy, MAE, and processing speed, making it suitable for practical applications. The detailed experimental setups are illustrated in Figures 6, 7, and 8.

Accuracy is the basic index to evaluate the performance of the classification system, which indicates the proportion of samples correctly identified by the system to the total samples. Figure 6 shows that the accuracy curve of this system is much higher than other systems, so the following conclusions can be drawn:

High recognition ability: The system has a strong recognition ability for all kinds of clothing styles and can accurately distinguish different categories.

Robustness: The system can maintain high recognition accuracy when dealing with different kinds of images with different complexity, which shows that the system has good robustness.

Practicality: High accuracy means that the system can provide reliable results for users in practical applications and meet their needs.

MAE is used to measure the average deviation between the system's predicted value and the actual value. In Figure 7, with the increase in sample size, the MAE value remains stable or gradually decreases, so it can be inferred that:

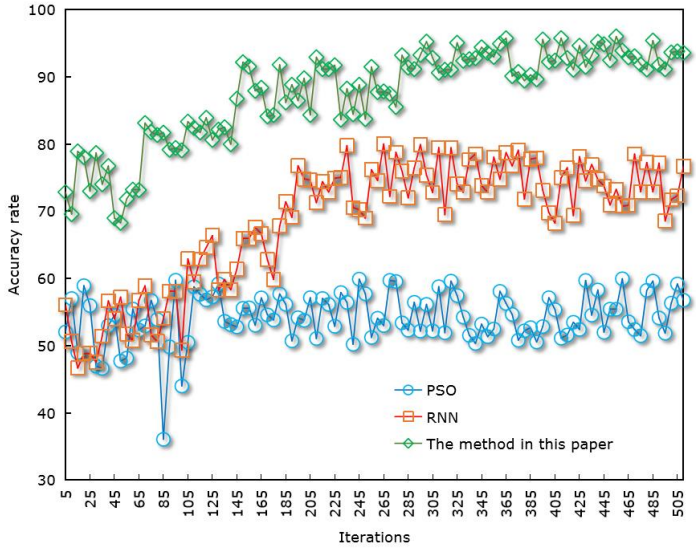

Figure 6: Accuracy rate.

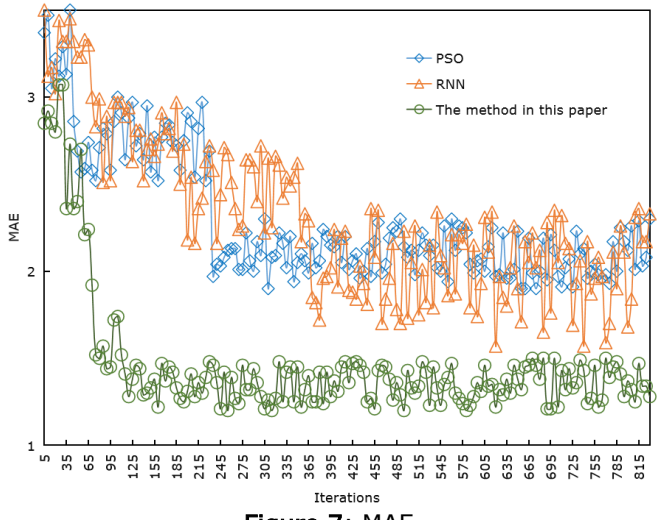

Figure 7: MAE.

Accuracy: The system's predicted results are very close to the actual results, which shows that the system has high accuracy.

Consistency: In different scenarios, the system's prediction error can be kept at a low and stable level, which shows that the system has good consistency.

Reliability: A low MAE value increases the user's trust in the prediction results of the system, making the system more reliable in practical application.

Information processing speed is an important index to evaluate system efficiency. In the results shown in Figure 8, the processing speed curve of this system is higher than that of other systems, and the processing time keeps a relatively stable growth with the increase of the workload. Therefore, the following conclusions can be drawn:

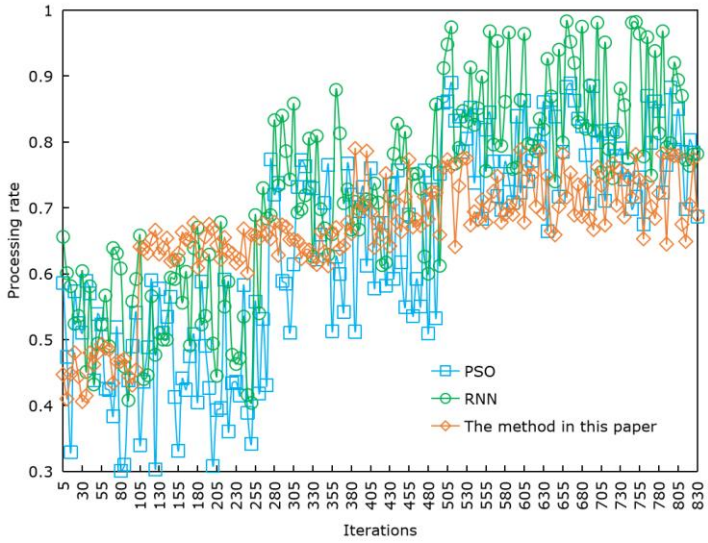

Figure 8: Processing rate.

Efficiency: The system can quickly process a large quantity of image data and give the recognition results in a short time.

Extensibility: With the increase of tasks, the system can maintain efficient processing capacity, which shows that the system has good scalability.

Practicality: In practical applications, fast information processing speed is very important for improving user experience and meeting real-time requirements.

6 CONCLUSIONS

This study is devoted to the automatic identification and DM of clothing styles and has achieved a series of remarkable results in the process. Firstly, the algorithm selection and technology research are carried out to determine the most suitable computer vision algorithm and CAD technology for this study. Then, based on the selected algorithm and technology, an automatic clothing style recognition system is developed. Finally, the data identified by the system is deeply analyzed by DM technology to provide support for the decision-making of clothing enterprises. Its research significance lies in:

⊖ Improve the intelligence level of the clothing industry. Through the automatic and intelligent clothing style identification system, the dependence on labor can be reduced, and production efficiency and quality can be improved.

⊜ Enhance the market competitiveness of garment enterprises. Identifying clothing styles quickly and accurately is helpful for enterprises to grasp market trends and consumer demand in time so as to adjust product strategies and market strategies and enhance market competitiveness.

⊛ Promote the wider application of computer vision and CAD technology in the clothing industry. The successful implementation of this study will fully show the great potential of computer vision and CAD in the field of clothing, and then it is expected to stimulate the interest of more researchers and enterprises and promote them to actively participate in the in-depth research and development and wide application of related technologies.

Although some achievements have been made in this study, there are still some limitations and shortcomings. First of all, in terms of data acquisition, due to the diversity and complexity of data sources, there may be uneven data quality, which affects the accuracy of identification and the effect of DM to some extent. In the future, more advanced data cleaning and integration technologies can

be considered to improve data quality. Secondly, in terms of algorithms, although this study has adopted a variety of algorithms for comparison and selection, there may still be other better algorithms that have not been discovered. In the future, we can continue to pay attention to the latest research progress in the field of algorithms and apply new technologies to this research in time.

Looking ahead, I aspire to further enhance and broaden the foundations laid by this research. On the one hand, we can explore the introduction of more advanced technologies into the automatic identification system of clothing styles, such as three-dimensional scanning, virtual reality, and other technologies, in order to achieve more accurate and comprehensive style identification. On the other hand, it can expand the application scope of DM, such as analyzing and forecasting consumer behavior and market trends more deeply and providing more comprehensive and accurate information support for the decision-making of the clothing industry.

Yuan Wang, https://orcid.org/0009-0000-5894-4096
Feng Cao, https://orcid.org/0009-0007-2865-4195

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