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Computer-Aided Design AND APPLICATIONS

Fusion Algorithm of Fashion Trend Analysis and CAD Design Driven by Big Data

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Abstract. The aim of this article is to enhance precision and productivity in clothing design while fostering innovation in the apparel industry via the integration of big data analytics and CAD design algorithms. Our research methodology encompasses literature reviews, case studies, algorithm development, and validation. To this end, we conducted two sets of controlled experiments: one utilizing cutting-edge technologies and the other relying on traditional design methods. By comparing the design outcomes of both groups, we assessed the performance of these technologies in terms of fashion trend awareness, design efficiency, and cost optimization. The findings reveal that the experimental group outperformed the control group in grasping fashion trends, resulting in designs that are more market-relevant and well-received by consumers. This success can be attributed to the intelligent colour-matching algorithm's proficiency in capturing and incorporating prevalent market colours. Regarding design efficiency, the experimental group leveraged an automatic typesetting algorithm to streamline and automate the design process, significantly reducing the time required. Furthermore, the group achieved notable cost savings through the use of a fabric selection optimization algorithm, which optimized material usage and lowered production costs. In conclusion, integrating big data analytics and CAD design algorithms has demonstrated significant benefits for clothing design in terms of trend awareness, efficiency, and cost control.

Keywords: Big Data; Fashion Trends; Computer-Aided Design; Design Efficiency
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1 INTRODUCTION

Computer vision technology can deeply analyze and identify fashion elements through image and video processing, providing designers with more accurate and comprehensive design references. Bayoudh et al. [1] explored the application of computer vision in deep multimodal fashion trend clothing design. Through techniques such as digital systems, it can recognize, track, and interpret information in images, thereby extracting useful data and information. Deep multimodal fashion trend clothing design is a method that integrates multiple design elements and trends. It involves in-depth analysis and understanding of fashion elements, as well as integration and innovation of various fashion trends. Designers need to consider fashion elements from multiple perspectives and levels to create unique clothing designs. In the fashion industry, modern fashion recommendation systems have become an important marketing tool that can provide customized fashion advice and shopping experience to users based on their personalized needs and preferences. Deldjoo et al. [2] provide an overview of modern fashion recommendation systems, with a focus on their integration with CAD calculations. Modern fashion recommendation systems are mainly based on user behaviour data, fashion trends, and personalized algorithms, providing users with personalized fashion advice. These suggestions can include various fashion products such as clothing, shoes, accessories, etc. The goal of a recommendation system is to improve the shopping experience and satisfaction of users through precise recommendations while increasing sales volume. CAD technology can help designers quickly create personalized clothing designs to meet the specific needs of users. By combining with recommendation systems, users can customize clothing according to their preferences and needs, improving the personalization of shopping.

Fashion trend prediction is a crucial link in the fashion industry, which affects the design, production, and sales of products. Traditional fashion trend prediction is mainly based on the intuition of designers, market research, and historical data on popular elements. However, with the rapid development of big data technology, the methods and means of fashion trend prediction are also undergoing changes. Dubreuil and Lu [3] explored traditional and big data fashion trend prediction methods and conducted empirical tests based on WGSN and EDITED. Select popular element data from the past three years as the research object, including popular elements in clothing, footwear, accessories, and other fields. The data is sourced from WGSN and EDITED databases, as well as market research institutions. By comparing the prediction results of WGSN and EDITED with traditional methods, it was found that the big data fashion trend prediction method outperformed traditional methods in terms of accuracy and recall. WGSN and EDITED can more accurately capture changes in fashion trends and timely reflect consumer needs and preferences. In addition, big data methods can process large amounts of real-time data, improving the timeliness of predictions. Augmented reality technology can combine virtual creativity with the real world, providing designers with broader creative space and richer ways of expression. Elfeky et al. [4] explored the development of clothing design skills in fashion design. Through augmented reality technology, users can try on various clothing in a virtual environment to preview the effect. This virtual fitting function greatly improves the user experience, allowing users to clothing, while also providing designers with more accurate feedback, which helps optimize the design. Augmented reality technology can help designers create in virtual environments, making designs more comprehensive through real-time previews and adjustments. This technology breaks traditional design limitations and allows designers to unleash their creativity more freely.

Through professional graphics processing software, designers can create, modify, synthesize, and output various graphics to meet different design needs. In visual fashion trend analysis, computer graphics processing technology is mainly used to digitize, analyze, and display fashion elements [5]. Through computer graphics processing technology, it can extract key fashion elements from various fashion materials, such as colours, patterns, styles, etc., providing references for subsequent design work. Through computer graphics processing technology, the designed clothing can be virtually presented on the model, helping designers better evaluate the actual effect of the design and improve design efficiency. As an important global economic pillar, the sustainable development of the fashion industry is of great significance for environmental protection and human well-being. Big data, as an important driving force for the fashion industry, has brought new opportunities and challenges to sustainable fashion design. Hur and Cassidy [6] discussed their views and attitudes towards sustainable fashion design driven by big data, as well as the challenges and opportunities of achieving sustainability in fashion. The supply chain of the fashion industry is usually long and complex, making sustainability issues difficult to track and manage. Improving supply chain transparency is key to achieving sustainability, but it requires joint efforts from businesses, suppliers, manufacturers, and other partners. The application of big data technology requires professional skills and talents. However, there is currently a relative shortage of composite talents in the fashion industry with expertise in big data analysis and sustainability. Collaborating with suppliers, manufacturers, and other partners to promote sustainable fashion development is the key to achieving win-win outcomes. By establishing a shared data platform and transparent communication mechanisms, enterprises can jointly address sustainability issues and create more business value.

Knitted and woven fabrics are two major categories of textiles, with significant differences in structure and characteristics. Knitted fabrics are made up of interconnected coils, which have good elasticity and softness; And woven fabrics are made by interweaving warp and weft yarns, which have high strength and stability. Indrie et al. [7] explored how to use computer-aided design and virtual simulation techniques to design and simulate knitted and woven fabrics. The knitted fabric CAD system can quickly generate various knitted fabric patterns with different structures and textures according to the requirements of designers. The CAD system for woven fabrics can generate various patterns of woven fabrics with different organizational structures and textures according to the requirements of designers. As the carrier of fashion and culture, the capture and prediction of fashion trends are very important for brands and markets. The traditional fashion design process often depends on the designer's experience and intuition, but in the era of big data, market dynamics, and consumer demand can be more accurately grasped through data mining and analysis.

At the same time, CAD technology is more and more widely used in fashion design, which can improve design efficiency and optimize design schemes. However, effectively combining big data analysis with CAD design to drive design decisions with data is still a major challenge facing the current clothing industry. Therefore, this study aims to explore the algorithm integration of fashion trend analysis and CAD design driven by big data so as to provide new ideas and methods for the innovative development of the clothing industry. With the swift progression of science and technology, coupled with escalating global market competition, the clothing industry finds itself facing unique challenges alongside promising opportunities. Over the past few years, a significant number of garment enterprises have made it a priority to integrate and harness the power of data analysis and CAD technology, leading to considerable achievements. Furthermore, prominent brands have established sophisticated data analysis platforms to monitor consumer behaviour and market trends in real-time. This, in turn, has proved instrumental in guiding crucial decisions related to product design and manufacturing. However, although big data technology and CAD design technology have made remarkable achievements in their respective fields, their fusion application is still in the initial stage, especially in algorithm fusion and intelligent design.

The core components of this investigation encompass:

An examination of big data utilization techniques and case studies in predicting fashion trends;

A delve into the practical usage of CAD technology within fashion design, alongside its benefits and constraints;

An exploration of the integration tactics between big data-fueled clothing trend prediction algorithms and CAD design optimization methods;

Experimental validation of the efficiency and applicability of the integrated algorithm.

Its novel contributions are highlighted below:

A cutting-edge prediction approach is introduced by amalgamating big data technology with fashion trend forecasting. This advancement surpasses the confinements of conventional methods, enhancing both the precision and far-sightedness of predictions.

The integration of the CAD design optimization algorithm into the apparel design workflow ushers in automation and intelligence. This innovation elevates design efficiency while mitigating costs, thus bolstering the rapid advancement of clothing enterprises.

The synergy between big data-driven fashion trend predictions and the CAD design optimization algorithm gives rise to a fresh, comprehensive design paradigm. This method paves the way for innovative advancements within the clothing industry, offering a new perspective and direction.

This article initially presents the backdrop, significance, current research standing, contents, objectives, and methodologies of the study. Subsequently, it delves into the utilization of big data in predicting fashion trends. Additionally, the article examines the implementation of CAD technology in fashion design, along with its merits and drawbacks. Furthermore, the strategic integration of algorithms for fashion trends driven by big data and CAD design is explored. Ultimately, the efficacy of this integrated algorithm is substantiated through meticulous experimental design and rigorous analysis of results. In conclusion, the findings are summarized, and future research directions are anticipated.

2 RELATED WORK

Jankoska [8] explored the application of CAD methods in 3D fashion trend design analysis. Through CAD methods, designers can simulate the wearing effect of clothing in a 3D environment, including different body shapes, postures, etc., in order to better evaluate the actual effect of the design. In addition, 3D simulation can be used for virtual matching and combination, exploring more design possibilities. With the help of CAD methods, designers can present their designed clothing in a dynamic form, allowing the audience to have a more intuitive understanding of the characteristics and effects of the clothing. For example, using virtual reality technology or augmented reality technology for dynamic display can bring viewers a more immersive experience. Based on historical data and market information, using CAD methods for data mining and analysis can predict future fashion trends, providing inspiration and direction for designers. By analyzing the changing patterns of popular elements and the trends of market demand, we can better grasp the development trends of fashion trends. In the textile industry, fabric defect detection is a crucial step in ensuring product quality and preventing waste in the production process. Traditional defect detection methods mainly rely on manual inspection [9]. Deep learning algorithms play an important role in fabric defect detection. Convolutional neural networks (CNNs) are an important type of deep learning that has been widely used in image recognition and computer vision tasks. By training CNN models, they can learn the texture and structural features of normal fabrics from a large number of defect-free fabric images, and apply them to actual fabric images to achieve automatic detection of fabric defects. Specifically, the CNN model first extracts feature from the input fabric image and then classifies the extracted features through a classifier to determine whether there are defects. The CNN model trained through a large amount of data has good generalization ability and can accurately detect and classify defects in new fabric images.

With the rapid development of digital technology, big data has penetrated various industries, especially in the fashion field, reshaping the way brands communicate and the aesthetic experience of consumers. As an important tool in fashion design, computer-aided design (CAD), combined with big data, provides designers with unprecedented creative space. Social media platforms such as Instagram have become the forefront for luxury fashion brands to showcase their CAD visual aesthetics and attract target audiences. CAD technology allows designers to create, modify, and optimize designs on computers, with precision and efficiency far exceeding traditional manual drawing. With the support of big data, CAD is no longer just a design tool but has become a bridge connecting consumers, market trends, and designer creativity. Designers can transform these insights into elements in CAD design by analyzing user data, fashion trends, and consumer feedback on social media, in order to create works that better meet market demands [10]. VR technology has brought infinite possibilities to fashion trend clothing design, providing designers with a brand-new creative platform. Lee et al. [11] explored the collaborative exploration and creativity enhancement of virtual reality in fashion trend clothing design. In the traditional fashion design process, communication is often limited by physical distance and time. Virtual reality technology provides a real-time communication platform for team members, where everyone can express their opinions in the virtual environment and provide timely feedback on design effects, thereby improving work efficiency and collaborative effects. Through VR technology, designers can immerse themselves in different scenes and environments, drawing inspiration from them. This immersive experience helps stimulate the creativity and imagination of designers, driving design to a higher level. Virtual reality technology provides possibilities for the cross-border integration of fashion, technology, art, and other fields. Designers can use this platform to conduct various experiments and innovative attempts, integrating knowledge and elements from different fields into fashion design, and creating unique and personalized works.

With the advent of the digital age, big data has become an indispensable and important resource in various industries. In the fashion industry, the application of big data is becoming increasingly widespread, playing a crucial role in design, production, marketing, and communication. Noris et al. [12] aim to provide a systematic review of digital fashion driven by big data from the perspectives of marketing and communication, exploring its current development status, trends, and future prospects. Through big data analysis, brands and enterprises can more accurately predict sales volume, develop more reasonable production and inventory plans, reduce costs, and improve operational efficiency. Meanwhile, big data can also help enterprises optimize their logistics and distribution systems, enhancing customer experience. Big data has played an important role in the marketing and communication of the fashion industry. Brands and businesses can analyze consumer browsing, purchasing, and social media behavior data to understand their interests and needs, and thus develop more precise marketing strategies. At the same time, big data can also help enterprises evaluate the effectiveness of marketing activities and optimize marketing budgets. With the advancement of technology and educational innovation, blended learning has become an important trend in the field of education. Blended learning combines online and offline learning methods, aiming to improve learning outcomes and student engagement. Onofrei and Ferry [13] explored how reusable learning objects can be used to assist blended learning in fashion design courses for college students majoring in aesthetics and engineering. Reusable learning objects are standardized and modular learning resources that can be reused in various teaching contexts. In clothing design, reusable learning objects can include design elements of various clothing styles, patterns, colour combinations, etc. These elements can serve as basic resources for students to reuse or refer to in different design tasks. In blended learning, students can acquire basic theoretical knowledge offline through physical textbooks, classroom lectures, and other methods, and then use reusable learning objects online for practical operations and creative design. For students majoring in fashion design, big data not only provides rich materials and inspiration but also brings new challenges and opportunities. Robinson et al. [14] explored the creativity and tolerance for ambiguity of fashion design students driven by big data. The emergence of big data provides unprecedented creative materials and inspiration for students majoring in fashion design. Through data mining and analysis, students can gain a deeper understanding of market trends, consumer preferences, and brand dynamics, providing strong support for creativity. In addition, big data also provides students with diverse creative methods and presentation methods, making design more diverse and diverse. Ambiguity is a common phenomenon in clothing design. Due to the diversity of fashion and individual aesthetic differences, the same design may have different interpretations in different audiences. Therefore, for students majoring in fashion design, having a high tolerance for ambiguity is crucial.

Accurately predicting and grasping trend trends is crucial for brands and businesses in the fashion industry. Data-driven fashion trend prediction systems are becoming a new favourite in the industry. Zhao et al. [15] explored a data-driven fashion trend prediction system based on T-platform analysis and its application in clothing and textile trend research. The data-driven fashion trend prediction system is a system that utilizes technologies such as big data analysis, machine learning, and artificial intelligence to deeply mine and process massive data in the fashion industry. Through real-time monitoring and analysis of diverse data sources such as runway shows, social media, and e-commerce sales, this system can timely detect and track changes in fashion elements, and predict future trends. Through quantitative analysis and data mining of these key elements, the system can extract new dynamics and trends in the fashion industry, providing valuable reference information for designers and brands. The research on clothing and textile trends is an important task in the fashion industry, aimed at exploring the fashion trends and design concepts of clothing and textiles. Traditional fashion research mainly relies on the experience and intuition of designers, and the emergence of data-driven fashion trend prediction systems has brought new opportunities for this work. Fashion informatics is an emerging interdisciplinary field that combines knowledge from multiple disciplines such as information science, statistics, and computer science, aiming to study various information in the fashion field and extract valuable insights from it. With the advent of the big data era, data mining technology has been widely applied in fashion informatics. Zhao and Min [16] explored the rise of fashion informatics and its important value in the fashion industry through a data mining-based fashion social network analysis case. The development of fashion informatics stems from the continuous digitization of the fashion industry. With the popularity of the Internet and social media, fashion brands, designers and consumers interact more and more frequently, and the amount of data generated is also growing. These data contain valuable information such as consumer preferences, trends, and market dynamics. Therefore, how to extract valuable information from these data has become a focus of attention in the fashion industry.

3 APPLICATION OF CAD TECHNOLOGY IN FASHION DESIGN

3.1 The Functions and Characteristics of the Garment Design CAD System

In the field of fashion design, CAD technology allows designers to complete a series of design processes on the computer, such as fashion design, pattern drawing, fabric selection, layout, and fitting modification, through professional software tools. The application of CAD technology greatly improves the accuracy of fashion design and also provides designers with broader design space and richer design means. The functions and characteristics of the garment design CAD system are shown in Table 1.

Functions/features	*Specific content*
Style design	Provide rich drawing tools and a fabric library to support designers in quickly drawing and modifying clothing-style drawings.
Pattern drawing	Provide accurate pattern drawing tools to support the design and editing of various complex patterns.
Fabric selection and simulation	A large number of fabric samples are built in, which supports the simulation of fabric texture and texture and helps designers preview the design effect more intuitively.
Typesetting layout	According to the designed pattern diagram and fabric information, the cutting pattern and layout diagram are automatically generated to optimize the material utilization rate.
Fitting modification	Support virtual fitting function so that designers can preview the wearing effect of clothes on the human body in the design stage, which is convenient for timely modification and improvement of design.
Data management and output	Provide perfect data management function, support the storage, export, and sharing of design data, and facilitate the cooperation and communication between design teams.

Table 1: Functions and characteristics of garment Design CAD system.

3.2 Case Analysis of the Application of CAD Technology in Fashion Design

Take a well-known clothing brand as an example; the brand adopted CAD technology when designing new clothes. At first, the designer drew the style chart and pattern of the clothing using CAD software and simulated it by using the fabric samples in the fabric library. Subsequently, the software automatically generates the cutting pattern and layout diagram, which greatly improves the efficiency of cutting and sewing. In the virtual fitting stage, the designer found some details and made timely modifications. Finally, this garment has achieved good sales performance in the market, which proves the important role of CAD technology in garment design.

Fashion trends refer to the comprehensive expression of clothing style, colour, material, and collocation, which are widely accepted and popular in the clothing market in a certain period. These trends are usually influenced by many factors, including social culture, economic development, authoritative guidance of the fashion industry, and consumer psychology. The fashion trend of clothing not only reflects the aesthetic concept and fashion trend of society but also is an important basis for the market positioning, product design, and marketing promotion of clothing brands. The three main characteristics of the fashion trend are shown in Table 2.

Characteristic	*Specific content*
Timeliness	Popular elements are accepted and sought after by the public for some time but will be gradually replaced by new elements over time.
Period	Some classic or retroelements may be popular again after some time.
Territoriality	Cultural differences and consumption habits in different regions lead to differences in fashion trends.

Table 2: Characteristics of Popular Trends.

In the clothing industry, the application of big data is mainly reflected in the following aspects:

Market trend prediction: By analyzing consumers' purchase history, search records, social media interaction, and other data, predict the clothing styles, colours, and materials that may be popular in the future.

Consumer behaviour analysis: through the analysis of consumer demographic information, purchasing preferences, wearing habits, and other data, we can understand the needs and preferences of consumers and provide accurate market positioning and product design basis for clothing brands.

Supply chain management optimization: use big data technology to track inventory, sales data, and supply chain performance in real-time, optimize inventory management, reduce inventory backlog, and improve logistics efficiency.

Personalized customization service: By analyzing consumers' body data, wearing preferences, and other information, a personalized clothing customization service is provided to meet consumers' personalized needs for clothing.

The main steps of the fashion trend analysis method based on big data are shown in Table 3.

Step	*Way*	*Specific content*
1	Data collection	Collect data from various channels, including e-commerce platforms, social media, fashion magazines, clothing stores, etc., to ensure the comprehensiveness and diversity of data.
2	Data preprocessing	The collected data are cleaned, duplicated, transformed, and standardized to improve the quality and usability of the data.
3	Data analysis	Statistical analysis, machine learning, and other methods are used to analyze the processed data and extract information related to clothing fashion trends.
4	Trend forecast	Based on historical data and the current market situation, the prediction model is used to predict future fashion trends in clothing.
5	Results visualization	Visualize the analysis results in the form of charts, reports, etc., which is convenient for decision-makers to understand and apply.

Table 3: Analysis method of fashion trend in clothing.

To demonstrate the utilization of a big data-based fashion trend analysis approach, this segment utilizes the clothing market of a renowned brand as a case study. Initially, pertinent data about the brand is gathered, encompassing sales figures, consumer feedback, social media engagement, and more. Subsequently, big data analytical techniques are employed to scrutinize this data and cull out insights about clothing fashion trends. These insights are then utilized to prognosticate the brand's clothing fashion trends, and the prognostications are juxtaposed against actual market developments to appraise the precision and efficacy of the analytical methodology. Ultimately, the findings serve as decision-making aids for the brand's clothing design, production, and marketing strategies during the pertinent period.

4 ALGORITHM FUSION OF FASHION TRENDS DRIVEN BY BIG DATA AND CAD DESIGN

4.1 Analysis of the Necessity and Feasibility of Algorithm Fusion

With the increasing diversification of consumer demand, a single fashion trend prediction or CAD in the modern clothing industry. Therefore, it is particularly necessary to combine fashion trend analysis driven by big data with CAD design to form a fusion algorithm. This integration can comprehensively consider many factors, such as market trends, consumer preferences, design efficiency, and production costs, and provide more comprehensive and accurate design decision support for clothing enterprises.

With the continuous growth of computer technology and artificial intelligence, the ability of big data processing and the intelligent level of CAD design software is also improving, which provides technical feasibility for the integration of the two. Through algorithm fusion, the results of big data analysis can be directly applied to the CAD design process to realize data-driven design optimization and automation.

4.2 Prediction Algorithm of Clothing Fashion Trend Based on Big Data

The prediction algorithm of clothing fashion trends based on big data mainly extracts information related to clothing fashion trends through deep mining and analysis of historical sales data, consumer behaviour data, social media data, and other multi-source data. These algorithms usually include data preprocessing, feature extraction, model building, and prediction output. Among them, data preprocessing is mainly to clean, transform, and standardize the original data to improve the availability of the data; Feature extraction is to extract features related to fashion trends from the processed data; Model building is to build a prediction model based on the extracted features; Finally, the future trend is predicted by the model, and the prediction results are output. In this article, CNN is used to extract features to build a prediction model. The output layer of CNN needs to classify the results of images, so it needs to use classifiers. The calculation of the Softmax function is as follows:

$$p\ i = \frac{\exp\ \theta_i^T x}{\sum_{k=1}^{k} \exp\ \theta_i^T x} \tag{1}$$

The encoder is realized by the Transformer structure. Given a set of image features I extracted from the input image, the arrangement invariant coding X can be obtained through $self-attention$ used in a Transformer:

$$self-attention\ I\ = attention\ Q,K,V\ = soft\max\left(\frac{QK^T}{\sqrt{d}}\right)V \tag{2}$$

Where Q is the query vector; $\langle K,V \rangle$ is a set of corresponding data pairs; d is the scale factor. Model identification calling function SIM :

$$Y = SIM\ \ net,P \tag{3}$$

In this context, net it represents the designated neural network while P denoting either the training or test sample input vector. Additionally, Y signifies the computed network output vector that corresponds to P. The schematic representation of the model's architecture is depicted in Figure 1.

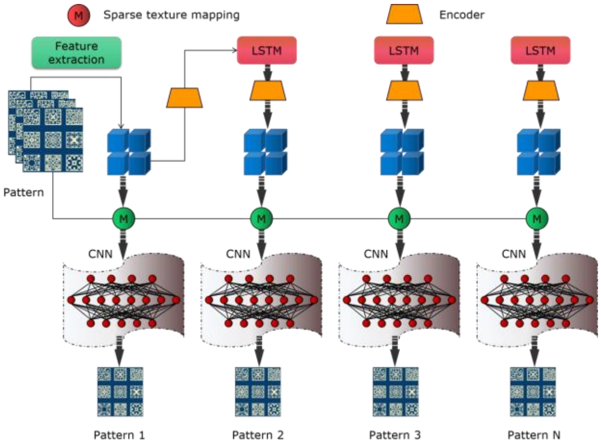

Figure 1: Model structure.

In this article, the overall loss function of the CNN model is defined as:

$$L(W) = \sum_{i=1}^{|I|}\left(\sum_{k=1}^{K}\ell\left(X_i^{k};W\right) + \ell\left(X_i^{fuse};W\right)\right) \tag{4}$$

4.3 Optimization Algorithm of CAD Design

The CAD design optimization algorithm primarily focuses on enhancing crucial aspects like efficiency, cost, and quality during the clothing design process. The traditional garment typesetting process often depends on the designer's manual operation and empirical judgment, which is not only inefficient but also difficult to ensure the typesetting accuracy and material utilization. The automatic typesetting algorithm can automatically calculate the optimal cutting pattern and layout scheme through the built-in optimization algorithm according to the input clothing style and size information. The two-dimensional scale space of a clothing pattern is defined as follows:

$$L(x,y,\sigma) = G(x,y,\sigma) * I(x,y) \tag{5}$$

$$G(x,y,\sigma) = \frac{1}{2\pi\sigma^2} e^{\frac{\left((x-m/2)^2+(y-n/2)^2\right)}{2\sigma^2}} \tag{6}$$

Where $L(x,y,\sigma)$ represents the scale space of the pattern; $G(x,y,\sigma)$ is a Gaussian function with variable scale; "$*$" is a convolution operator; (x,y) is the size of spatial coordinates that determines the smoothness of the pattern; The bigger σ, the smoother the pattern, and the smaller σ, the clearer the pattern.

Firstly, the algorithm receives and processes data such as clothing style drawings, size information, and fabric characteristics inputted by designers. Then, the garment version is intelligently analyzed and disassembled into different components (such as front piece, back piece, sleeves, etc.). Then, according to the designer's demand, fabric characteristics, and production efficiency, the optimal typesetting scheme is automatically calculated. In this article, PSO (Particle swarm optimization) is used to find the optimal solution among many typesetting schemes. The formula of velocity and position in PSO is:

$$v_{id}^{k+1} = \omega v_{id}^{k} + c_1 r_1 \ \ p_{id} - x_{id}^{k} \ \ + c_2 r_2 \ \ p_{gd} - x_{id} \tag{7}$$

$$x_{id}^{k+1} = x_{id}^{k} + v_{id}^{k+1} \tag{8}$$

Colour plays an important role in fashion design, which directly affects consumers' visual feelings and purchase decisions. The intelligent colour-matching algorithm constructed in this article will extract features from the collected colour data, which can include colour hue, saturation, brightness, and other attributes. Then, train and learn according to the extracted colour features. Through a large number of training data, the model can learn the relationship and law between different colours, thus providing suggestions for new colour-matching tasks. Based on model training, the algorithm will generate a series of colour-matching rules. These rules can be customized according to different design requirements and style preferences to meet the individual needs of different users. At the same time, intelligent colour-matching algorithms usually need to provide a user interface so that users can input their own design needs and preferences and get corresponding colour-matching suggestions. Users can adjust and provide feedback according to the suggestions provided by the algorithm so as to continuously optimize the colour-matching results.

In addition, fabric, as the basic material of clothing, has performance, cost, and environmental protection that directly affect the quality and market competitiveness of clothing. The following are the steps to realize the fabric selection optimization algorithm:

Data collection and preparation: collect various fabric samples, including their physical properties (such as texture, thickness, weight, elasticity, etc.), visual properties (such as colour, pattern, gloss), and functional properties (such as air permeability, warmth retention, and wear resistance). Standardize fabric samples to ensure the consistency and comparability of data. Establish a fabric database to store all relevant information on fabric samples.

Demand definition and weight distribution: cooperate with designers to define the demands of fashion design, such as style, comfort, durability, and cost. According to the design requirements, different fabric attributes are assigned weights to reflect their importance in the final selection.

Algorithm model construction: use a decision tree to build a fabric selection model (as shown in Figure 2).

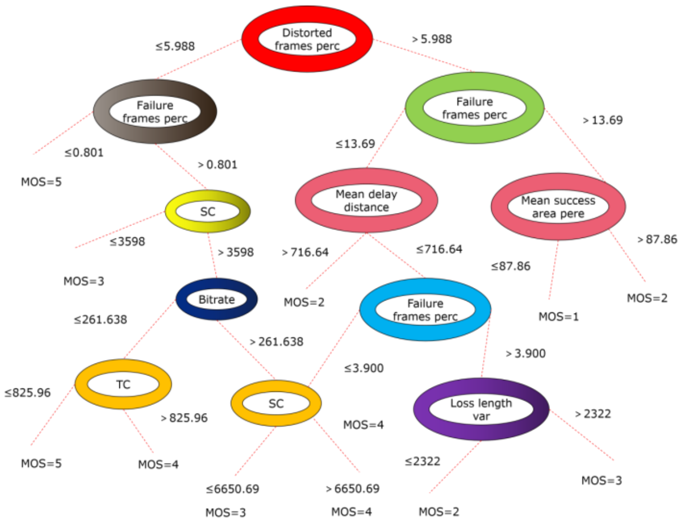

Figure 2: Decision tree model.

Suppose that in class C_i s_i is the specific number of samples. For the designated sample categorization, the anticipated details can be derived from the subsequent equation:

$$I\ s_1, s_2, s_3, \ldots, s_m\ = -\sum_{i=1}^{m} p_i \log_2\ p_i \tag{9}$$

Herein, p_i is equivalent to the likelihood of C_i, which may represent any given sample, as estimated by si / s. We denote s_{ij} as the distinct count of samples belonging to class C_i. The entropy or anticipated information within the subset, as partitioned A, is expressed as follows:

$$E\ A\ = \sum_{i=1}^{v} \frac{s_{1j} + s_{2j} + s_{3j} + \ldots + s_{mj}}{s} I\ s_{1j}, s_{2j}, s_{3j}, \ldots, s_{mj} \tag{10}$$

In this context, $\frac{s_{1j} + s_{2j} + s_{3j} + \ldots + s_{mj}}{s}$ it designates the corresponding weight attributed to the j subset. The smaller the entropy value, the higher the purity of the subset. Train the model to identify the relationship between different fabric properties and design requirements. The performance of the model is optimized by cross-validation and other technologies to ensure its generalization ability.

Fabric screening and recommendation: According to the design requirements and constraints provided by designers, the algorithm screens out qualified fabric samples from the fabric database. The algorithm evaluates the screened fabrics according to the trained model and sorts them according to the degree of matching with the design requirements. Generate a fabric recommendation list, including the best matching fabric and its detailed information.

User feedback and iteration: Provide a user interface so that designers can view, compare, and select recommended fabrics. Collect feedback from designers to understand the effectiveness of algorithm recommendations and possible improvement points. Using the collected feedback data, the algorithm is iteratively optimized to improve the accuracy and satisfaction of fabric selection.

Through the above steps, the fabric selection optimization algorithm can help designers quickly and accurately find the fabric that best meets the design requirements, improve the design efficiency, and reduce the cost and time of trial and error.

4.4 Fusion Algorithm of Fashion Trend Prediction and CAD Design Optimization

In this article, the above two algorithms of fashion trend prediction and CAD design optimization are combined to form a new comprehensive algorithm. Firstly, the algorithm uses the clothing fashion trend prediction algorithm based on big data to predict future fashion trends and obtain relevant fashion elements and trend information. Then, this information is used as input conditions and applied to CAD design optimization algorithms to guide designers in making design decisions such as style design, pattern drawing, and fabric selection. Finally, the optimized cutting pattern and layout drawing are automatically generated by CAD design software, as well as the corresponding colour scheme and fabric selection suggestions.

5 EXPERIMENTAL DESIGN AND RESULT DISCUSSION

5.1 Experimental Method and Result Analysis

In order to verify the fusion effect of big data-driven fashion trends and CAD design algorithms, this article collected a series of experimental data. These data mainly include historical sales records, consumer evaluations, fashion trend information on social media, and related parameters of CAD design. In the data preprocessing stage, data cleaning is carried out to remove repeated, invalid, and irrelevant data, and data conversion and standardization are carried out at the same time to ensure the consistency and comparability of data. The experiment is divided into two groups by comparative analysis: the control group adopts the traditional fashion design process, that is, designers design styles and choose fabrics according to experience and market research; The experimental group uses the fusion algorithm of fashion trend-prediction driven by big data and CAD design optimization to design clothes. The specific steps are as follows:

The design process of the control group: the designer completes the stage of clothing style design, fabric selection, layout, and so on according to market research and his own experience.

The design process of the experimental group: First, use big data analysis technology to mine the collected data deeply and predict future trends. Then, this trend information is input into the CAD design optimization algorithm to guide designers in making decisions such as style design and fabric selection. Finally, the optimized cutting pattern and layout drawing are automatically generated by CAD software.

During the experiment, this article ensures that the design objectives, design cycle, and cost budget of the two groups are consistent so as to eliminate the influence of other factors on the results. After the experiment, the design results of the two groups are compared and analyzed (as shown in Figure 3 and Figure 4).

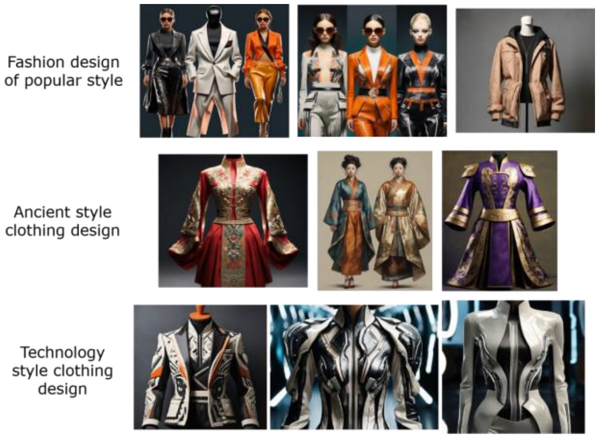

Figure 3: Design example of the control group.

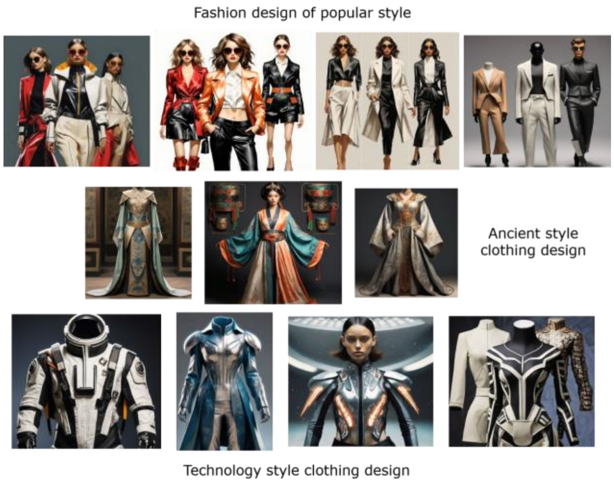

Figure 4: Design example of the experimental group.

The test results of fashion trend mastery are shown in Figure 5.

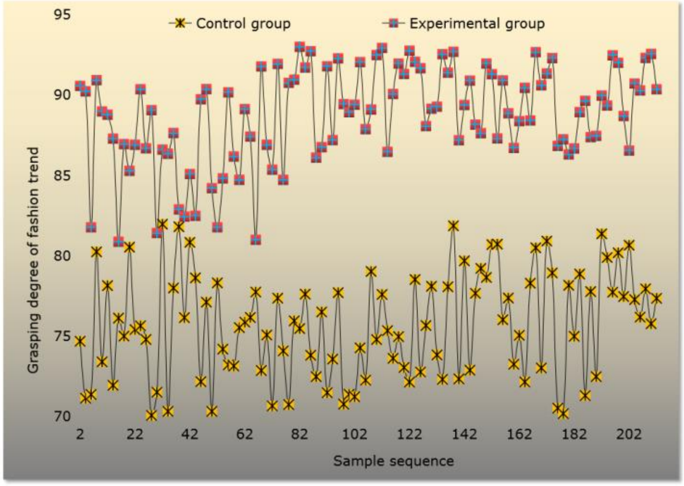

Figure 5: Grasping degree of fashion trend.

The test results of design efficiency are shown in Figure 6.

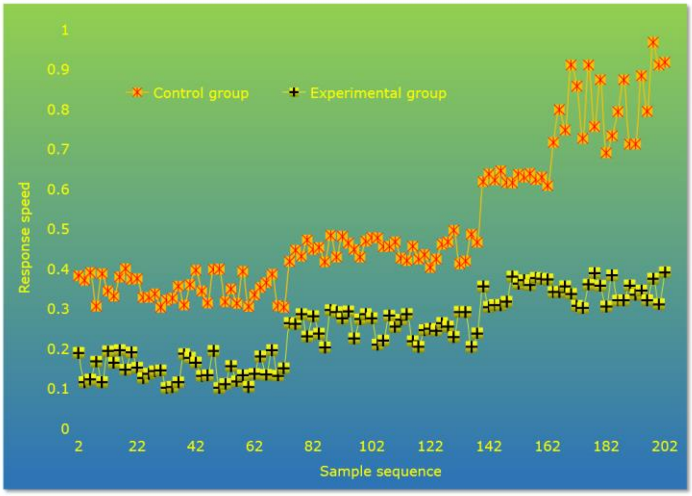

Figure 6: Design efficiency.

The cost optimization test results are shown in Figure 7. The findings revealed that the experimental group excelled compared to the control group in the subsequent areas.

Grasping the fashion trend: the design of the experimental group is more in line with the market trend and has a high degree of consumer acceptance. The experimental group is better than the control group at grasping fashion trends, which means that the design of the experimental group can better capture and fit the current market trends. This is because the experimental group adopts advanced technologies, such as an intelligent colour-matching algorithm, which can help designers quickly identify and apply popular colours, patterns, and styles in the market. Therefore, the design results of the experimental group are more likely to attract consumers' attention and meet their aesthetic needs, thus improving the market acceptance and sales volume of the products.

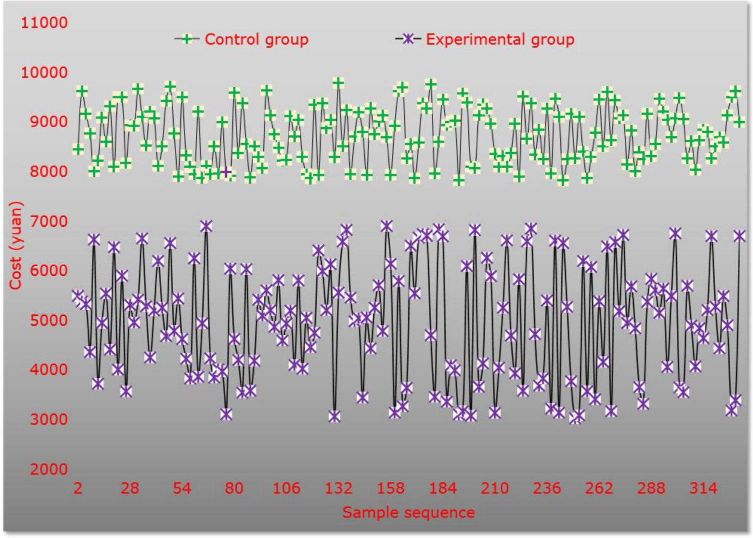

Figure 7: Cost optimization.

Design efficiency: In terms of design efficiency, the experimental group has a higher degree of automation, and the design cycle is obviously shortened. This is because the experimental group effectively integrated the automatic typesetting algorithm and other related technologies, thus realizing the automation and intelligence of the design process. Automatic typesetting algorithms can quickly and accurately generate cutting patterns and layout schemes, reducing the time and workload for designers to adjust manually. In addition, the experimental group also adopted other tools and methods to improve the design efficiency, such as template design and batch processing, which further improved the design efficiency.

Cost optimization: In terms of cost optimization, the experimental group achieved effective cost control through intelligent typesetting and fabric selection optimization. Intelligent typesetting algorithms can maximize the utilization rate of materials and reduce waste, thus reducing production costs. Moreover, the fabric selection optimization algorithm can comprehensively consider factors such as fabric performance, cost, and environmental protection, provide designers with the best fabric selection suggestions, and further control costs. These optimization measures not only help to reduce production costs but also improve the quality and competitiveness of products.

5.2 Results Discussion and Enlightenment

Through this experiment, the effectiveness and superiority of the integration of big data-driven fashion trends and CAD design algorithms in fashion design are fully verified. This integration helps to reduce costs and enhance market competitiveness. At the same time, the experimental results also provide us with the following enlightenment:

Continuously optimize the performance of the algorithm: With the continuous growth of technology and the market, the performance and stability of the algorithm also need to be continuously optimized and improved. In the future, we can consider introducing more advanced machine learning and artificial intelligence technologies to further optimize the performance of the algorithm.

Expand the application field of the algorithm: In addition to the clothing design field, the fusion algorithm of fashion trend prediction and CAD design optimization driven by big data can also be extended to other related fields, such as home design and industrial design. Through cross-domain cooperation and application, the development and innovation of the algorithm can be further promoted.

6 CONCLUSIONS

In this study, a novel forecasting technique is proposed, integrating big data technology with clothing fashion trend prognostication. The process of clothing design is enhanced by introducing the CAD design optimization algorithm, thereby achieving automated and intelligent design. Through rigorous empirical assessments and validations, this research underscores the remarkable accuracy and foresight of big data-driven fashion trend predictions. The CAD design optimization algorithm excels in automated design decision-making. By amalgamating these two advancements, a comprehensive design approach emerges, elevating design precision and efficiency while mitigating costs and bolstering market competitiveness. This innovation propels the clothing industry forward, injecting vitality into its progress and innovation.

Looking ahead, as technology evolves and market dynamics shift, the algorithmic convergence of big data-driven fashion trends and CAD design is poised for further advancement and application. Ongoing efforts will be directed toward refining the performance and stability of the algorithm to align with evolving market demands and technical specifications. Moreover, this integrated methodology is poised for expansion into adjacent domains such as home design and industrial design, fostering cross-disciplinary collaboration and sparking innovation.

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