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Computer Vision-Inspired Design of Children's Medical Products

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Abstract. The purpose of this study is to optimize the CAD (computer-aided design) of children's medical products by using computer vision and DM (Data mining) technology. This article explores the application potential of computer vision and DM technology in the design of children's medical products. This article constructs a CAD design model of children's medical products combining computer vision and DM technology and verifies the feasibility and effectiveness of the CAD design model through simulation experiments. Simulation experiments and comparative experiments are carried out in this article to verify the performance of the CAD design model. The results show that the design scheme generated based on the CAD design model is significantly better than the traditional design method in personalization, accuracy, and efficiency. In addition, the user survey results also show that the medical products generated by using CAD design models can better meet the specific needs and preferences of children and improve user satisfaction with products. It provides a new and efficient method and technical support for the design of children's medical products.

Keywords: Computer Vision; Data Mining; Children's Medical Products; Computer-Aided Design
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1 INTRODUCTION

With the continuous progress of medical technology and the increasing demand for children's health, children's medical products have become an important part of the field of medical devices. A healthcare disease prediction and diagnosis system based on the Internet of Things and cloud technology can provide doctors and patients with more accurate and personalized diagnoses and treatment plans by collecting and analyzing a large amount of biomedical data. At the same time, this system can also help doctors and patients track and monitor their condition in a timely manner, improving treatment effectiveness and patient satisfaction. A healthcare disease prediction and diagnosis system based on the Internet of Things and cloud technology typically includes a data collection layer, a data storage layer, a data processing layer, and an application layer. Using machine learning algorithms to clean, preprocess, and analyze data, extracting useful information and knowledge. Using cloud computing and machine learning algorithms to process and analyze massive amounts of data, extracting useful information and knowledge. Track and monitor changes in the patient's condition in a timely manner, providing doctors and patients with more accurate diagnoses and treatment plans. However, the current design stage of children's medical products often relies on traditional design methods and experience, which lack systematicity and scientificity, resulting in low design efficiency and difficulty in guaranteeing product quality. The application of computer vision and data mining technology in the medical field is becoming increasingly widespread. In the design of children's medical products, computer vision, and data mining technologies can improve the accuracy and efficiency of products, providing children with a better medical experience. Bers [1] explored the application of computer vision and data mining in the design of children's medical products. Computer vision technology can accurately judge the physiological characteristics of children by recognizing and analyzing their facial features, body language, etc. For example, by recognizing children's facial expressions, the degree of pain or emotional state can be determined, providing doctors with more accurate diagnostic evidence. Computer vision technology can automatically analyze and recognize children's behaviour, thereby achieving accurate judgment of children's behaviour. For example, by identifying and analyzing children's movements, postures, etc., it is possible to determine whether they have abnormal behaviour or disease symptoms, thereby providing doctors with more accurate diagnostic evidence. Data mining technology can mine and analyze a large amount of children's health data, thereby discovering the occurrence and development patterns of diseases and providing more accurate and effective support for disease prevention and treatment. For example, by mining and analyzing a large amount of children's health data, the probability of a certain disease occurrence can be predicted, providing doctors with a more accurate diagnostic basis and treatment plans.

Therefore, optimizing the design stage of children's medical products and improving the design efficiency and product quality have become urgent problems. Computer-aided design (CAD) is playing an increasingly important role in the design of children's medical products. Computer vision and data mining, as two important computer technologies, have also been widely applied in the design of children's medical products. Bhatt et al. [2] will introduce the application of computer vision and data mining in the design of children's medical products and analyze their advantages and challenges. It explores the application of computer vision and data mining in computer-aided design of children's medical products. By combining these two technologies, the design process of children's medical products can be improved, improving design efficiency and accuracy. Computer vision is mainly used for image recognition and processing in the design of children's medical products. Through image recognition technology, children's physical characteristics and disease conditions can be identified from a given image. For example, computer vision technology can be used to recognize and analyze children's facial expressions to evaluate their level of pain or emotional state. Computer vision can also be used to construct computer models of children's medical products and conduct simulation tests. By using computer models, it is possible to simulate the usage and effectiveness of products, thereby identifying and solving potential design problems in advance. This helps to improve the reliability and safety of the product and reduce development costs. In recent years, the rapid growth of computer vision and DM has provided new ideas and methods for the design of children's medical products. The Internet of Things technology can achieve remote monitoring and data collection of children's medical products, connect various medical devices, sensors, etc., to the network, and achieve real-time transmission and sharing of data. Through IoT technology, doctors can always understand the patient's condition and treatment effectiveness, adjust treatment plans in a timely manner, and improve treatment effectiveness. Bhuiyan et al. [3] explored the empowering technologies of IoT computer vision and data mining in the application and market opportunities of children's healthcare products. By combining the Internet of Things, computer vision, and data mining technologies, we provide more efficient, accurate, and personalized support for children's healthcare. The application of computer vision technology in children's medical products, which can achieve automatic analysis and recognition of medical images, is becoming increasingly widespread. Through preprocessing, feature extraction, and classification of medical images, computer vision technology can assist doctors in diagnosing diseases and formulating treatment plans, improving the accuracy and efficiency of diagnosis. Data mining technology can deeply analyze and mine massive amounts of children's medical data, discovering patterns and trends hidden within the data. Through data analysis, data mining techniques can assist doctors in predicting changes in patient's conditions and treatment outcomes, adjusting treatment plans in a timely manner, and improving treatment outcomes.

Computer vision technology can extract useful information from images and videos through image processing and pattern recognition and provide data support for product design. DM technology can find the correlation and law between data through the analysis and mining of a large number of data and provide a decision-making basis for product design. With the continuous development of technology, artificial intelligence and machine learning have been widely applied in many fields. In the design of intelligent medical products, these two technologies have also played an important role. Artificial intelligence can simulate human thinking and behaviour, while machine learning is a technology that continuously optimizes algorithms through data and experience. By combining these two technologies, Cioffici et al. [4] can improve the design process of intelligent medical products and enhance design efficiency and accuracy. Through artificial intelligence technology, it is possible to simulate a doctor's treatment plan, diagnostic process, etc., thereby providing more references for the design of intelligent medical products. In addition, artificial intelligence can also be used to simulate the behaviour and reactions of patients in order to better understand their needs and preferences. Machine learning is mainly used in the design of intelligent medical products to optimize algorithms and improve performance. Through machine learning technology, continuous optimization and improvement can be made based on product usage and feedback data to enhance product performance and user experience. For example, machine learning algorithms can be used to optimize the fault detection and recovery mechanisms of products in order to improve their reliability and stability. Therefore, this article applies computer vision and DM technology to the design of children's medical products, which is expected to improve design efficiency and product quality and meet children's health needs. DiPietro et al. [5] explored the positive effects of computer and robot-assisted therapy on improving social and intellectual functioning in children with autism spectrum disorders. For children with autism spectrum disorders, the improvement of social and intellectual functions is crucial. In recent years, computer and robot-assisted therapies have achieved significant results in the treatment of children with ASD. By designing games with social interaction and cognitive training functions, computer game therapy can help children with autism spectrum disorder improve their social skills and cognitive abilities. These games are usually fun and interactive, which can attract children's attention and stimulate their interest in learning. Computer-assisted language therapy utilizes computer technology to provide language training for children with autism spectrum disorders. By simulating real-life dialogue scenarios, computers can provide personalized language training to help children improve their oral expression abilities. Social robots are robots specifically designed for social interaction with children with autism spectrum disorders. They can provide personalized social training to help children improve their social skills and emotional understanding. Social robots can also provide children with a stable and consistent social interaction environment, promoting the development of their social skills. The use of children's medical products is crucial for their health and growth. However, due to the incomplete development of children's physical and cognitive abilities, they often find it difficult to use medical products correctly. Therefore, the method of recognizing the operational actions of children's medical products based on computer vision is of great significance for improving the efficiency and safety of medical product use. Faris et al. [6] introduced the research status and application of computer vision technology in recognition of operational actions in children's medical products and analyzed its advantages, disadvantages, and future development trends. The application of computer vision technology in the recognition of operational actions in children's medical products mainly includes the design and implementation of action recognition algorithms. These algorithms are usually based on technologies such as deep learning, machine learning, and image processing, which analyze and process video or image sequences to recognize and classify the actions of children when using medical products.

Hashimoto et al. [7] explored the application of computer vision analysis of intraoperative videos in automatic recognition of surgical steps during gastrectomy. Through computer vision technology, automatic analysis and recognition of surgical videos can be achieved, thereby improving the accuracy and efficiency of surgery. It introduces the application of computer vision analysis in gastric resection surgery and analyzes its advantages and challenges. The computer vision analysis of surgical videos has been widely applied in the medical field. Accurate identification of surgical steps is of great significance for the success of gastric resection surgery. Through computer vision technology, automatic analysis and recognition of surgical videos can be achieved, thereby achieving accurate judgment of surgical steps. It will explore the application of computer vision analysis of intraoperative videos in the automatic recognition of surgical steps during gastrectomy. In computer vision analysis, image preprocessing is the first step. For surgical videos, it is necessary to perform noise reduction, enhancement, and other processing to improve image quality. Through image preprocessing, interference factors in the image can be removed, improving the accuracy of subsequent analysis. Feature extraction is a crucial step in computer vision analysis. For surgical videos, recognition of surgical steps can be achieved by extracting features such as shape, texture, and colour from the image. For example, the shape features of gastric tissue can be extracted to determine whether a resection operation is necessary. This study has important theoretical and practical significance. Firstly, this study applied computer vision and DM technology to the design of children's medical products, which injected new vitality and innovative elements into the field of medical devices. Secondly, the CAD design model proposed in this study can improve the design efficiency and product quality of children's medical products, reduce production costs and risks, and thus better meet children's health needs. In addition, this study can also provide a reference for CAD in other fields and promote the development and application of related technologies. It is of great significance to promote scientific and technological progress and industrial upgrading in the field of medical devices. The innovations of this article are as follows:

(1) In this study, computer vision and DM technology are applied to the CAD design of children's medical products and the whole process from data collection to design scheme generation is automated. This innovative CAD design model not only improves the design efficiency but also ensures that the design scheme is more in line with the actual needs and physiological characteristics of children.

(2) By collecting and analyzing the data on children's body shape and physiological characteristics, the CAD design model can generate personalized medical product design schemes. Compared with the traditional one-size-fits-all design method, this personalized design method can better meet the specific needs and preferences of different children.

(3) Using computer simulation technology to simulate the stage of children using medical products and generate corresponding data for model training and testing. This method not only reduces the experimental cost but also can find and solve potential problems in the product design stage and improve the usability of products and user satisfaction.

This article first introduces the present situation of children's medical products and expounds on the importance of computer vision and DM in the design of children's medical products. The goal of this study is to optimize the CAD of children's medical products by using computer vision and DM technology. Then, the basic principles, algorithms and technologies of computer vision and DM are introduced. Based on this, a theoretical framework integrating computer vision and DM technology is proposed to guide the CAD of children's medical products. Then, the analysis is carried out, and the experimental results are displayed visually by means of charts and images, which is convenient for understanding and analysis. Finally, the representative cases of children's medical product design are selected for research. The results of the case study are displayed and compared with the traditional design method, highlighting the advantages and value of this study. Finally, the future research direction and suggestions are put forward.

2 RELATED WORK

Hu et al. [8] conducted bibliometric analysis and visualization of medical data mining research under computer vision. By sorting and analyzing relevant literature, it revealed the research status, hotspots, and trends in this field and presented the research results using visualization technology. Intended to provide reference and inspiration for related research and promote the development of computer vision in the field of medical data mining. It selected relevant literature from databases such as Web of Science and PubMed as the research objects. Through keyword search and screening, literature related to medical data mining research under computer vision is ultimately obtained. By analyzing the disciplinary distribution of literature, it can be found that medical data mining research under computer vision involves multiple disciplinary fields, such as medical imaging, biomedical engineering, computer science, etc. At the same time, research in this field also exhibits interdisciplinary cooperation, and scholars from different fields work together to promote the development of this field. By constructing and analyzing collaborative networks, we can reveal the cooperative relationships and patterns among different scholars. Collaborative networks can help researchers better understand the current status and trends of collaboration in this field, providing reference and inspiration for future collaborative research. Vital sign monitoring is an important component of the healthcare field and is of great significance for the timely detection and treatment of diseases. Traditional vital sign monitoring methods often require direct operation and observation by doctors or professionals, which has certain limitations. In recent years, with the continuous development of computer vision technology, it has become possible to monitor vital signs remotely using computer vision systems. Khanam et al. [9] explored the feasibility and application value of using computer vision systems to monitor vital signs remotely in different non-clinical and clinical settings by introducing the advantages and challenges of computer vision systems in vital sign monitoring. By analyzing changes in facial expressions, computer vision systems can monitor the patient's emotional state, pain level, and other vital signs. For example, in pain management, computer vision systems can monitor the patient's pain level in real-time, providing doctors with more accurate treatment plans. By analyzing parameters such as respiratory rate and respiratory depth, computer vision systems can monitor the patient's respiratory status. By analyzing the small changes in heartbeat images, computer vision systems can monitor the patient's heartbeat status. For example, in heart disease management, computer vision systems can monitor the patient's heart rate in real-time and provide timely treatment advice to doctors.

With the continuous development of computer vision technology, its application in the medical field is also becoming increasingly widespread. In the field of children's healthcare, computer vision technology can provide more intuitive, vivid, and personalized medical services for children. However, there are subjective and coercive issues with computer vision data annotation in the design of children's medical products. How to balance these issues is the focus of this article's research. Miceli et al. [10] explored the application of computer vision data annotation in children's medical product design and analyzed its subjectivity and imposition by introducing the importance of computer vision data annotation in the design of children's medical products, as well as how to balance the influence of subjectivity and imposition. Computer vision data annotation is an important part of children's medical product design, which can help designers better understand the needs and characteristics of children and provide more accurate and personalized medical services for them. Meanwhile, computer vision data annotation can also improve the efficiency and safety of medical products, providing better protection for children's health. Miller [11] explored the application of computer vision and data mining in the design of paper models for computer science students. By combining computer vision and data mining techniques, the design process of paper models can be improved, improving design efficiency and accuracy. In paper model design, these two technologies also play an important role. Computer vision can be used to recognize and process image data, while data mining can be used to analyze and mine patterns and trends in data. By combining these two technologies, the design process of paper models can be improved, improving design efficiency and accuracy. Computer vision is mainly used for image recognition and processing in paper model design. Through image recognition technology, the structure and features of the paper model can be identified from a given image. For example, computer vision technology can be used to identify and measure the folded parts of paper models to ensure the accuracy and practicality of the design. Computer vision can also be used to automate the inspection of errors or defects in design. Through image processing technology, it is possible to detect whether the folded parts of the paper model are correctly aligned and if there are any other issues. This helps to improve the accuracy and quality of the design.

Children's healthcare services are an important component of the healthcare field and have significant implications for the healthy growth of children. With the rapid development of big data and machine learning algorithms, the application of computer vision and data mining technology in children's healthcare services is gradually receiving attention. These technologies can help doctors and researchers better understand the health status of children, providing more accurate and personalized diagnoses and treatment plans. Ngiam and Khor [12] explored the application of computer vision and data mining in children's healthcare services, particularly in the areas of big data and machine learning algorithms. Computer vision technology can extract features and information related to children's health status by analyzing and processing images. By analyzing medical images of children, such as X-rays, CT images, etc., computer vision technology can assist doctors in disease diagnosis, improving the accuracy and efficiency of diagnosis. By measuring and analyzing the growth and development indicators of children, computer vision technology can assist doctors in evaluating the growth and development status of children, providing a basis for formulating personalized treatment plans. Children's healthcare is an important component of the healthcare field and is of great significance for the healthy growth of children. With the continuous development of technologies such as the Internet of Things and blockchain, the application of computer vision and data mining in children's medical products and healthcare blockchain use cases based on the Internet of Things is gradually receiving attention. These technologies can help doctors and researchers better understand the health status of children, provide more accurate and personalized diagnosis and treatment plans, and improve the efficiency and quality of healthcare. Ray et al. [13] explored the application of computer vision and data mining in the use case of healthcare blockchain for children's medical products based on the Internet of Things by introducing the importance of computer vision and data mining in the field of children's healthcare, as well as the application of Internet of Things and blockchain technology in the healthcare field. The application of data mining technology in the field of children's healthcare mainly includes disease pattern mining, treatment effect evaluation, and prediction model construction. By mining and analyzing a large amount of child case data, data mining techniques can discover the occurrence and development patterns of diseases, providing a basis for disease prevention and treatment. In addition, by mining and analyzing data on children's health status and related factors, data mining techniques can construct predictive models to predict the future development trends of children's health status.

Salman et al. [14] reviewed the application progress of computer vision data mining drug design in neurodegenerative diseases. By introducing computer vision data mining technology, the characteristics of neurodegenerative diseases, and the application of computer vision data mining in drug design. It aims to explore how to use computer vision data mining technology to provide new ideas and methods for drug treatment of neurodegenerative diseases. Neurodegenerative diseases are a type of disease characterized mainly by neurodegenerative changes, such as Alzheimer's disease (AD), Parkinson's disease (PD), etc. The aetiology and pathogenesis of these diseases are complex, and the effectiveness of drug treatment is limited. Therefore, it is necessary to explore new treatment methods. Computer vision data mining drug design is a drug design method based on computer simulation and data mining technology, which can quickly and accurately screen and optimize candidate drugs, providing new ideas and methods for the treatment of neurodegenerative diseases. Computer vision data mining technology is a drug design method based on computer vision and data mining technology. It can extract features and patterns related to drug therapy by mining and analyzing a large number of biomedical images and data, providing a basis for drug design and optimization. Computer vision data mining technology includes multiple stages, such as image processing, feature extraction, and pattern recognition, which can achieve comprehensive analysis and in-depth mining of biomedical data. The application of computer vision and data mining technology in the medical field is becoming increasingly widespread. Computer vision technology can achieve automatic analysis and recognition of medical images, while data mining technology can mine and analyze a large amount of medical data, providing more accurate and effective support for medical diagnosis and treatment. This article will explore the medical value of computer vision and data mining in the development of computer vision datasets. Scheuerman et al. [15] explored the medical value of computer vision and data mining in the development of computer vision datasets. Computer vision and data mining technologies have broad application prospects in the medical field and are of great significance for improving the level of medical diagnosis and treatment. This article will introduce the application of computer vision and data mining technology in the medical field and analyze their value in the development of computer vision datasets. Computer vision technology can achieve automatic processing and analysis of medical images. By performing preprocessing, feature extraction, and classification recognition on medical images, automatic detection and localization of disease lesions can be achieved, improving the accuracy and efficiency of medical diagnosis.

Thakkar et al. [16] explored the impact of datasets on the development of computer CAD visual synthesis planning tools in the pharmaceutical field. As the core of computer vision technology, datasets are of great significance for the development and application of synthesis planning tools. It introduces the types and sources of datasets, analyzes their impact on synthesis planning tools, and finally puts forward relevant suggestions and prospects. As one of the important applications of computer vision technology, the computer CAD visual synthesis planning tool is of great significance for improving the efficiency and quality of pharmaceutical production. As the core of computer vision technology, datasets have a significant impact on the development and application of synthesis planning tools. This article will explore datasets and their impact on the development of computer CAD visual synthesis planning tools in the pharmaceutical industry. In the pharmaceutical field, datasets mainly include image data, text data, time series data, etc. Among them, image data is the main processing object of computer vision technology, including the appearance of drugs, images during the production process, etc. Text data includes information on the ingredients and production processes of drugs. Time series data includes various parameters and indicators in the production process. With the continuous growth of healthcare demand, intelligent medical IoT systems have gradually become a research hotspot. In the field of maternal and infant health monitoring, achieving real-time monitoring and analysis of physiological data of mothers and infants is of great significance for improving the quality and safety of medical care. However, traditional healthcare methods often suffer from issues such as inaccurate data and low efficiency. Therefore, it is of great significance to use deep convolutional generative adversarial networks to achieve dynamic monitoring of mother and baby in intelligent medical IoT systems. Venkatasubramanian [17] explores how to use deep convolutional generative adversarial networks (GANs) to achieve dynamic monitoring of mother and baby in intelligent medical IoT systems. By combining deep learning technology and Internet of Things technology, real-time monitoring and analysis of maternal and infant physiological data can be achieved, providing more accurate and effective support for healthcare. This article will introduce the application of deep convolutional generative adversarial networks in maternal and child dynamic monitoring and analyze their advantages and challenges. Utilize IoT technology to achieve real-time collection of maternal and infant physiological data, including physiological indicators such as heart rate, blood pressure, and blood sugar. Then, preprocess these data, such as denoising, normalization, etc., to improve the quality and stability of the data.

With the continuous development of computer vision technology, virtual reality and augmented reality technology have gradually become research hotspots. These technologies can provide people with more intuitive, vivid, and personalized experiences, thus having broad application prospects in the medical field. In the field of children's healthcare, virtual and augmented reality technologies can provide children with more vivid, interesting, and easily understandable medical services, improving the efficiency and safety of medical product use. Yeung et al. [18] explored the application of virtual and augmented reality technologies under computer vision in children's medical products. By combining virtual reality and augmented reality technology, we provide children with more intuitive, vivid, and personalized medical services. Virtual reality technology can provide children with more intuitive and vivid medical services by simulating real medical scenarios. For example, before children's surgery, doctors can use virtual reality technology to demonstrate the surgical process to children, allowing them to understand the specific steps and precautions of the surgery, thereby reducing their tension and fear. In addition, virtual reality technology can also be used for children's rehabilitation training, pain management, and other aspects, providing more personalized medical services for children. The application of computer vision and biomedical data mining in the field of healthcare is becoming increasingly widespread. These technologies can help us better understand and process massive amounts of biomedical data, providing more efficient, accurate, and personalized support for healthcare. However, how to effectively utilize these technologies for data mining and knowledge discovery is an important issue. Zheng et al. [19] introduce specialized knowledge graph benchmarks for computer vision data mining and biomedical data mining to help us better understand and apply these technologies. A knowledge graph is a graphical model used to represent and store knowledge. In computer vision data mining, knowledge graphs can be used to represent various features and attributes in images, as well as their relationships. By constructing a knowledge graph, we can conduct in-depth analysis and understanding of images to extract useful information and knowledge. For example, in medical image analysis, knowledge graphs can help doctors better understand and diagnose the condition and improve treatment effectiveness. Biomedical data mining is the process of processing and analyzing biomedical data using data mining techniques. In biomedical data mining, knowledge graphs can be used to represent various attributes and relationships in biomedical data, as well as their interactions. By constructing a knowledge graph in the biomedical field, we can conduct in-depth analysis and understanding of biomedical data and extract useful information and knowledge.

3 METHODOLOGY

3.1 Data Collection

Based on the above research, this article designs a CAD design model of children's medical products by combining computer vision and DM technology and carries out simulation experiments. The data sources of this study mainly include the following aspects:

(1) Data on children's body shape and physiological characteristics: Monitoring and measuring children's body shape and physiological characteristics through medical equipment or sensors to obtain relevant data. These data include children's height, weight, body shape, bone structure, breathing frequency, heart rate and so on.

(2) Process data of children using medical products: Computer vision technology is used to monitor and record the stage of children using medical products and obtain relevant data. These data include children's posture, movements and expressions when using medical products.

(3) User data and market data: Collect user data and market data through questionnaires, user evaluations, sales records, etc., to understand users' needs and preferences for medical products, as well as market trends and competition.

Data types mainly include structured data and unstructured data. Data collection methods include measurement of medical equipment or sensors, monitoring and recording of computer vision technology, questionnaire survey, and user evaluation.

3.2 Data Processing

Data processing is one of the key links in this study, which mainly includes the following steps:

(1) Data cleaning: cleaning and processing the collected data to eliminate noise and abnormal values and improve data quality. For example, for image data, operations such as denoising and enhancement can be performed. For numerical data, smoothing or outlier elimination can be performed.

(2) Feature detection: representative features are extracted from the cleaned data to describe children's body shape, physiological characteristics, and the stage of use of medical products. For image data, computer vision technology can be used to extract features such as edges, corners and

textures. For numerical data, statistical methods can be used to extract features such as mean, variance and trend.

(3) Feature selection: Select the features related to children's medical product design from the extracted features so as to reduce the data dimension and improve the calculation efficiency. Feature selection methods include statistics-based methods (chi-square test, information gain, etc.) and machine learning-based methods (recursive feature elimination, L1 regularization, etc.).

3.3 Model Construction

In the design of children's medical products, a highly personalized and accurate CAD design model can be constructed by combining computer vision and DM so as to ensure that the products can better meet the actual needs of children. In this section, a 3D reconstruction and measurement method of children's bones based on a computer vision algorithm is proposed, and a CAD model suitable for children's bone development characteristics is established for specific medical devices by combining information such as user demand and market trends. The following are the main steps to build this CAD design model:

(1) Demand analysis and definition

The design of any product begins with an in-depth understanding and analysis of requirements. This step is particularly important for children's medical products. Firstly, this article needs to collect information from multiple dimensions: body shape data related to children, physiological characteristics, and specific process data of their use of medical products. Moreover, market trends and user needs are also indispensable parts. For example, if the goal is to design a ventilator for children's breathing problems, then we must deeply understand the key factors, such as children's breathing frequency and breathing depth.

(2) Data fusion and modeling

After collecting a lot of relevant data, the next step is to fuse these data and build a CAD design model on this basis. In this process, computer vision technology plays a core role. Using a computer vision algorithm, we can extract bone structure information from children's medical image data. Through a series of image processing and analysis steps such as image segmentation, feature detection and 3D reconstruction, a high-precision 3D model of children's bones can be generated. The 3D model can not only accurately show the shape and structure of bones but also provide detailed measurement data, such as the length, angle and curvature of bones. In the CAD design model, if the 3D model $F(x,y,z)$ with $L \times M \times N$ size becomes a new 3D model $I(x,y,z)$ with $KL \times KM \times KN$ size, it is expressed as follows:

$$I(x,y,z) = F(\mathrm{int}(c \times x), \mathrm{int}(c \times y), \mathrm{int}(c \times z)) \tag{1}$$

$$c = \frac{1}{k} \tag{2}$$

When $k > 1$ the 3D model is reduced, When $k < 1$ the 3D model is enlarged, a new 3D model can be constructed by the following formula:

$$I(x,y,z) = F(x - m_p, y - m_p, z - m_p) \tag{3}$$

In this article, a fineness function $D(O,d,m)$ is established to describe the fineness of bones. Namely:

$$D = \begin{cases} 0 & d > d_0 \\ D(O,d,m) & d \le d_0 \end{cases} \tag{4}$$

Among them O are the symbol of bones, d the distance of bones from the viewpoint, and m the importance of bone weight. The creation stage of a 3D simulated human skeleton is shown in Figure 1.

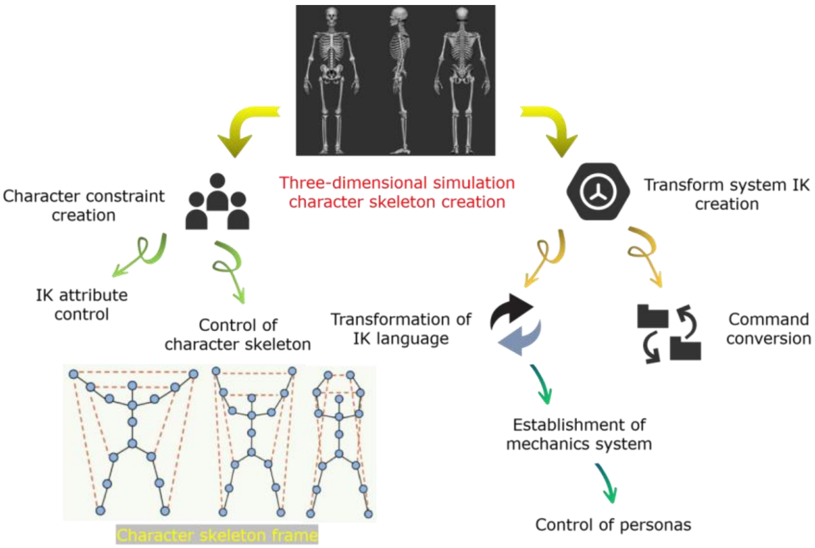

Figure 1: Flowchart for creating a 3D simulated human skeleton.

After obtaining the 3D data of children's bones, it is fused with the previously collected information, such as user needs and market trends. This information includes children's age, gender, physical condition and expectations of parents and medical staff. Through in-depth analysis of these data, we can gain insight into the characteristics and differences of bone growth of children of different ages and sexes, as well as the special needs of the market and users of medical devices. In the stage of model design, this article not only considers the functionality of the product, such as the therapeutic effect, ease of use and safety of medical devices but also pays attention to its fit with children's physiological characteristics. For example, the design of a ventilator for children will optimize the shape and size of the ventilator according to the respiratory structure and breathing habits of children so as to provide more comfortable and effective breathing support.

(3) Model verification and optimization

After designing a preliminary CAD model, the next step is to verify its effectiveness and accuracy. At this time, DM technology comes in handy. Specifically, the model can be trained and tested with historical data to assess its performance. In this article, a data analysis method of medical devices based on DM technology is adopted, and the CAD model is adjusted and optimized according to the analysis results. First of all, collect a large number of data about the use of medical devices, including operating parameters, frequency of use, fault records, maintenance records and patient feedback. Then, these data are processed and analyzed by DM technology. Through data cleaning, feature detection and pattern recognition, we can find useful information and potential problems hidden in the data. The minimization problem's objective function is formulated as:

$$f(w) = \min \frac{\lambda}{2}\left\|w\right\|^2 + \frac{1}{m}\sum l(w,(x,y)) \tag{5}$$

Where $(w,(x,y))$ is:

$$l(w,(x,y)) = \min \ 0,1 - y < w,x >> w \tag{6}$$

Ensure that the running time of the algorithm is met $O(\frac{n}{\lambda_\varepsilon})$. Where n is the sum of dimensions in the constraint space of w and x. In order to solve the dual problem of nonlinear nuclear correspondence, the following mapping transformation is carried out:

$$S = \quad x_1, x_2, x_3, \ldots, x_n \tag{7}$$

The self-information of a sample data point can be expressed as:

$$H(X) = \sum_i p_i \log \frac{1}{p_i} \quad (i = 1,2,3,\ldots,n) \tag{8}$$

The information entropy of this data set can be expressed as:

$$\sum a_i y_i x_i \to w(i \neq 0) \tag{9}$$

Set $0\log(0) = 0$. Information entropy is used to measure the amount of information. If the uncertainty is smaller, the information amount is smaller, and the entropy is smaller.

In the stage of DM, some problems or bottlenecks related to the performance of medical devices may be found. These problems may involve the accuracy, stability, durability, and ease of use of the instrument. Once the problems or performance bottlenecks of medical devices are found, the next step is to make necessary adjustments and optimizations to the CAD model. Different optimization strategies can be adopted according to the nature and severity of the problem. If the problem involves the accuracy and stability of the instrument, the performance of the instrument can be improved by improving the design parameters, optimizing the material selection or enhancing the manufacturing process. If the problem involves the usability and user experience of the instrument, the user experience can be improved by improving the interface design, optimizing the operation process or adding auxiliary functions.

After adjusting and optimizing the CAD model, it is necessary to verify and assess the new design. This can be done by computer simulation, laboratory tests or clinical trials. Through these verification and evaluation steps, this article can ensure that the finally designed medical products are efficient and safe and can meet the needs of patients and market expectations.

4 EXPERIMENTAL DESIGN AND IMPLEMENTATION

4.1 Experimental Design

The main goal of this experiment is to verify the feasibility of the CAD design model of children's medical products based on computer vision and DM technology. Specifically, the experiment will verify whether the CAD design model can generate a medical product design scheme that meets the design requirements and goals according to children's body shapes, physiological characteristics, and process data of using medical products. Moreover, the performance of the CAD design model in terms of design scheme accuracy, design efficiency and user satisfaction is assessed. This is done in order to find the problems and shortcomings of the CAD design model and provide the basis for subsequent improvement and optimization.

In order to achieve the above experimental objectives, this study will adopt the following experimental methods:

(1) Simulation experiment: Using computer simulation technology to simulate the stage of children using medical products and generate corresponding data. These data will be used to train and test CAD design models.

(2) Comparative experiment: Compare the design scheme generated by the CAD design model with the design scheme generated by the traditional design method and assess the performance of the CAD design model in terms of design efficiency and product quality.

(3) User survey: Investigate the users of medical products generated by using CAD design model, understand the satisfaction and demand feedback of users, and provide the basis for model improvement and optimization.

The specific steps of the experiment are shown in Table 1.

Step number	*Experimental procedure*	*Experimental description*
1	Prepare experimental data	Collect children's body shapes and physiological characteristics, process data on using medical products, and collect information such as user needs and market trends.
2	Constructing CAD design model	Based on computer vision and DM technology, the CAD design model of children's medical products is constructed.
3	Simulation experiment	Computer simulation technology is used to simulate the stage of children using medical products and generate corresponding data. These data will be used to train and test CAD design models.
4	Generate design scheme	According to the trained CAD design model, the medical product design scheme that meets the design requirements and objectives is generated.
5	Contrast experiment	The design scheme generated by the CAD design model is compared with the design scheme generated by the traditional design method, and the performance of the CAD design model is assessed.
6	User survey	Investigate the users of medical products generated by using CAD design model to understand the satisfaction and demand feedback of users.

Table 1: Experimental procedure.

4.2 Experimental Implementation

In the implementation stage of the experiment, the collected data need to be preprocessed and prepared first. This includes data cleaning, feature detection and feature selection to ensure the accuracy and availability of data. Specific work includes removing outliers, filling missing values, and standardizing data. Moreover, it is necessary to visually analyze the data to understand the distribution and characteristics of the data more intuitively.

After the data is ready, the CAD design model needs to be realized according to the methodology described in the previous section. This includes the steps of selecting the appropriate algorithm and technology, setting model parameters and so on. After the realization, the CAD design model is trained and optimized by using the prepared data to improve the performance and accuracy of the model.

During the implementation of the experiment, it is necessary to record the operation process and data collection of the experiment in detail. This includes the construction of the experimental environment, the configuration of experimental equipment, the collection and arrangement of experimental data and other steps. Moreover, statistical analysis and visual display of experimental data are needed to understand the experimental results and the performance of the model more intuitively. During the experiment, it is necessary to maintain the integrity and accuracy of the data and ensure the reliability and effectiveness of the experimental results.

5 EXPERIMENTAL RESULTS AND ANALYSIS

Through the implementation of the experimental process described in the previous section, this article collected a lot of experimental data. These data include children's body shapes, physiological characteristics, and process data of using medical products, as well as design scheme data generated by the CAD design model. The specific data are shown as follows:

(1) Children's body shape and physiological characteristics data, including the measured values and statistical results of children's height, weight, body shape, bone structure, breathing frequency, heart rate and other data.

(2) Process data on children's use of medical products, including monitoring records and statistical results of children's posture, movements and expressions when using medical products.

(3) Design scheme data generated by 3)CAD design model, including the display and comparison results of the 3D model, size parameters, performance indicators and other data of the design scheme.

In order to assess the performance of the CAD design model, the following performance indicators are adopted in the experiment: the accuracy, design efficiency, innovation and user satisfaction of children's medical product design scheme. In this section, in order to better show the experimental results and analysis conclusions, the experimental results are visually displayed by means of charts, images and so on. Specifically, the distribution and characteristics of experimental data are displayed by drawing charts such as histograms and scatter plots. This helps to understand the characteristics and laws of data more intuitively. Moreover, by drawing the histogram of the survey results of user satisfaction, the user's satisfaction and demand feedback on medical products generated by the CAD design model are displayed. This helps to understand the user's evaluation and demand for products more intuitively. The accuracy comparison results of children's medical product design scheme are shown in Figure 2.

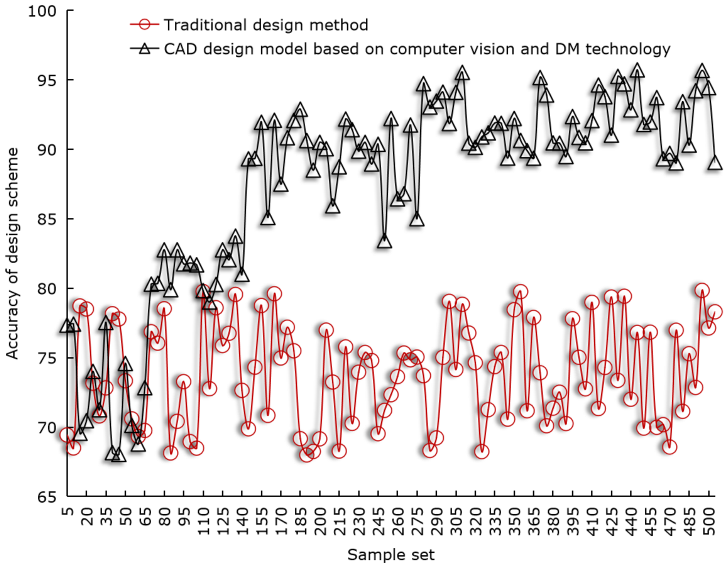

Figure 2: Accuracy comparison of design schemes.

Figure 2 shows the comparison results of two different design schemes in terms of accuracy. It can be observed that the design scheme generated by the innovative method in this article is significantly superior to the traditional method in accuracy. The efficiency of children's medical product design scheme is shown in Figure 3.

The design scheme based on computer vision and DM technology is significantly higher in efficiency than the traditional design scheme. This difference is reflected in many aspects, such as design cycle, resource utilization, design iteration times and so on. The innovative comparison of children's medical product design scheme is shown in Figure 4.

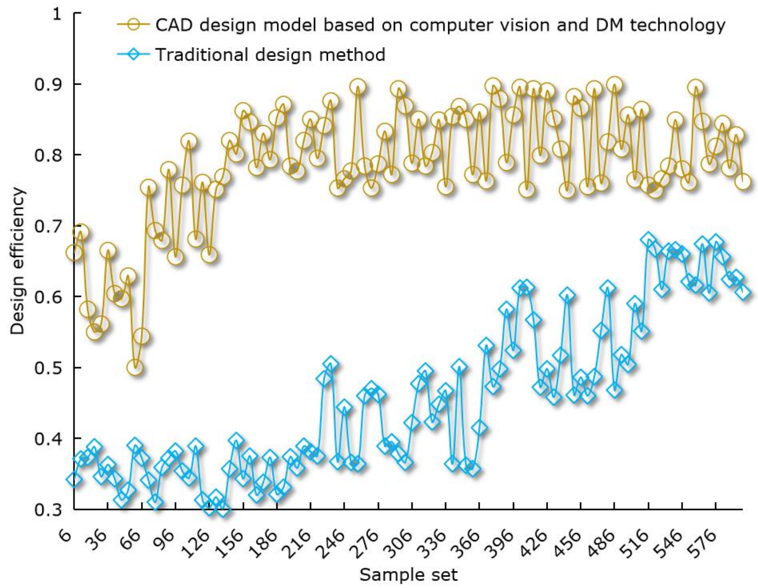

Figure 3: Comparison of design efficiency.

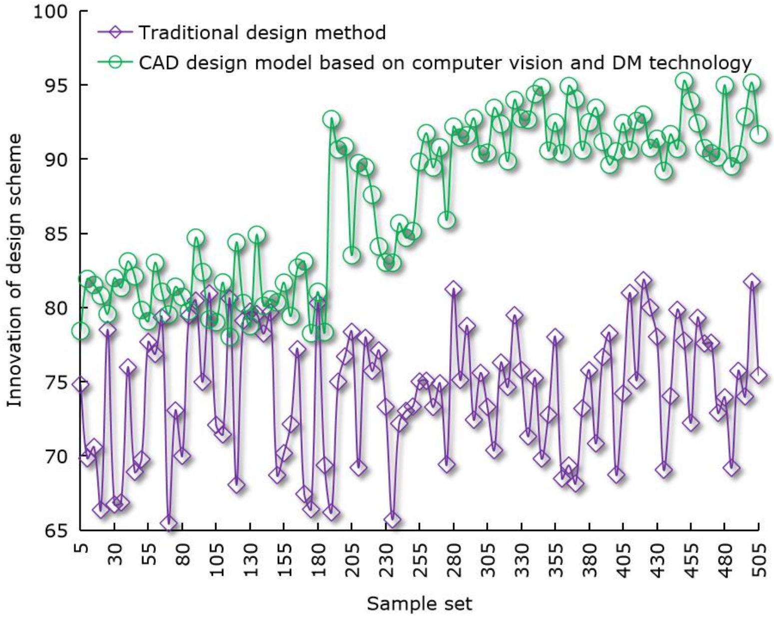

Figure 4: Innovative comparison of design schemes for children's medical products.

The design scheme based on computer vision and DM technology has achieved higher scores in innovation. This shows that the new technology is not only limited to improving the accuracy and efficiency of design but can also promote innovation. The user satisfaction of the designed product is shown in Figure 5.

Compared with the traditional design scheme, the comparison of user satisfaction with different design methods is shown in Figure 6.

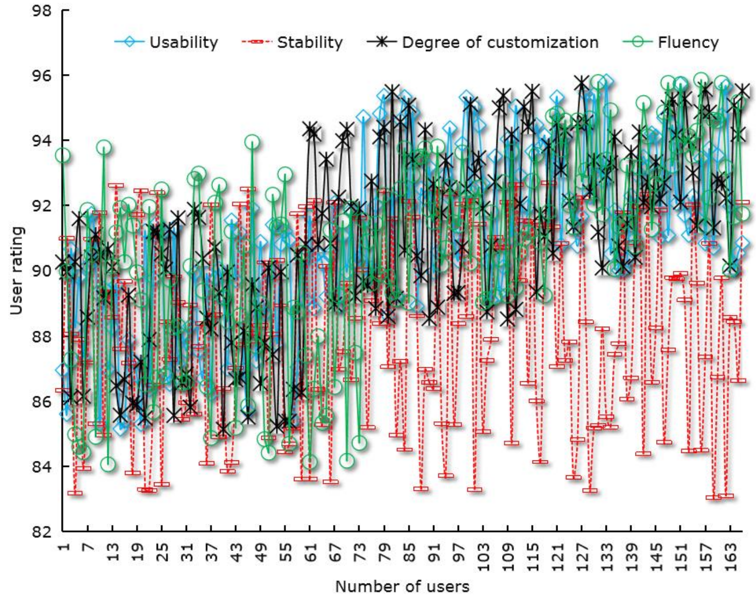

Figure 5: User satisfaction.

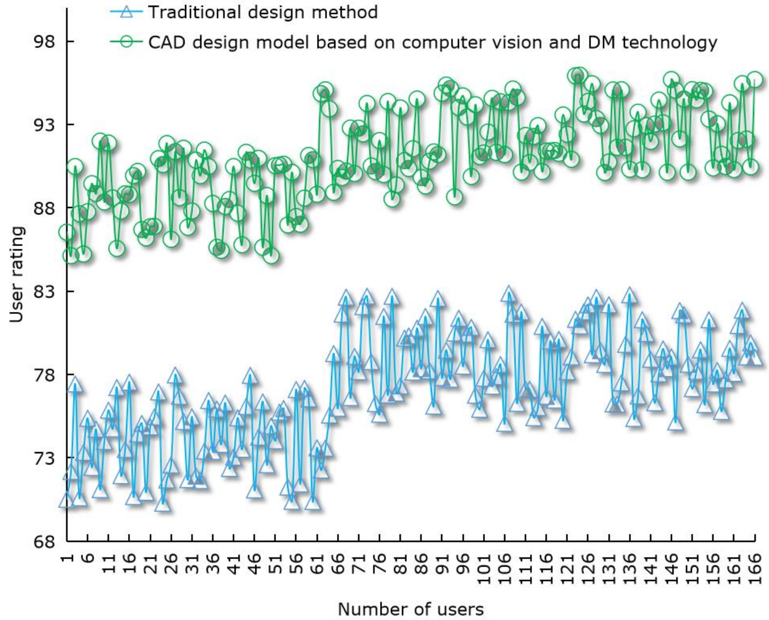

Figure 6: Comparison of user satisfaction.

From the scoring data in Figure 6, it can be concluded that the design scheme in this article has obtained a higher score in terms of user satisfaction. This shows that the use of this method in design can significantly improve the satisfaction and recognition of users. User satisfaction is one of the important indicators to measure the success of a product. In the field of children's medical products, the improvement of user satisfaction means that products can better meet the needs and expectations of children and parents, thus enhancing the market competitiveness of products.

Moreover, high customer satisfaction can establish a good brand image and reputation for enterprises, attract more potential users and promote long-term sales of products.

Through in-depth analysis and discussion of the experimental data, this section draws the following conclusions:

The CAD design model can generate a medical product design scheme that meets the design requirements and objectives according to children's body shapes, physiological characteristics, and processing data using medical products. Compared with traditional design methods, the CAD design model has obvious advantages in design efficiency and product quality.

(2) The design scheme generated by 2) the CAD design model performs well in meeting the needs of users and market trends and can meet the needs and preferences of different users. Moreover, the CAD design model has strong flexibility and expansibility and can adapt to different scenarios and application requirements.

(3) Through user surveys, it is found that users have high satisfaction and demand feedback on medical products generated by the CAD design model. This shows that the CAD design model plays an important role in improving product quality and user satisfaction.

6 CASE STUDY

6.1 Case Selection and Analysis

In order to verify the practical application effect of the CAD design model proposed in this study, this article chooses a representative case of children's medical product design for research. This case is a design of an atomized inhaler for the treatment of children's respiratory diseases.

There are two reasons for choosing this case. Representative: Aerosol inhaler is a common medical product for children, and its design involves many factors, such as children's body shape, physiological characteristics and usage habits, which can fully reflect the application value of the CAD design model. Practical significance: Children's respiratory diseases have a high incidence among children. As one of the effective means to treat such diseases, the design quality of atomized inhalers is directly related to the treatment effect and children's health.

In the case analysis stage, this article uses the proposed CAD design model to analyze and design the selected design case of atomizing inhalers in detail. The specific steps are as follows:

(1) Data collection: collect the data on children's body shape, physiological characteristics and the stage of using atomized inhalers, as well as information such as user needs and market trends.

(2) Establish CAD design model: Based on the collected data, use the CAD design model proposed in this study to build the design scheme of the aerosol inhaler. In the design process, children's physiological characteristics and usage habits, as well as the performance, safety and ease of use of the product, are fully considered.

(3) Design scheme evaluation: The design scheme generated by the CAD design model is assessed by using the evaluation indexes proposed in this study, including accuracy and efficiency. Moreover, experts and users are invited to assess and provide feedback on the products so as to optimize the design scheme further.

6.2 Case Result Display

Through case analysis, the design scheme of the atomized inhaler based on the CAD design model is obtained in this article. In order to show the results of the case study more intuitively, this article compares the design scheme generated by the CAD design model with that generated by the traditional design method. See Figure 7 for details.

Traditional design scheme

Design scheme of atomizing inhaler based on CAD design model

Figure 7: Case comparison of different design methods.

Compared with the traditional design method, this scheme has the following advantages and values:

(1) Personalized design: The CAD design model can carry out personalized design according to the data of children's body shape and physiological characteristics, making the products more in line with children's use needs and habits. Moreover, users can customize products according to their own preferences and needs, which improves the applicability of products and user satisfaction.

(2) Efficiency: CAD design model can significantly shorten the design cycle, reduce the design cost, and improve the product development efficiency and market competitiveness. In addition, the CAD design model also supports concurrent design and collaborative design, which is beneficial to team cooperation and project management.

(3) Innovation: The CAD design model can introduce advanced computer vision and DM technology to provide more innovative ideas and inspiration for product design. Moreover, the CAD design model also supports virtual simulation and testing of products, which is helpful in finding potential problems and improving the performance and quality of products.

7 CONCLUSIONS

In this study, the application of computer vision, DM technology and CAD design model in the design of children's medical products has been deeply explored, and remarkable research results have been achieved. Simulation experiments and comparative experiments are carried out in this article to verify the performance of the CAD design model. The simulation experiment uses computer simulation technology to simulate the stage of children using medical products and generates corresponding data for model training and testing. In contrast experiment, the design scheme generated by the CAD design model is compared with the design scheme generated by the traditional design method in detail, and its advantages in accuracy, efficiency and innovation are assessed. The results show that the design scheme of children's medical products based on the CAD design model is superior to the design scheme generated by traditional design methods in accuracy, efficiency and innovation. This shows that the CAD design model proposed in this study has a wide application prospect and important value significance in the field of children's medical product design.

This study not only assesses the performance of the CAD design model through comparative experiments but also investigates the users of medical products generated by the CAD design model and comprehensively assesses the practical application effect of the CAD design model from multiple dimensions. This comprehensive evaluation method can more accurately reflect the advantages and disadvantages of the CAD design model. Moreover, the user-oriented design method is helpful to improve the market acceptance and user satisfaction of products. It provides a valuable reference for subsequent research and improvement. As technology continues to advance and application scenarios expand, we are optimistic that this approach will assume a progressively significant role in medical product design, offering a more user-friendly, efficient, and secure experience to a broader patient population.

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