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parameters, feed-forward operation is carried out again, so that the loop continues until the network model converges, so as to achieve the purpose of model training [15]. The level structure of convolutional neural network includes data input layer, convolution calculation layer, ReLU excitation layer, pooling layer and fully connection layer.

Data input layer

The processing of this layer is mainly to preprocess the original image data, including:

A. Removing Mean: the center of each dimension of the input data is changed to 0. The purpose is to pull the center of the sample back to the origin of the coordinate system.

B. Normalization: normalize the amplitude to the same range, that is, reduce the interference caused by the difference of data value range of each dimension. For example, there are features A and B of two dimensions, the range of A is 0 to 10, and the range of B is 0 to 10000. If the direct use of these two features is problematic, the good way is to normalize, that is, the data of A and B is converted into the range of 0 to 1.

PCA / whitening: dimension reduction with PCA; whitening is the normalization of amplitude on each characteristic axis of data.

Convolution calculation layer

This layer is the most important level of convolutional neural network, and also the reason of the name of "convolutional neural network".

In this convolution layer, there are two key operations:

A. local correlation, each neuron is regarded as a filter.

B. the window (receptive field) slides, and the filter calculates the local data.

ReLU excitation layer

The output of convolution layer is mapped nonlinearly. CNN adopts the excitation function of ReLU (Rectified Linear Unit), which is characterized by fast convergence and simple gradient calculation.

Pooling layer

The pooling layer is sandwiched in the middle of the continuous convolution layer to compress the amount of data and parameters and reduce over fitting. The input is the image, and the main function of the

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pooling layer is to compress the image. The methods used in the pooling layer are Max pool and Average pool.

Fully connected layer

All the neurons in the two layers have weight connection. Generally, the fully connection layer is at the tail of convolutional neural network, which is the same as the connection mode of traditional neural network neurons

Fig 3 and TABLE III show the structure framework and parameter setting of the deep convolutional neural network in case teaching.

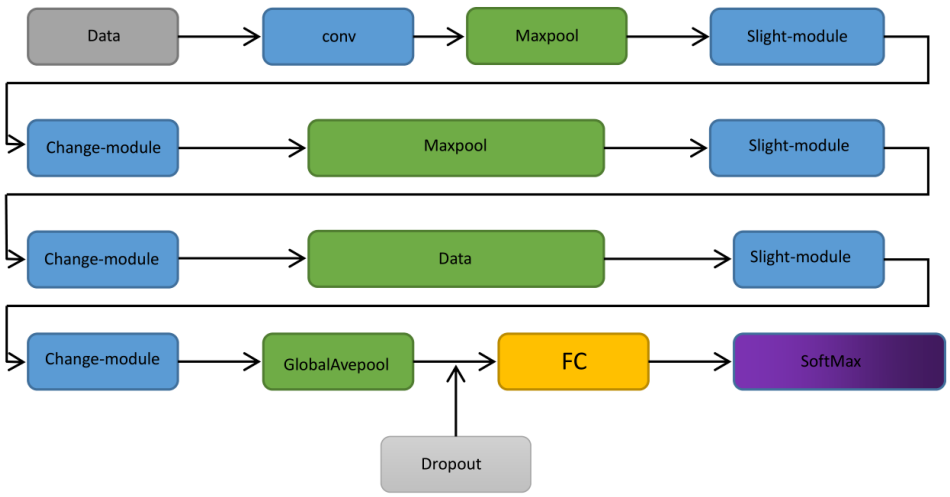

Fig 3: Structure diagram of deep convolutional neural network introduced in case teaching

TABLE III. Parameter setting of deep convolutional neural network in case teaching

Hierarchical structure	Convolution kernel size / step size/pad	Output dimension
Input	---	227×227×3
Conv0/BN	11×11/4/0	55×55×128
Max Pool	3×3/2/0	27×27×128
Slight_Module	---	27×27×128
Change_Module	5×5/1/2	27×27×256
	3×3/1/1 3×3/1/1	
	1×1/1/0	
Max Pool	3×3/2/0	13×13×256

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Slight_Module	---	13×13×256
Change_Module	5×5/1/2	13×13×512
	3×3/1/1 3×3/1/1	
	1×1/1/0	
Average pool	2×2/2/1	7×7×512
Slight_Module	---	7×7×512
Change_Module	5×5/1/2	7×7×512
	3×3/1/1 3×3/1/1	
	1×1/1/0	
GlobalAvepool		101/43
FC	---	101/43

4.2.2 Training framework

At present, there are three main neural network training frameworks:

A. Caffe: from Berkeley's mainstream CV toolkit, it supports C++, python, Matlab, and model zoo, including a large number of pre-trained models for use.

B. TensorFlow: Google's deep learning framework, Tensor board visualization is very convenient, data and model parallelization is good and fast.

C. Torch: A convolutional neural network toolkit used by Facebook. The local interface of time-domain convolution makes it very intuitive to use and simple to define a new network layer.

TensorFlow's visual operation is convenient [16], and it is convenient for the clothing classification development of smart home wardrobe system. Therefore, the TensorFlow framework is selected for convolutional neural network training in case and practical teaching. With the flexible structure in TensorFlow, computing can be deployed to one or more CPUs or GPUs in desktop devices, servers or mobile devices through an API.

TensorFlow object detection API is a framework built on TensorFlow to identify specific objects in images. TensorFlow supports transitional learning of five pre-training models to improve recognition speed. TensorFlow Lite is a lightweight solution of TensorFlow for mobile and embedded devices. It supports machine learning reasoning on devices with low latency and small binary size. TensorFlow Lite also supports the hardware acceleration of Android and IOS neural network API, with no problem of cross platform. TensorFlow Lite uses many technologies to achieve low latency, such as optimizing the mobile application kernel, perfusion activation, and quantization kernel that allows smaller and faster (fixed-point mathematics) models [17].

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4.2.3 Interface design

After defining the system structure and logic level, as well as deep convolutional neural network embedded analysis, smart home wardrobe system interface design becomes the focus of case and practice teaching. In the teaching process, the teacher combines the deep convolutional neural network level structure to carry out the inter-face case display analysis, but before the display, teacher instructs the students to analyze the pain points for the system users. There are two main problems: One is the general acceleration of urban life rhythm, people often do not have more time to tidy up the wardrobe, and then the wardrobe tidying becomes the difficulty of home life. Second, with the improvement of the quality of life, people's pursuit of fashion and the demand for scientific and exquisite matching of clothing are becoming higher and higher. Based on the above two pain points, the students' practical design are required to try to achieve targeted recommendation of "thousands of people and thousands of faces", so that users can enjoy "private customization" services. The design interface given by the teaching case presented to students is easy to operate and be a clear logic. The simple icon has a strong ability of information transmission to ensure that users can identify it correctly and quickly. The red and white color design and matching reflect and highlight the brand color, while leaving a deep impression on customers. Through classification and typesetting, enhance the visual expression of the page. Each page shows the main functions directly below to ensure fast and convenient. Generally speaking, the layout of the interface is clear, the key points are highlighted, the functional structure is reasonable, and the use is easier.

The main scanning function page can start intelligent scanning and scan users' clothing and accessories to assist in storage, sorting and classification.

In order to provide users with information about fashion clothing and matching that they are interested in, a "stroll" page with recommendation function is designed. There are five interfaces in the secondary page, which can slide left and right or click to switch; the search function enables users to search relevant content more quickly and accurately, and can also directly jump to mainstream shopping Apps such as "Taobao", "Tmall", etc. In addition, it is also designed with user interaction function. Users can access through mobile phones and other mobile terminals, and realize real-time information sharing and communication interaction in the form of words and pictures.

The weather page updates the detailed weather information in real time, and pro-vides the user with human-machine interactive intelligent clothing recommendation service according to the weather conditions. Fig 4 is the human- machine interaction workflow.

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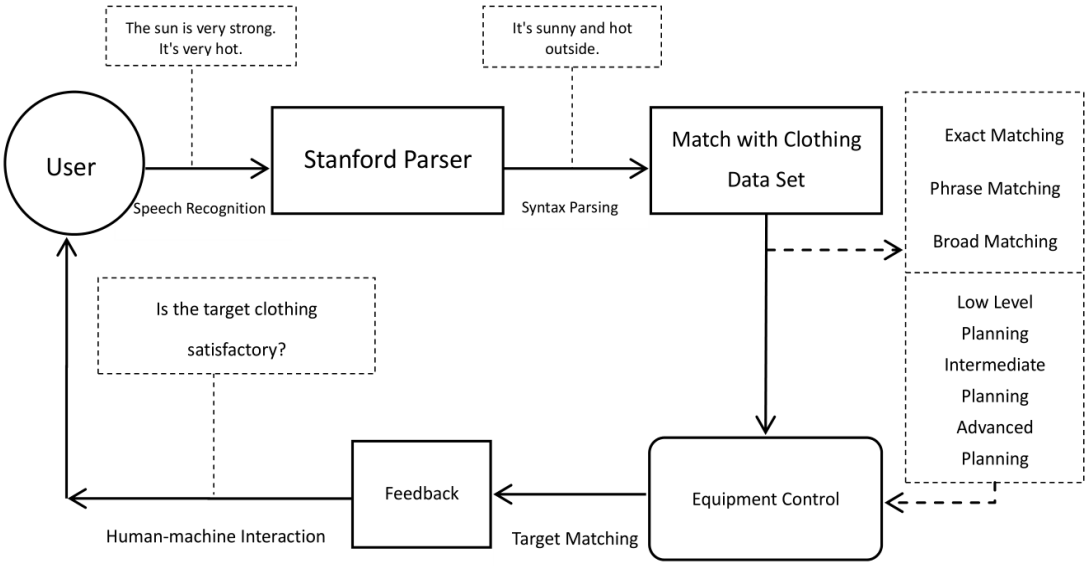

Fig 4: Human-machine interaction workflow

The "Wardrobe" page can be used for digital scientific sorting, editing, scientific recommendation and selection of user's clothing accessories after scanning, and also provides human-machine interaction function.

"My" page contains user level and check-in system, including personal infor-mation, clothing management, recommendation and purchase, fashion front, and settings. The settings include system settings, user interface settings and user feedback to improve the user's affinity and trust for the system.

Some examples of page design are shown in fig 5.

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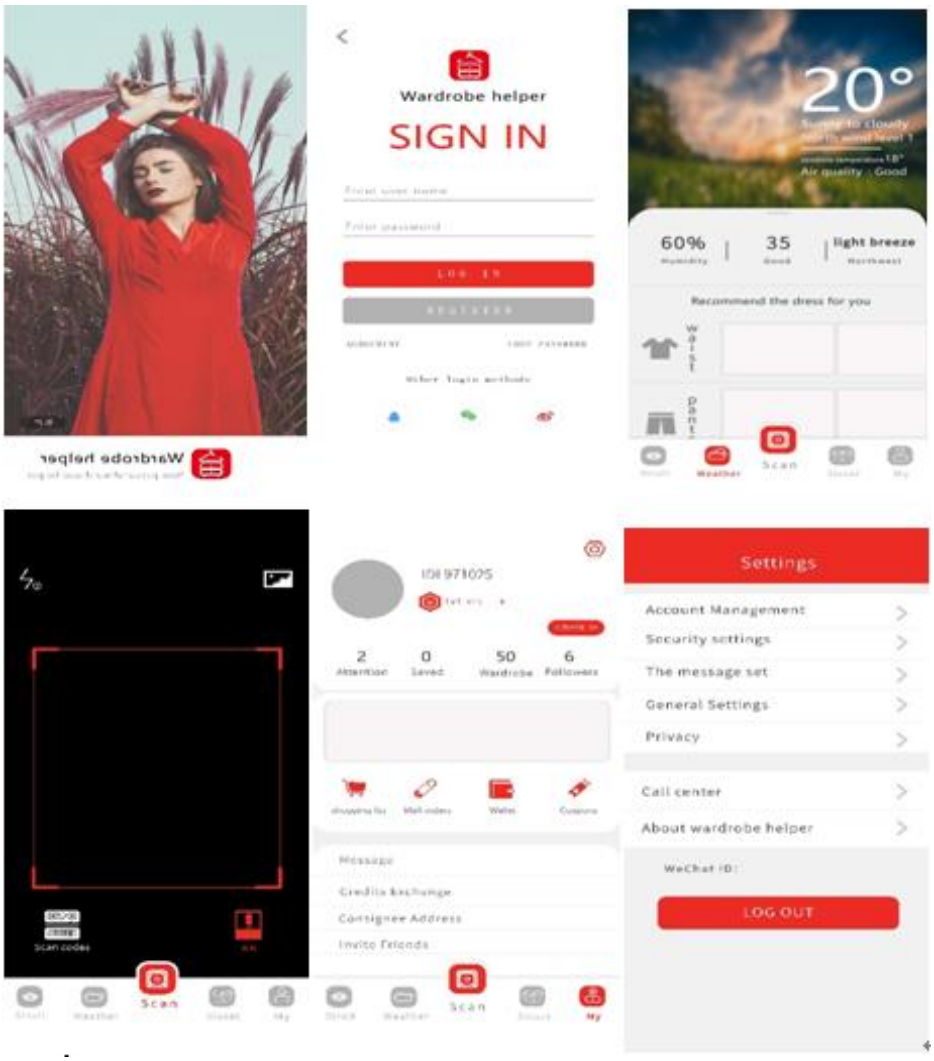

Fig 5: Interface design of some functional modules of the system

V. INVESTIGATION AND ANALYSIS OF STUDENTS' LEARNING EXPERIENCE

The mediation of fake insights innovation, such as profound convolutional neural arrange, not as it were effectively guides understudies to create item plan and course learning from basic computer-aided computer program into the following, under-standing and application of advanced cutting-edge advances, such as manufactured insights and huge information, but too makes portion of the educating substance of item plan alter from straightforward computer program educating and computer program application to item advancement plan instructing based on cutting-edge innovation. In arrange to superior get it how students learn and their learning encounter, whereas presenting convolution neural net-work innovation to improve the educating substance and educating implies of item de-sign claim to fame and carrying out the inventive application of savvy domestic closet case educating, the inquire about bunch pays consideration to examining and following students' learning involvement and learning impact

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5.1 Students Carried out Technical Study and Application Discussion

Convolutional neural network has become a mainstream technology for image processing. Although it involves the field of artificial intelligence, it is of great significance for students majoring in product design to preliminary contact and learn this technology to carry out object positioning, object recognition, target segmentation and key point detection. In case teaching, students learn and understand the process of using convolution neural network technology to process images, especially have an intuitive feeling of how to convert design language into computer language and store, analyze and calculate. For example, color images are superimposed into three channels of images through red, green and blue (RGB) and converted into matrices for computer recognition, so as to complete the data input of neural network. Then, through the increase of convolution layer and its operation, the multi-layer network is used to extract the features of complex images, and the nonlinear problems are solved by using nonlinear functions such as ReLU. Next, the feature matrix is segmented by pooling layer to reduce the dimension. Finally, the local features and each feature matrix are combined into vector representatives to calculate the score of each category. After students understand the operation principle of the above technology, the course teaching officially begins to use the neural network training framework for training, so as to make the trained convolutional neural network correctly classify the images and complete the complex image processing tasks. Students also further appreciate the advantages and application prospects of artificial intelligence technology in the process of learning and perception.

On this basis, carrying out practical design operation is the key link for students to make more effective use of convolution neural network technology. Students extract the features through convolution neural network technology and combine their own design experience to carry out personalized interface design of smart home wardrobe system. In the teaching and discussion link in the design process, the research group interviewed students, the feedback learning experience is mainly reflected in three aspects: first, the introduction of new technology in the teaching of smart home product design has improved students' awareness of understanding and paying attention to the forefront of science and technology, and realized the important role of convolution neural network technology in image processing and product design; second, case teaching is combined with practical design. Students have high interest and strong applicability, and can timely and deeply understand new technologies and their application fields. At the same time, it exercises students' practical ability, conforms to the practice of paying attention to design technology and design principles set in the course teaching objectives and enables students to have the learning goal of integrating "design, technology, users, business and culture" to create new products; third, some students also put forward the limitations of the current technology in the process of image recognition and processing, compared and analyzed it with manual image recognition and processing, summarized their advantages and disadvantages, and considered the future development and application prospects. In this process, students trained scientific thinking methods, and improved comparative research, asking questions, analyzing questions, solving problems and giving full play to the ability of design creativity and innovation in combination with computer science, which is also one of the important objectives of talent training and course teaching of the major.

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5.2 Questionnaire on Students' Learning Experience

At the end of the course, the research group issued the questionnaire of students' learning experience (using the visual simulation scoring method [18]) to the students of product design major (40 students in each class), that is, the students who study in the traditional teaching mode and the students who study in the case teaching mode based on the application of deep convolutional neural network technology, so as to collect the feedback and evaluate the teaching and learning effect. The contents of the self-assessment form are divided into eight parts: design thinking, scientific research thinking, communication ability, practical ability, comprehension ability, class participation, learning interest and learning satisfaction, each of which is 10 points. The content setting and feedback of the questionnaire are summarized as follows:

The design thinking item includes the function and influence of the application of convolution neural network technology on design innovation, design conception, design test, design method and design problem solving. Students' feedback results are mainly reflected in the effective acquisition of cutting-edge design technologies and design innovation points, the breakthrough and reform of design ideas and design problem solving, the multiple paths of design methods and design directions, and the combination of man-machine and so on.

The scientific research thinking item mainly includes the current research hotspots and advanced research methods related to convolution neural network technology, the theoretical system and operation approach of convolution neural network technology to image processing, and the scientific demonstration and evaluation of experimental cases. Students' feedback results focus on their awareness of interdisciplinary cognition and research has been significantly enhanced. The new development of convolutional neural network technology has broadened their own scientific research vision, and the specific case analysis has improved the demonstration ability of the application of new technology.

The communication ability item mainly include the listening ability, question raising ability, communication ability of students in the process of introducing convolution neural network technology into case teaching, as well as the cooperation ability, expression ability and design ability in the process of practical design. The information fed back by students mainly includes case teaching and practical design, which strengthens communication and cooperation, but lacks practical communication and dialogue with product and interface experience users.

The practical ability item is mainly reflected in the students' actual feelings in the aspects of investigation and analysis and the development of smart home wardrobe system and its interface design. Students generally believe that through the pain point analysis, the design direction and problems to be solved are clarified, and the construction of system function modules and logic levels strengthens their specific perception of the system application structure. The interface design is based on convolutional neural network technology, and the designed works are more scientific and rational.

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The comprehension ability item mainly includes students' understanding of the application of convolutional neural network technology and its associated artificial intelligence and human-computer interaction, as well as the learning and understanding of smart home system. Some students can understand the overall idea and process of the application of the technology, but due to the limitations of the discipline background and the short teaching time, it is difficult to thoroughly understand the specific application details of the technology.

Class participation item mainly includes question and answer interaction of new technology case teaching, cooperative discussion of practical design, representation of work display and so on. The vast majority of students are positive. A small number of students have low participation in some teaching and interaction links because they are difficult to effectively and comprehensively understand knowledge points in a short time, and the feedback of the questionnaire is also positively correlated.

Learning interest item mainly includes students' interest and evaluation in teaching contents, teaching forms, teaching links and teaching methods. The feedback results are very optimistic. Students express strong interest, and the scores for each content of interest items are more than 7 points (0-10 points).

The item of learning satisfaction mainly includes students' satisfaction with the introduction of convolution neural network technology teaching, satisfaction with the setting of teaching links, satisfaction with the difficulty of teaching content and teaching requirements, satisfaction with teaching methods, self-evaluation of the fit between course learning and personal needs and so on. Students' overall feedback satisfaction is high, and their learning experience and learning harvest are good, only a few students said that although they were interested in new technology and case teaching, they thought that learning was difficult and their learning satisfaction was general.

VI. CASE TEACHING EFFECT OF APPLICATION OF DEEP CONVOLUTIONAL NEURAL NETWORK TECHNOLOGY

6.1 Teaching Effect 1

Students' enthusiasm for learning has been greatly enhanced, and their initiative in learning has been significantly enhanced. This change is clearly reflected in the questionnaire survey results of students' learning experience. Based on the results of the questionnaire survey, the research group adopted SPSS19.0 data statistical analysis software, and the measurement data is described by mean ± standard deviation, $P < 0.05$ indicates that there is significant difference between the comparison items.

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TABLE IV. Comparison of learning self-assessment between traditional teaching class and case teaching class

Contents	Traditional teaching class	Case teaching class
Design thinking	4.18±0.87	7.65±0.74
Scientific research thinking	5.20±0.82	7.03±0.86
Communication ability	5.75±0.83	7.22±0.81
Practical ability	5.83±0.87	7.18±0.79
Comprehension ability	6.04±0.72	7.82±0.81
Class participation	5.60±0.87	7.88±0.82
Learning interest	5.22±0.81	7.91±0.85
Learning satisfaction	4.59±0.83	7.63±0.90

The comparison of each group of data in TABLE IV shows significant differences, that is, $P < 0.05$. The results are obvious. Case teaching based on the application of deep convolutional neural network technology is very popular with students, which to a large extent stimulates students' interest in learning and desire for hands-on design practice. In specific module structure analysis and interface design, it also directly improves their ability of practical operation.

6.2 Teaching Effect 2

The case teaching of innovative design of smart home wardrobe system not only focuses on the introduction of current popular technologies such as artificial intelligence, big data and Internet of things, but also enables students to contact new product development and innovative design in close and multi-dimensional way. Through the case analysis of a series of links such as technology introduction, design explanation, product demonstration and practical application, students can fully feel the application of new technology, appreciate the charm of new products, and then improve the innovative design capability of students. Through the data statistics comparison, the two groups of students in the traditional teaching class and the case teaching class are quite different in learning performance and learning effect. Generally speaking, the case teaching class has significant learning effect, the students' performance has increased significantly, and their learning achievements are diversified and rich. The reason why this effect is mainly attributed to the introduction of convolution neural network technology and the case teaching of innovative design of smart home wardrobe system is that: firstly, the effect of previous traditional teaching has been recorded over the years, and there is no major change or breakthrough in students' course learning results. Secondly, most of the achievements of case teaching classes are highly related to convolution neural network technology and innovative design of smart home wardrobe system. Thirdly, the comprehensive assessment results of courses closely related to the course content have been greatly improved. TABLE V shows the comparison of learning achievements and assessment results between traditional teaching class and case teaching class. For course comprehensive assessment results, SPSS19.0 software is also used for data difference statistical analysis, and the score of course comprehensive

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assessment is 100 points.

TABLE V. Comparison of learning achievements and assessment results between traditional teaching class and case teaching class

Contents		Traditional teaching class	Case teaching class
Number of national patent applications	Invention patent	0	1
	Utility model patent	2	8
	Appearance patent	5	12
Attend academic conferences(Person time)	International conference	0	2
	Domestic conference	9	17
Competition Award (Person time)	International level	0	2
	National level	0	2
	Provincial level	1	3
	Municipal and school level	3	9
Course comprehensive assessment results	/	79.21±3.53	88.59±2.67

6.3 Teaching Effect 3

The introduction of innovative case design teaching of smart home wardrobe system and convolutional neural network and Internet of things technology make the students majoring in product design have a broader scientific and technological vision, broader their design thinking, and significantly improved their attention to the cutting-edge of science and technology. In the organized classroom discussion, students are keen to discuss the development of all kinds of the latest science and technology. In addition, through the vivid explanation of specific case analysis, and the introduction of new technology in product design combination point and application point, students' application concept of new technology is significantly enhanced, and they have a clear understanding of the application path of new technology as well.

VII. CONCLUSION

7.1 Conclusion 1

By the end of 2020, the number of internet users in China reached 989 million, an increase of 85.4 million over March 2020, and the internet penetration rate reached 70.4%. Among them, the number of mobile Internet users in China reached 986 million, an increase of 88.85 million over March 2020, and the proportion of internet users using mobile internet reached 99.7%. Hence, the keen domestic closet framework can optimize the user's closet space administration through straightforward portable terminal

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operation, give logical clothing coordinating reference, and make the savvy domestic life coordinated into people's life speedier. Taking the application of convolutional neural network and other technologies as the starting point, the teaching case of innovative design of smart home wardrobe system shows the students how to design and formulate a set of meticulous logic map, scientifically and humanely subdivide the main function module, and carry out the collection and analysis of a large number of clothing data, and on this basis, carry out the interface design of mobile terminal system, and finally complete the design and development of smart home wardrobe system, and provide quality life services for users with smart products. The design and implementation of this process make students directly and deeply feel the specific design path, application channels and huge future development space of new intelligent products, stimulate their interest in learning, effectively improve the teaching quality, teaching effect and students' innovation and practice ability of product design major, and also provide a reference for the case teaching of the combination of product design talents training and cutting-edge technology.

7.2 Conclusion 2

Intelligent home and related system design is one of the mainstream directions of future product design. The case teaching of intelligent home product design based on artificial intelligence technology such as deep convolutional neural network, which promotes students' cognition and understanding of the cutting-edge of product design technology, improves teaching effect and quality, causes students to think more deeply about practice and explore development. For example, the detailed design of intelligent wardrobe, such as the user inputting the clothing code in the system and guiding the mechanical arm of the wardrobe to take out the clothes directly through the computer; further design and development of the clothing automatic storage function, using advanced computer technology, ergonomics and other principles to enable the user to put the clothes into the wardrobe, the intelligent device identifies the clothes and automatically places them directly through the track , and synchronized to the intelligent system, users can directly see the overall situation of the wardrobe in the system, so as to make the home life more energy-saving, healthy and humanized, and improve the public's pleasant feeling of life and realize a new home experience of "Future technology, People-oriented".

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