Design of Human-Computer Interaction Product Interface of Intelligent Service System based on User Experience

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***Abstract*—The current intelligent service platform for human-computer interaction products and services on the user experience is not comprehensive enough, resulting in user satisfaction cannot reach the ideal level. Therefore, a new human-computer interface of intelligent service system based on user experience is designed. Build a user experience based intelligent service system hardware platform, the introduction of the full name of hypertext markup language, so that more personalized design to be met. Design user experience PC terminal and Bluetooth/RS-485 gateway module to achieve two-way signal conversion between Bluetooth and RS-485. Based on ARM processor, the speech recognition of human-computer interaction is completed, the features of collected data are extracted, and the hand gesture recognition is completed. In order to optimize the human-computer interaction effect, Kinect is used to track and identify moving objects, and the 3D interactive image is simulated by fused texture. Experimental results show that the proposed method has a higher probability of receiving data, and the recognition rate of gesture features and recognition accuracy can reach more than 90%.**

***Keywords*—User experience; intelligent service system; human-computer interaction; interface design; ARM processor; gateway module**

I. INTRODUCTION

With the rapid improvement of computer's storage capacity and processing speed, the performance of service robot is getting better and better. More and more service robots are applied to all walks of life [1]. In order to make the service robot enter into people's daily life from the laboratory, some key technologies must be broken through, such as path planning, environment representation, control system, human-computer interaction, mechanism design and so on. As an interactive channel between user and robot, the human-computer interaction of intelligent service system is a crucial technology [2]. The human-computer interaction system of a friendly and natural intelligent service system is the key to the success of service robot. The purpose of the human-computer interaction design of intelligent service systems is to make the communication between humans and robots more convenient, more reliable and more in line with human interaction habits, as well as to reduce users' psychological and physical burdens [3].

The most important thing in the human-computer interaction of intelligent service system is how to make the user complete the task best, rather than how to design the best human-computer interaction of intelligent service system. In applications, the current research direction is no longer the pursuit of function, but "user-centric" design [4-5]. In modern software development, the research and development of human-computer interface of intelligent service system is of great importance. It connects people with computer technology and realizes humanization of computer technology. The human-machine interface of intelligent service system is the most closely related part of application system, so the workload of this part accounts for a large proportion of the whole development work [6-8].

Three core technical modules of intelligent robot: interaction+perception+operation control. Among them, the full name of interaction is human-computer interaction and recognition module. The functions of this module mainly include speech synthesis, speech recognition, image acquisition, image recognition, etc. The technologies related to speech recognition include speech recognition, natural language understanding, natural language generation, speech synthesis and dialogue engine. Image recognition technology includes image processing, analysis, understanding and other different types of technology. But at present, people pay more and more attention to the cross-platform of programs, that is, programs with the same function can run on different system platforms, and keep the same function and interface style, thus enhancing the portability and flexibility of programs. It should be noted that the current intelligent service robot cannot achieve this goal, and the existing technology does not support the robot to be truly customer-centric and truly intelligent and humanized. The innovation of the research is to realize voice recognition and gesture recognition with (Advanced RISC Machines) ARM processor, and realize tracking and recognition of moving images with Kinect technology, thus truly realizing human-computer interaction centered on user experience.

The organizational structure of the paper is as follows. The second part analyzes the current situation of human-computer interaction design of intelligent service robots at home and abroad. The third part designs the human interaction interface of the intelligent service robot with user experience as the center. In the fourth part, the feasibility and reliability of the proposed method are verified by using the comparative design method. The fifth part analyzes the research results and gives a conclusion.

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II. Related Work

Robots are high-end emerging technologies that integrate machinery, information, images, materials and other disciplines. Among them, intelligent service robots supported by machine learning, deep learning, artificial intelligence and other technologies have been gradually applied to cleaning, rehabilitation, medical, home services and other fields.

The author in [6] pointed out that the home service robot is a special robot serving human beings, which can replace people to complete home service work, mainly engaged in anti-theft monitoring, security inspection, cleaning, cargo handling, home appliance control, home entertainment, pathological monitoring, children education, alarm clock timing, home statistics, etc. According to the degree of intelligence and the purpose of use, home service robots can be divided into primary small home robots, children's early education robots and human-computer interactive home service robots. The author in [7] pointed out that service robots not only have the characteristics of strong mobility and flexibility, but also can provide a solid hardware foundation for their application in the service industry. They also have the characteristics of convenient mechanical structure, strong human-computer interaction, etc. People can obtain a good user experience in the process of using service robots. The author in [8] proposed a combination of hidden Markov model and Gaussian mixture model to achieve high-precision recognition in the process of dialect interaction. External tools can also be used in the recognition process. This technology has very strong practical value.

The author in [9] tracks interactive targets in real time by improving the efficiency of tracking algorithms. In the case of dialogue analysis, it truly realizes human-computer interaction of intelligent robots by analyzing dialogue video data information. The author in [10] found out how failures occurred and how to solve them in the process of multi-mode voice communication between the interactor and intelligent service robot. Such interdisciplinary work provides opportunities for the communicators and robots to gain new insights into communication problems, so as to provide resources for the mechanisms that can later realize complex human-computer interaction. The author in [11] believed that in the interaction process, the interactor could convey a total of eight positive and negative emotions to the intelligent service robot through touch, and the research results provided a possibility for the follow-up people-centered service. The author in [12] found through experiments that women can communicate emotions for a longer time by using more diversified interaction methods and touching more areas on the robot than male participants. The author in [13] proposed a visual saliency evaluation method of multimedia human-computer interaction interface based on human vision. The adaptive Gaussian filter is used to filter the human-computer interaction interface. The gradient direction of the interface image is converted into the derivative of the horizontal and vertical directions through the Guassian function to determine the size of the interface gradient direction, and the corrected interactive interface image is obtained. According to different co-occurrence concepts of interface image visual saliency, the influence index of human visual saliency is quantified, and the spatial position function of interactive interface is obtained Set the number of direction types and edge points in each image block of the interactive interface, and obtain the texture complexity function of a pixel in each sub image of the interface The weighting coefficient is given, the interface spatial position function and the texture complexity function of pixels are used as evaluation indexes for weighted output, and the evaluation results of visual saliency of interactive interface are given. The author in [14] analyzes the ergonomic criteria and the aesthetic evaluation criteria of interface layout, establishes four basic principles of interface layout: hierarchy, relevance, simplicity and comfort, and constructs a multi-objective optimization mathematical model of interface element layout according to the principles. Based on this model, an improved genetic algorithm is adopted, a multi-objective optimization method of interface element layout based on genetic algorithm is established. The basic principles of product operation interface layout design are given, and a multi-objective optimization method and process of product operation interface element layout based on genetic algorithm are proposed.

However, the methods mentioned above are not comprehensive enough to consider user experience, leading to the failure of user satisfaction to reach the ideal level. Therefore, a new human-computer interaction product interface of intelligent service system based on user experience is designed. Research and creatively put forward the human-computer interaction key points of the intelligent service robot with user experience as the centre, providing technical support and guarantee for the intelligent robot to develop in the direction of intelligence, interaction and personalization.

III. Design of Human-Computer Interaction Product Interface of Intelligent Service System based on User Experience

A. Hardware Platform Construction of Intelligent Service System based on User Experience

The introduction of the full name of the Hypertext Markup Language, or HTML, as a way of building and presenting Internet content, will transform the “Web” from a mere tool for presenting content into a full-fledged application platform that will become the standard for a new generation of the Internet. “HTML” 5 adds the ability to interact and present multimedia. Relatively speaking, the user experience has a more specialized level of functionality that allows more personalized design to be satisfied, unlike the H5.

The design of human-machine interface system of intelligent service system based on user experience is shown in Fig. 1.

The framework shown in Fig. 1 is mainly composed of 360PC terminal, gateway module and controller, and the above three parts are briefly introduced respectively. 360 (Program Counter) PC terminal is intended for operation of tablet computers. The gateway module is Bluetooth/RS-485, which is used to integrate Bluetooth and RS-485 chips, so as to achieve the goal of simultaneous Bluetooth wireless communication and RS-485 communication. The controller is

programmable and used in PLC industry. Components 1 and 2 are mainly used to realize information exchange under Bluetooth wireless communication. At the same time, the module and the controller achieve bi-directional data communication through Modbus (Remote Terminal Units) RTU, mainly by shielding the communication interface of the module on the controller. Module and RS-485 signal bidirectional conversion, in order to achieve 360PC and (Programmable logic Controller) PLC information exchange, the need for the data link between the two to be set up.

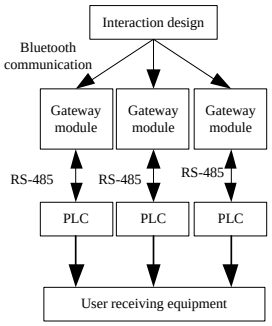

Fig. 1. System platform framework

1) User Experience PC Side:

The UX PC side, also known as epub360, is a very useful tool for H5 interaction design, and is used on Windows platforms, where designers can design professional-level H5 works online without any programming required. But the epub360 idea is the request specialized level function, it may better achieve the designer to the specialized design request.

a) Professional Animation Control. Epub360 is an H5 design tool, is the only SVG path and deformation animation, and control fine sequence frame animation design tools, it can not only relational control, but also a true sense of the control of the interactive animation, is professional.

b) Professional Interactive settings. It combines dozens of Epub360 provided by the trigger control, can be triggered by gestures, can also shake, related control, personalized interaction design, and can be perfect to meet the designer's needs.

c) Professional Social application. Our country is the first to apply WeChat's JsSDK advanced interface, which can complete the functions of personality nickname, avatar picture, friend circle photo, small video, and easily achieve the H5 design of social interaction class such as friend circle comment, click like.

d) Professional Data application. Some advanced data components, such as parameter variables, database, etc., can complete the H5 design of light game, such as small test, puzzle game, etc., and WebApp level professional application can also realize the visual design in the near future.

i) Top toolbar: Add basic and advanced components for the middle section; publish and manipulate the general preview on the left; and operate shortcuts such as save on the right.

ii) List of pages: Overview of the entire page; Add or remove pages; adjust the order of the page; manage the page group.

iii) Canvas: The main design areas are the safety zone inner frame and the bleeding zone outer frame, which are 640 x 960 px and 740 x 1136 px, respectively.

iv) Mobile phone adaptation: The canvas area is specially designed for mobile phone adaptation and consists mainly of an inner and outer frame. Area A is 640 x 960, visible on any phone, and area B is 740 x 1136, and its primary function is to ensure that no white parts are visible on the phone screen.

2) Bluetooth/RS-485 Gateway Module

The role of the module is to carry out Bluetooth and RS-485 two-way signal conversion to achieve the user experience between the PC and PLC can communicate with each other. Gateway module is mainly used for Bluetooth 4.0 and user experience PC in the wireless band, the frequency of 2.4 GHz, and then realizes the operation of Bluetooth 4.0 protocol; Modbus RTU protocol is required through the RS-485 interface to connect with the PLC, the former is wired connection. This module carries on the simultaneous communication between the user experience PC and PLC. The module interprets the data packet sent by the receiving 360 PC terminal, interprets it as the Bluetooth 4.0 protocol, obtains the required and effective data, and then carries out the control instruction or data conversion. If it is necessary for the user to experience the instruction that is to be sent by the PC terminal, it needs to convert it into the Modb protocol, and then transmit it to the PLC, so that the PLC can effectively identify the above instruction. At the same time, the module needs to read, analyze and convert the data sent by PLC and the data collected by PLC according to Modbus RTU protocol, and send the converted data to 360 PC terminal.

B. User Experience

1) Layout Design based on User Sensory Experience

In the process of layout design, we should fully consider the visual flow of the user, follow the left to right and top to bottom order, based on this to highlight the content, so as to attract the user's attention. First, the main menu is set at the top, the left side of the bottom is a secondary menu, the right side is a column link, the middle is the main recommended content, this layout is clearer, but also very convenient to operate, with the advantages and characteristics of symmetrical point of view, so this layout is currently widely used [15-17]. For example, Jing Dong Mall is the way to use screen segmentation for typesetting, to achieve a flexible combination of content, the display of pictures and text to facilitate. At the same time, KnowNet, douban and other websites are also used in this format. Next is the grid multi-column page layout method, this can present more content at the same time in the layout, not only the form is more beautiful, reading is also very convenient, has the very strong maneuverability, quite suits in the online shopping platform foundation demonstration page.

2) Color Design based on the User's Sensory Experience

In the interface design of Internet products, the reasonable combination of colors can give users a very good impression, so as to attract more users to use. In general, the color design of an interface based on user experience needs to consider the following contents: First, the color design needs to have sufficient pertinence, understand the groups that the Internet products face, and understand the habits and emotions of the groups, so as to identify the colors suitable for the products and user experience. For example, if KnowNet is primarily for the sharing of knowledge and experience, then the blue color representing rationality will be used as the primary color of the interface. Secondly, we should have enough comfort in color design, according to the physiology and engineering of human body, according to the physiological characteristics of human vision to choose the color, to reduce fatigue, and improve the comfort of the product.

3) Font Design based on the User's Sensory Experience

In the interface design of Internet products, font plays a key role in information transmission and content description. Whether the design is reasonable or not directly determines the user's reading experience. The font design based on the user experience needs to start from the following aspects: First, for the selection of font, the fonts commonly used in the interface of Internet products include bold type, Song type, round type and calligraphy type. In the selection of font, it is necessary to take into account the user's usual reading habits, but also to combine certain aesthetic habits. In order to make it more convenient for users to find, some content with larger headings will choose bold type, and the remaining text will generally choose bold type or Song type. For example, the major domestic news portal is the application of bold, so that people click and browse. Secondly, the text layout, generally speaking, the interface design of Internet products will involve the font, font size and text color, and so on. It requires designers to make reasonable arrangement of the position of various words, so that they can find the required content more quickly. For example, the use of visual physiology to arrange content in order from high to low purity colors make the user attracted to the color text. Colors can also be used to classify and facilitate user operations [18]. In addition, we can also use word spacing, line spacing and other paragraph settings to highlight the content, so as to greatly simplify the user reading process, shorten the reading time.

C. Speech Recognition based on ARM Processor

Nowadays, there are many kinds of embedded processors, such as MCU, ARM, embedded X86 and so on. The processor is the center of system operation and control, and it tends to adopt RISC instruction set Harvard architecture. ARM (Advanced RISC Machines) is an embedded microprocessor that is also the company's name. In November 1990 ARM was founded in Cambridge, UK. Unlike other semiconductor companies, ARM is an intellectual property (IP) provider, working on intellectual property designs for 16/32-bit RISC microprocessors (reduced instruction set computer, RISC). It does not produce chips by itself, but rather manufactures distinctive chips from partners through the transfer of design proposals. Embedded in full swing today, ARM company has accounted for 75% of the market share. Its microprocessors and technology have been used in all walks of life, almost all kinds of electronic products microprocessors use ARM technology, such as image, consumer entertainment, automobile, security, industrial control, wireless, and mass storage market. In 2001, almost monopolized the global RISC chip market has become the field of RISC chip standards. ARM's success, on the one hand thanks to its unique mode of operation, on the other hand, an important aspect is its own excellent performance. ARM processor has the following characteristics:

1) Low power consumption, small size, low cost, high performance.

a) Support for ARM (32-bit)/Thumb (16-bit) dual instruction sets, with good compatibility with 8-bit/16-bit devices.

2) Using a large number of registers, the instructions are executed faster.

3) A variety of addressing methods, that is flexible and efficient.

4) Fixed instruction length.

Because this paper is based on embedded ARM system intelligent service system human-computer interaction interface design, not a single application system customization, so here is a general pattern design. As a voice interface of service robot, it is usually used by ordinary users, the language is rich and diverse, and the same meaning may have different ways of expression. Moreover, dynamic keyword importing is used to enlarge the recognition range, which is more helpful to set up multiple expressions and make speech recognition more natural.

Fig. 2 is a design flow chart of a common pattern of human-computer interaction in intelligent service system. Both the speech recognition module and the speech synthesis module are encapsulated as an interface (API) that can be invoked by other applications for voice interaction, and the application performs actions based on the return structure of the speech module (i.e., the recognition results).

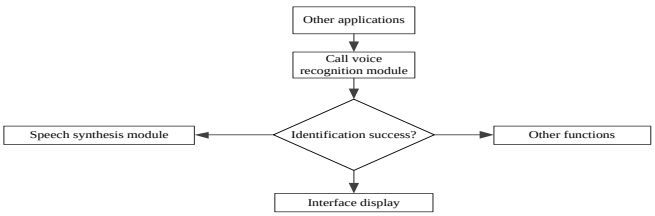

Fig. 2. Flow chart of voice interaction

D. Gesture Recognition based on User Experience

Hand gesture recognition is the basis of human-computer interaction in intelligent service system, which enhances the user experience to extract the features of collected data and complete the recognition according to the features to realize the human-computer interaction. Gesture acceleration features usually include frequency-domain features, time-domain features and other domain features [19-22]. The frequency domain features include the frequency domain entropy, FFT coefficient and other features extracted by using wavelet or Fourier transform; the time domain features include signal

amplitude area, statistical maximum value, activity window length, mean value, axis correlation coefficient and standard deviation; the other domain features include the features extracted by using LDA or PCA, etc.

There are $s \times k$ pixels in each gesture motion image, and the values of all pixels are determined by the following formula:

$$\begin{cases} 0 & \text{Point does not pass through the data waveform curve} \\ \sum_{i \in [1,3]} 2^i \times 16 & \text{Point does not pass through the data waveform curve} \end{cases} \tag{1}$$

Where, i represents the number of waveform curves passed by the pixel position. The gesture image is obtained according to the gesture acceleration action as a column in matrix $V_{n \times m}$:

$$\begin{bmatrix} x_{1,1} & x_{1,2} & \text{L} & x_{1,k} \\ x_{2,1} & x_{2,2} & \text{L} & x_{2,k} \\ \text{L} & \text{L} & \text{L} & \text{L} \\ x_{s,1} & x_{s,2} & \text{L} & x_{s,k} \end{bmatrix} \rightarrow \begin{bmatrix} x_{1,1} \text{L} & x_{s,1} x_{1,2} \text{L} & x_{s,2} \text{L} & x_{1,k} \text{L} & x_{1,k} \end{bmatrix}^T \tag{2}$$

Transform the data existing in the gesture motion training set to obtain the gesture motion matrix $V_{n \times m}$.

Nonnegative matrix decomposition, which belongs to multivariate data analysis method, uses the product of two low rank nonnegative matrices to replace a nonnegative matrix, and extracts gesture features through nonnegative matrix decomposition method.

The nonnegative matrix algorithm is described by the following formula:

$$V_{n \times m} \approx W_{n \times r} H_{r \times m} \tag{3}$$

In the formula, H represents the weight matrix, W represents the base matrix, V represents the nonnegative matrix, and r represents the rank of the decomposition matrix.

The expression of the optimization objective function is as follows:

$$F = \sum_{i-1}^{n} \sum_{u=1}^{m} [V_{iu} \log(WH)_{iu} - (WH)_{iu}] \tag{4}$$

The iterative algorithm decomposes the base matrix W and the weight matrix H, and obtains the weight matrix $H_{r \times m}$ and the weight matrix $W_{n \times r}$ by decomposing the hand gesture action matrix $V_{n \times m}$.

Input the acquired weight matrix and base matrix into the following classifier to realize gesture recognition and complete human-computer interaction of the intelligent service system:

$$h_j(x) = \begin{cases} 1 & p_j g_j(x) < p_j \theta_j \\ 0 & others \end{cases} \tag{5}$$

In the expression, j represents the feature in the eigenvector; p_j represents the direction of the inequality; $g_j(x)$ represents the eigenvalue of the j rectangle in the sub window to be detected; θ_j represents the threshold of the classifier, the value is 2, $h_j(x)$ represents the classifier.

E. 3D Interactive Image Simulation of Interface based on Fused Texture

When Kinect is used to track and identify moving targets, the problem of target recognition needs to be solved first. However, because Kinect does not have recognition function, it needs to use color histogram for target recognition. At the same time, Kinect cannot directly track human bones. The bone data is acquired by denoising, segmentation and other related technologies on the basis of depth images. Among them, target identification and tracking mainly include virtual target identification and target personnel location tracking, and the specific operation steps are shown in Fig. 3.

In order to obtain better recognition results, the following methods based on image information are mainly used to analyze and research, using Kinect to shoot the color images in the study area, and accurately identify the virtual targets in the study area by color histogram matching results. Among them, color histogram is mainly used to describe the percentage of each color in the whole image. The calculation for color histogram matching is:

$$\begin{cases} d_{corre}(H_1, H_2) = \dfrac{\sum_i H_1(i) H_2(i)}{\sqrt{\sum_i H_1^2(i) H_1^2(i)}} \\ H_k^{'}(i) = H_k(i) - \dfrac{1}{N}\left(\sum_j H_k(j) \right) \end{cases} \tag{6}$$

In the above formula, $d_{corre}(H_1, H_2)$ represents the matching result; H stands for component; H_1 and H_2 stand for histogram functions; $H_k(i)$ and $H_k(j)$ represent the matching degree of the i and j histogram respectively. $H_k^{'}(i)$ stands for perfect match value; N represents the number of equal components of H.

The corresponding calculation formula of chi-square matching and intersection matching is as follows:

$$\begin{cases} d_{chis}(H_1, H_2) = \sum_i \dfrac{(H_1(i) - H_2(i))^2}{H_1(i) + H_2(i)} \\ d_{intersection} = \min \sum_i H_1(i) H_2(i) \end{cases} \tag{7}$$

Through the formulas (6) and (7), it can be seen that the larger the value of the calculation result of the correlation and

intersection matching algorithm is, the higher the histogram matching degree is, and the perfect matching value is 1; the smaller the value of the calculation result of the chi-square matching algorithm is, the higher the histogram matching degree is, and the value of the perfect matching is 0.

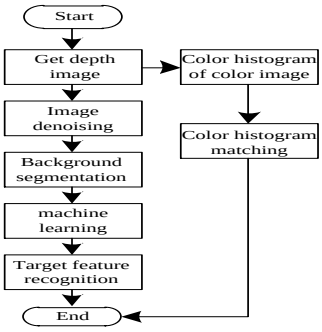

Fig. 3. Flow chart of target identification and tracking

In order to eliminate all the noise in the image, the median filtering method is used to denoise. Among them, the median filter formula is:

$$f(x,y) = \underset{(x,y)\in S_{xy}}{median}\{g(x,y)\} \tag{8}$$

In the above expression, $f(x,y)$ represents the filtered output value, S_{xy} the number of all pixels in the image, and $g(x,y)$ the gray value of the pixel.

To draw a structure image of a virtual object, it is necessary to first separate the moving object from the depth image. The following methods are mainly used for object detection and background segmentation based on user index numbers. The specific operation process is shown in Fig. 4:

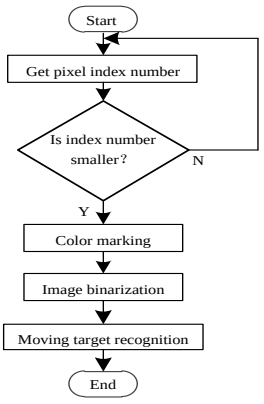

Fig. 4. Operational flow of moving target detection and background segmentation

1) Prioritize the use of Kinect to obtain depth images of each research scenario.

2) Extracting the depth value and user index number of pixels from the depth image.

3) An index number obtained through step (2) marks the moving object.

4) Binary processing shall be used to collect images, and the pixel values in the study area shall be set to 255, and the pixel values of the remaining nodes shall be set to 0, so as to separate the target from the background.

In the early stage of motion recognition, it is necessary to define the starting point and ending point of virtual target motion. Among them, the starting point and the ending point of the moving target are mainly judged by the radius of the palm ball. The radius of the palm ball can be obtained by (Software Development Kit) SDK, and the threshold value is 30mm. When the radius of the center of the hand is higher than the threshold, it indicates that the palm of the target is open, and vice versa, it is closed. If the radius of the palm ball gradually increases from less than 30mm to 30mm, the starting point is indicated, and recognition stops when Leap Motion again captures a threshold of less than 30mm.

The realization of moving target recognition and tracking localization is to recognize each structure accurately in the existing target contour image, and to determine the specific coordinates of the nodes. The above operation process is mainly completed through machine learning technology. Firstly, the sample of decision tree is trained, and then the classification model based on decision tree is obtained. Secondly, the feature value of depth image is classified and evaluated by machine learning. In order to eliminate the influence of external and internal factors on the data noise, the Kalman filtering algorithm is used to eliminate the data's optimal value and measured value iteratively. The Kalman filtering algorithm performs filtering operations on a time-dependent dynamic system, so a discrete control system needs to be added to the algorithm, and the formula is as follows (9):

$$x_{k+1} = F_{k+1}x_k + B_{k+1}u_{k+1} \tag{9}$$

In the above expression, x_{k+1} represents the running state of the system at $k+1$, x_k represents the running state of the system at k, F_{k+1} represents the transformation matrix acting on x_k, B_{k+1} represents the control parameters of the system, the value is 1.5, and u_{k+1} represents the control matrix.

At time $k+1$, the measurements in the system need to meet the following conditions:

$$Z_{k+1} = H_{k+1}x_{k+1} + v_{k+1} \tag{10}$$

In the above formula, H_{k+1} represents the measurement matrix projected into the measurement space by the state at moment x_{k+1}; v_{k+1} stands for measurement noise.

The state at moment $k+1$ can be deduced by formula (10), and the specific calculation formula is as follows:

In the above expression, $\Re(k+1|k)$ represents the optimal value of the system at time $k+1$, and $x(k|k)$ represents the optimal value of the system at time k.

$$\Re(k+1|k)=\frac{F_{k+1}\cdot\Re(k|k)}{u(k+1)} \tag{11}$$

In the phase of Kalman filter prediction, the LEAP SDK is used to obtain the position and pose information of the next period of time. Given the moment, the central coordinate of the moving object is O, and the following formulae can be obtained in combination with the law of motion:

$$\begin{cases}\aleph=v_k t+\dfrac{a_k t^2}{2}\\ p_{k+1}=\Re(k|k)\cdot\aleph\end{cases} \tag{12}$$

In the above formula, v_k represents the running speed of the moving target; a_k represents acceleration; p_{k+1} represents the coordinate position at time t, and $\aleph$ represents the motion change law of the virtual target.

Based on the above analysis, the moving target structure information is extracted through the depth image, and all the extracted structure information is fused to track and identify the human-computer interaction target of the intelligent service system.

IV. Analysis of Experimental Results

In order to verify the overall effectiveness of the design method of the human-computer interaction interface of the intelligent service system, it is necessary to test the design method of the human-computer interaction interface of the intelligent service system under the enhanced user experience. The experimental platform for this test is Division Mockup, and the probability of data received by the host computer is used as a test indicator to test the design method of the human-computer interaction interface, the design method of the human-computer interaction interface based on the evaluation of visual significance and the multi-objective optimization design method of the layout of product operation interface elements. The higher the probability of data received by the host computer is, the better the human-computer interaction effect is. The test results are shown in Fig. 5.

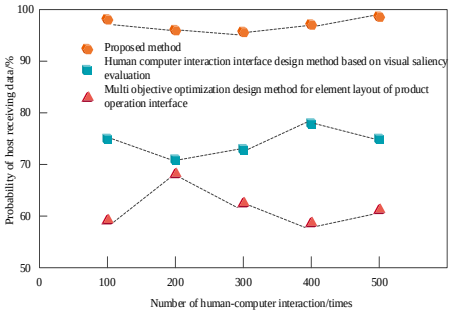

Fig. 5. Test result of probability of receiving data by host

By analyzing the data in Fig. 5, it can be seen that in the process of human-computer interaction, the host receiving data probability of the proposed method is more than 90%, and most of the relevant data can be received to realize human-computer interaction, while the host receiving probability of the human-computer interface design method based on visual significance evaluation and the multi-objective optimization design method of product operation interface element layout fluctuate around 80% and 70% respectively, The data received by the above two methods is not enough to effectively realize human-computer interaction. Comparing the test results of the above methods, it can be seen that the host receiving data probability of the proposed method in the process of human-computer interaction is high, because the method constructs a data transmission model based on game theory, collects relevant data and information in the process of human-computer interaction, and improves the host receiving data probability.

The proposed method, the human-computer interaction interface design method based on visual saliency evaluation and the multi-objective optimization design method of product operation interface element layout are used to recognize human gestures. The feature recognition rate and recognition accuracy are used as test indicators. The test results are shown in Fig. 6 and Fig. 7, respectively.

Through analyzing the data in Fig. 6 and 7, we can see that the recognition rate and accuracy of the proposed method are high in many experiments, which shows that the proposed method can recognize human gestures accurately and comprehensively. When the method of human gesture recognition based on visual saliency assessment is used, the feature recognition rate and feature recognition accuracy are both low, which indicates that the method of human gesture recognition based on visual saliency assessment is not effective and comprehensive.

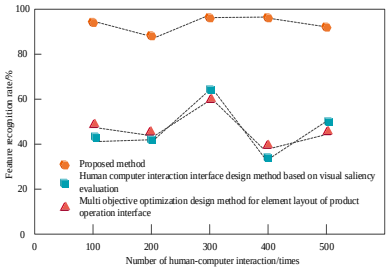

Fig. 6. Test results of feature recognition rate

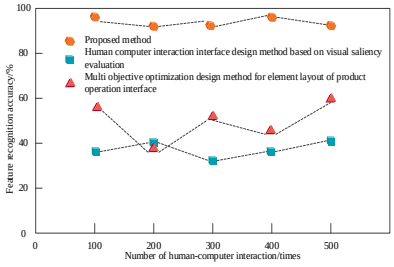

Fig. 7. Test results of feature recognition accuracy

Compared with the test results of the proposed method, the human-computer interaction design method based on visual significance evaluation and the multi-objective optimization design method for product operation interface layout, the proposed method has the best performance in the human-

computer interaction, because the proposed method uses the data transmission model to collect the relevant information of the human-computer interaction, adopts the non-negative matrix decomposition method to extract the features of the gesture information, and inputs the features into the classifier to accurately realize the recognition of the gesture, thus improving the feature recognition rate and the feature recognition accuracy.

In the process of human-computer interaction, user satisfaction is the focus of attention. The overall performance of the method is tested by using user satisfaction as a test index. The test results are shown in Fig. 8.

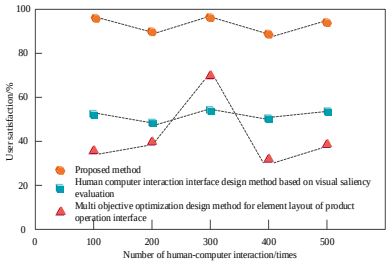

Fig. 8. User satisfaction test results

Through the analysis of the data in Fig. 8, it can be seen that the user's satisfaction with the proposed method is more than 80% in many iterations, and the user's satisfaction with the human-computer interaction design method based on visual significance evaluation and the multi-objective optimization design method for element layout of product operation interface fluctuate around 40% and 60%, respectively. Through the above analysis, the human-computer interaction effect of the proposed method is better, and the user's satisfaction is the highest, because the proposed method constructs the data transmission model through game theory, and can accurately collect the user's static information and dynamic information in the process of human-computer interaction, and feed the fused dynamic information and static information back to the human-computer interaction system. The human-computer interaction system responds to the acquired data, completes the human-computer interaction process of the intelligent service system, meets the user's needs, and thus improves the user's satisfaction.

Fig. 9(a) and Fig. 9(b) refer to the performance of different human-computer interaction methods in indoor and outdoor environments respectively. It can be seen from the figure that the error of the three human-computer interface optimization methods decreases with the increase of the data size. When the data size reaches about 25, it tends to be stable, while the accuracy shows the opposite change rule. In the indoor environment, the convergence errors of the proposed method, the human-computer interaction interface design method based on visual significance evaluation, and the multi-objective optimization design method of product operation interface element layout are 0.156, 0.278, and 0.415, respectively. The accuracy was 97.58%, 95.21% and 92.24%, respectively. In outdoor environment, the convergence errors of the three methods are 0.217, 0.489 and 0.658, respectively. The accuracy was 96.12%, 93.21% and 91.25%, respectively. Therefore, the proposed human-computer interaction method has ideal performance in both indoor and outdoor environments.

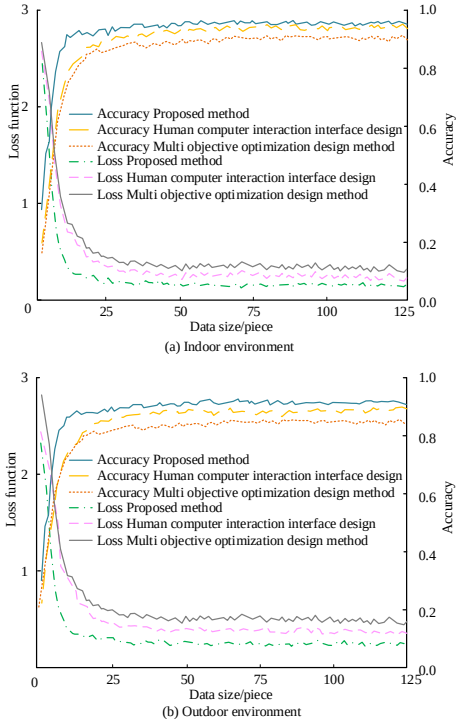

Fig. 9. Performance of different human-computer interaction methods in indoor and outdoor environments

V. Discussion and Conclusion

In order to solve the problems of the current intelligent service platform, such as the low probability of receiving data, the low recognition rate and the low recognition accuracy, a new intelligent service system based on user experience is designed. This introduces the full name of the Hypertext Markup Language and design user experience PC and Bluetooth/RS-485 gateway module. Speech recognition module based on ARM processor is designed to realize human-computer interaction of intelligent service system.

Compared with the human-computer interaction interface design method based on visual significance evaluation and the multi-objective optimization design method of product operation interface element layout, the proposed optimization design method of human interaction interface has higher action recognition accuracy and satisfaction. A large part of tasks completed by computers are completed by human-computer cooperation, which drives the emergence of human-computer interaction systems. However, the traditional human-computer interaction relying on external devices has been difficult to meet the needs of today's society. This has promoted gesture recognition based on machine vision to a certain extent. It is a novel human-computer interaction technology, which has received widespread attention from scholars at home and abroad. Kinect sensor technology is used to realize the tracking and recognition of moving objects. The device includes three functions, namely sensor data flow, bone tracking and advanced audio function. Sensor data stream

mainly refers to accessing low-level streams from depth, color camera sensors and microphone arrays; Bone tracking can mainly track the images of the application driven by the postures of 1-2 people in the field of vision; Advanced audio function, which can process some complex audio sound sources, such as echo, noise and beam forming, and can also integrate with the audio recognition library of Windows to collect infrared data and generate unit images. It can promote Kinect bone tracking to be more robust to users' dynamic gestures in different environments. In complex environments, Kinect uses a separation strategy for human segmentation. Its advantage is that it can build a corresponding segmentation mask for each tracked object and retain the human image. This makes it only necessary to transmit the human body image in the subsequent data stream processing, so as to reduce the amount of calculation of body sensing data.

The advantage of Kalman filter is not that its estimation deviation is small, but that it skillfully integrates observation data and estimation data, conducts closed-loop management of errors, and limits the errors to a certain range. Imagine that if there is no information fusion between the two, and only estimation data, the error will accumulate more and more with time, and the uncertainty will increase with time. For the control of landing on the moon so far and for a long time, It will lead to uncontrollable error when arriving near the moon, and the introduction of observation data will correct the estimated data to prevent the error of estimated data from being too large to be spectral. The estimation data fusion of observation data is equivalent to closed-loop feedback management of the former's estimation. It is undeniable that the Kalman filter still has errors, and its advantage is that it can still maintain stable errors when the time is long, because it relies on an observation data in the information source when making decisions. If you listen to one side, you will be dark; if you listen to both sides, you will be clear. As for whether the error is lower than that of the individual estimated data or the individual observed data, further discussion is needed. At the same time, the color histogram used in the research can directly describe the information features of the target through the analysis of local gradient or edge direction density, greatly reducing the impact of local shape features, not only avoiding the overlap of the original feature vectors to a certain extent during the image formation process, but also preventing the impact of individual movement on the detection results, thus ensuring the accuracy of the collected image. It can be seen from the above analysis that the proposed method has higher probability of receiving data, higher recognition rate and accuracy of gesture features, and higher user satisfaction. The above experimental results show that the proposed method has better performance. However, there are still shortcomings in the research. In the process of data acquisition and subsequent action mapping, the time complexity of the algorithm leads to the jumping phenomenon in the action simulation process. Although the optimized Kalman filter eliminates the discontinuity of the action to a certain extent, when the speed becomes faster, the phenomenon of jamming will still occur.

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REFERENCES

[1] X. Li, J. Tu, H. Zhang, “Game User Experience Measurement Method Based on CV,” Packaging Engineering, vol. 40(8), pp. 136-140, 2019.

[2] U. Tandon, R. Kiran, A. N. Sah, “Customer satisfaction as mediator between website service quality and repurchase intention: An emerging economy case,” Operations Research, vol. 59(1-2), pp. 155-156, 2019.

[3] Z. Guo, D. Zhou, Q. Zhou, et al., “A hybrid method for evaluation of maintainability towards a design process using virtual reality,” Computers & Industrial Engineering, vol. 140(Feb.), pp. 106227.1-106227.14, 2020.

[4] T. Vuletic, “Systematic literature review of hand gestures used in human computer interaction interfaces,” International Journal of Human-Computer Studies, 2019.

[5] S. Ahmed, K. D. Kallu, S. Ahmed, et al., “Hand gestures recognition using radar sensors for human-computer-interaction: A Review,” Remote Sensing, vol. 13(3), pp. 527, 2021.

[6] D. Belanche, L. V. Casaló, C. Flavián, et al, “Service robot implementation: a theoretical framework and research agenda,” The Service Industries Journal, vol. 40(3-4), pp. 203-225, 2020.

[7] J. Hwang, J. Kim, H. Choi, “A review of magnetic actuation systems and magnetically actuated guidewire-and catheter-based microrobots for vascular interventions,” Intelligent Service Robotics, vol. 13(1), pp. 1-14, 2020.

[8] E. S. Cross, R. Ramsey, “Mind meets machine: towards a cognitive science of human–machine interactions,” Trends in Cognitive Sciences, vol. 25(3), pp. 200-212, 2021.

[9] M. Klumpp, H. Zijm, “Logistics innovation and social sustainability: How to prevent an artificial divide in human–computer interaction,” Journal of Business Logistics, 2019, 40(3): 265-278.

[10] B. A. Erol, A. Majumdar, P. Benavidez, et al, “Toward artificial emotional intelligence for cooperative social human–machine interaction,”. IEEE Transactions on Computational Social Systems, vol. 7(1), pp. 234-246, 2019.

[11] R. Belk, “Ethical issues in service robotics and artificial intelligence,” The Service Industries Journal, vol.41(13-14), pp. 860-876, 2021.

[12] S. Diederich, A. B. Brendel, S. Morana, et al, “On the design of and interaction with conversational agents: An organizing and assessing review of human-computer interaction research,” Journal of the Association for Information Systems, vol. 23(1), pp. 96-138, 2022.

[13] S. Wang. “Simulation of visual saliency evaluation method for multimedia human-computer interaction interface,” Computer Simulation, vol. 37(3), pp. 161-164, 2020.

[14] H. Kang, S. Yang, S. Deng, et al., “Multi-objective optimization design of product operation interface element layout,” Packaging Engineering, vol. 41(8), pp. 149-153,172, 2020.

[15] D Hazer-Rau, S Meudt, A Daucher, et al., “The uulmMAC database—A multimodal affective corpus for affective computing in human-computer interaction,” Sensors, vol. 20(8), pp. 2308-2319, 2020.

[16] Y. Li, F. Zou, W. Xie, “Customer satisfaction measurement combining with preference and unbalanced linguistic evaluation,” Computer Integrated Manufacturing Systems, vol. 25(1), pp. 165-172, 2019.

[17] T. Guzsvinecz, E. Orbán-Mihálykó,·C. Sik-Lányi, et al., "Investigation of spatial ability test completion times in virtual reality using a desktop display and the Gear VR," Virtual Reality, vol. 2021(3).

[18] E. Brivio, S. Serino, E. N. Cousa, et al., "Virtual reality and 360° panorama technology: a media comparison to study changes in sense of presence, anxiety, and positive emotions," Virtual Reality, vol. 2020(3), pp. 1154-1169.

[19] F. G. Pratticò, F. Lamberti, "Towards the adoption of virtual reality training systems for the self-tuition of industrial robot operators: A case study at KUKA," Computers in Industry, vol. 129(5), pp. 103446, 2021.

[20] E. Petrick, "A historiography of human-computer interaction," IEEE Annals of the History of Computing, vol. 78(9), pp. 158-69, 2020,

[21] Y. Zhao, P Ruan, X Liu, X Shan, "Study on user satisfaction evaluation based on online comment," Management Review, vol. 32(3), pp. 179-189, 2020.

[22] M. Klumpp, M. Hesenius, O. Meyer, et al., "Production logistics and human-computer interaction-state-of-the-art, challenges and requirements for the future," The International Journal of Advanced Manufacturing Technology, vol. 2019(9), pp. 1154-1168.