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Research Article

Modeling of Smart Watch and System Construction Method for the Elderly Based on Big Data

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Under the development trend of artificial intelligence and smart city, efforts should be made to improve the connection between the elderly and social development and realize the application of intelligence to travel for the elderly so that the elderly can also enjoy an intelligent and convenient life. With the deepening of China's aging population, a systematic re-innovative design of smart watches was carried out based on the physiological needs of the elderly living alone in cities. In order to solve the problem that intelligent products for the elderly on the market cannot meet the special needs of the elderly and improve the happiness of the elderly, in this paper, the design method of interaction design is used to analyze the basic needs of the elderly living alone in the city for new technologies. Then, big data, artificial intelligence, sophisticated electronic devices, and GPs-based positioning technologies are used to provide research ideas for the design of smart watches for the elderly living alone in the city. The intelligence can watch for the elderly's daily movement and posture and also rate and other physiological signals for real-time monitoring, assessment of elderly's physical health. The smart watches can realize the automatic alarm function of intelligence accidental falls, and they can also work with remote control and have a management platform, which has important social significance.

1. Introduction

In recent years, with the rapid development of global social productivity, China has been gradually falling into a crisis of the elderly, and the aging of China's population is becoming increasingly serious. The elderly are gradually weakened both physically and psychologically and gradually show worrying social functions, such as forgetfulness, inner loneliness, disease, lethargy, slow reaction, and physical loss, especially the elderly living alone in the city. Nowadays, most of these deficiencies can be made up by high-tech intelligent facilities, which are of great benefit in improving the quality of life of the elderly living alone in cities and alleviating the psychological distress and loss caused by aging. A good smart watch should also reduce the physical and mental burden on the elderly and promote physical and mental health, as shown in Figure 1. In this paper, through the method of interaction design, the technical machine is transformed into humanized intelligent products to meet the emotional needs and goal orientation of the elderly [1–3]. The application research of smart wearable mainly focuses on the status quo and existing problems of functional status assessment of the elderly.

In today's society, people's clothing, food, housing, and transportation are linked with intelligence, and artificial intelligence has quietly entered our daily life. The application of driverless cars, face recognition, fingerprint recognition, and other technologies is a fruitful achievement of artificial intelligence. The young are well integrated into all aspects of intelligent society, while the old are completely or semi-disconnected. There is a gap between the aging population and the rapid development of high technology, and the development of artificial intelligence should make the convenience of technology available to all people. For the aging population, a complex design can be simplified and intelligence can be integrated into their lives, which is also

Figure 1: Smart watch.

very consistent with the theme of a smart city [4–6]. The specific application and research progress of wearable sensors in the assessment of the functional status of the elderly are summarized, and it is believed that wearable devices provide the possibility for the realization of continuous monitoring of the physical activity of the elderly.

The five senses of touch, taste, hearing, vision, and smell are the most obvious manifestations for the elderly [7]. Elderly people's eyesight is weakened, their sensitivity to light is reduced, and their discrimination to color is reduced, which greatly hinders their use of intelligent products. For products designed for the elderly, fonts and ICONS should be enlarged as much as possible, and contrast colors should be adopted to enhance the recognition of ICONS by the elderly and enhance the readability of intelligent device information. In terms of hearing, the hearing range of the elderly aged 65 is reduced by about 50% compared with that of the 30-year-old group, resulting in the phenomenon of the back of hearing. According to the hearing characteristics of the elderly, the voice with a clear and appropriate volume should be selected, and noise should also be avoided to improve the comfort of the elderly when using the product [8–10]. At present, the speech recognition technology is not perfect in the emotion recognition of the user's speech, and the speech recognition is too mechanized and formatted, so it cannot recognize the user's speech flexibly. Smart products for the elderly use fewer voice functions to avoid frustration in their use. Elderly people suffer from decreased physical function, memory, reaction speed, and cognitive ability to learn new things. It is difficult to learn and master new knowledge, and it takes a long time to master new functions when using devices. Based on these features, products designed for the elderly are as simple and easy to learn as possible. Scientific interaction is used to replace monotonous instructions. ICONS and smart watch interfaces design is based on the elderly's understanding of objective things, which can help them master operation methods in a short time and memorize new things. Decline in motor function of the elderly and lower bone tenacity and flexibility is reduced; the product should choose comfortable breathable materials for the elderly to comfort, increase the area or areas of intelligent equipment buttons, to avoid the old error in operation, multi-azimuth considering the old special requirements, design reasonable smart watches, and meet the special needs of elderly [11]. It can be used to assess the frailty of the elderly, to assess their mobility, to assess the risk and behavior of falling, to assess the activities of daily living, to assess their mobility in specific diseases, etc.

Common smart wearable products for the elderly in the market often appear in convenient forms such as wristbands, watches, or necklaces. From the perspective of visual design, the font and icon size in the product and interface are too large, which is intended to be different from the mainstream products to meet the needs of the elderly [12–14]. From the perspective of functional design, most wearable products take positioning and emergency alarm as the main functions. For example, an anti-loss smart necklace can be worn on the neck or put in the pocket. When the elderly encounter an emergency, they can press the button on the device to call for help with one key. The distress signal will be transmitted to the family's mobile phone APP through the network to help relatives find the location of the elderly for help in time. Meanwhile, it can also monitor the lives and activities of the elderly in real time, which is suitable for the elderly with dementia. From the perspective of interaction design, in addition to the basic technical functions of watches, many elderly smart watches will add reminders, positioning, heart rate, mobile phone communication functions, and at most some auxiliary application functions. Normally, senior smart watches are a shrunk-down version of a phone because of the complexity of their interactions [15, 16]. Common smart wearable products for the elderly in the market often appear in convenient forms such as wristbands, watches, or necklaces.

Due to the portability of smart watches, the use of smart watches by elderly users while moving is a big application scenario. When the elderly users are in running or other sports, the screen of smart watches will shake greatly. In addition, the small screen limits the presentation of information, and users need to focus on the running environment and the screen at the same time, resulting in great difficulty in interaction [17–19]. Older users cannot see and understand what's on the screen, which greatly reduces the user experience of smart watches in sports applications [20, 21].

The important questions of how people interact with wearable devices in a moving environment and how that interaction affects people's moving behavior remain unresolved. On the one hand, existing studies mainly focus on the motion adaptability of smart phones and usually only use walking speed as an indicator to measure the user's motion state [22, 23]. On the other hand, in-depth research on motion posture is still in the laboratory stage, with the high cost and poor expansiveness of equipment. The research on gait is seldom combined with other behaviors (such as the interaction with intelligent devices during walking) [24, 25]. This paper will go deep into the research in this field, make up for the gaps in the research, and put forward the design criteria for improving the interaction design of smart watches and their motion adaptability. Firstly, the modeling of a smart watch for the elderly is proposed in Section 2.

Then, the system implementation will be further discussed in Section 3. Finally, in Section 4, the conclusion will be drawn.

2. A Smart Watch for the Elderly

Cardiovascular and cerebrovascular diseases are some of the most threatening diseases to human life and health in modern society. Daily monitoring of cardiac information has become an important source to ensure patients' lives and health safeties. Daily monitoring of heart rate information is of great significance for early detection of abnormal signs and timely treatment. Heart rate information is an important signal of human vital signs, so the monitoring of heart rate information can provide important reference data for cardiovascular and cerebrovascular diseases. In terms of visual design, fonts and icons in products and interfaces are too large. In order to distinguish itself from the mainstream products, it should meet the needs of the elderly.

At present, the heart rate detection methods on smart watches mainly include electric potential method and photoelectric method. The electric potential method is an electrode measurement method. The electrode measurement used on smart watches currently has two or three leads; that is, two or three electric shocks are required to read data, so the operation requires two or three fingers to touch, and the operation is complicated. In addition, being unable to actively read data is the biggest problem of electrode measurement, real-time monitoring and active upload of monitoring data cannot be realized, let alone remote monitoring. The principle of photoelectric heart rate detection is to measure the amount of light absorbed by red blood cells by photoelectric sensor. The interference error caused by ambient light source can be solved by amplifying circuit and filter. Photoelectric heart rate detection can be operated with one hand, without two or three electric shocks like electrode measurement. After the detection, the data can be automatically uploaded to the background system, and the data can also be read remotely. Therefore, it is more suitable for cloud big data services. Based on the above analysis, it is not difficult to see that photoelectric heart rate detection method is more suitable for real-time heart rate detection on smart watches at present. In addition, photoelectric method can also be widely used in other wearable devices for heart rate detection due to its simple operation and low cost. Smart wristbands and mobile phones designed by enterprises for the elderly have their main health monitoring function, in which the measurement results will be sent to their children's mobile phones.

Estimate heart rate based on length of fluctuation cycle. The value of heart rate can be calculated by the width of the trough, as shown in the following formula:

$$\mathrm{HR} = \frac{60 f_N}{\mathrm{median}\left(bb_\lambda\right)[n])}, \tag{1}$$

where f_N is the sampling rate and λ can be RED or IR.

Suppose $x[b]$ is a point on the smoothed PPG signal, and if the point is the lowest in the range W, which is medium, and half-width L, then it may be a trough. The formula is as follows:

$$X_\lambda[b] < \min\left(x_\lambda[b-l], \ldots x_\lambda[b-1], x_\lambda[b+1], \ldots x_\lambda[b+l]\right). \tag{2}$$

Through the above coarse sieve, screen out the possible troughs. To ensure the accuracy of troughs, further screening is needed. The main basis for trough selection after the second round is as follows: first, the two adjacent troughs are separated by a certain distance, not too close; second, the width and depth between two adjacent troughs do not change in a short time. Assume that the coordinates of the NTH trough are as follows:

$$\left(bx_\lambda[n], by_\lambda[n]\right). \tag{3}$$

The coordinates of the crest between $n-1$st trough and the NTH trough are

$$\left(px_\lambda[n], py_\lambda[n]\right). \tag{4}$$

Define the width and depth of the NTH trough as follows:

$$\begin{aligned} bb_\lambda[n] &= bx_\lambda[n] - bx_\lambda[n-1], \\ pb_\lambda[n] &= py_\lambda[n] - py_\lambda[n-1]. \end{aligned} \tag{5}$$

To eliminate the KTH trough, the KTH trough should satisfy the following formula:

$$\begin{aligned} &\left|Mbb_\lambda - \frac{Nbb_\lambda}{2}\right| + \left|Mpb_\lambda - \frac{pb_\lambda[k] + pb_\lambda[k+1]}{2}\right| \\ &> \left|Mbb_\lambda - Nbb_\lambda\right| + \left|Mpb_\lambda - Npb_\lambda\right|, \\ &pb_\lambda[k] < pb_\lambda[k+1], \\ &pb_\lambda[k+1] > 0.6Epb_\lambda. \end{aligned} \tag{6}$$

Therefore, after the elimination of the KTH trough, the width strain of the $k+1$ trough is the sum of the widths of the two troughs shown in the following formula:

$$Nbb_\lambda = bb_\lambda[k] + bb_\lambda[k+1]. \tag{7}$$

Because fall brings great harm to the elderly's body and mind, it is of great practical significance and social value to realize fall detection and real-time alarm for the elderly. First of all, the elderly fall information can be quickly transmitted to their children or medical institutions so that the elderly can receive timely treatment to avoid the irreparable consequences of falling. Second, the elderly can be more relieved to carry out outdoor activities freely and enhance their sense of security when living alone. Third, medical costs can be reduced, the burden on children can be reduced, and the social pressure brought on by the aging of the population can also be relieved. Based on the analysis, it is easy to find that the fall detection of the elderly may have two elements: the first is accurate, namely accurately identify daily activities and falling behaviors while the second is alarm. In order to enable the elderly to get timely assistance, after the fall, should immediately send an alarm with the fall and location information to inform their families or emergency center.

The fall detection method based on wearable devices is to collect human acceleration, angular velocity, and other parameters through the sensors in wearable devices and use these parameters to monitor human activities in real time. When a certain activity parameter of the human body such as acceleration and angular velocity changes greatly, a fall detection algorithm can be used to judge whether there is a fall. The fall detection method based on wearable equipment accuracy is more accurate, because wearable devices are easy to carry without being limited by the testing site, and do not involve the user's privacy, so the fall detection method based on wearable devices falls in the current detection method is the most suitable for the elderly fall detection method, and this method has gained more the favor of the researchers.

The acceleration and angular velocity signals collected by the sensors in a single direction on three axes are difficult to represent the overall motion (Figure 2 is the coordinate system). Therefore, their combined vectors, acceleration intensity vector SMVA and angular velocity intensity vector SVMW, are, respectively, defined as (8) and (9):

$$\mathrm{SMVA} = \sqrt{a_x^2 + a_y^2 + a_z^2}, \tag{8}$$

where a_x, a_y, and a_z are the acceleration values output by the acceleration sensor in the orthogonal directions of x, y, and z axes, respectively, and

$$\mathrm{SMVW} = \sqrt{w_x^2 + w_y^2 + w_z^2}, \tag{9}$$

where w_x, w_y, and w_z are the angular velocity values output by the gyroscope in the orthogonal directions of x, y, and z axes, respectively:

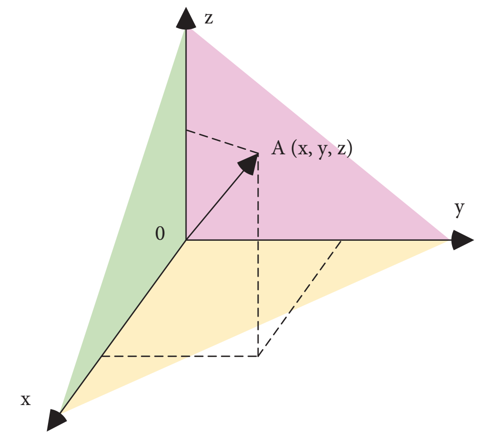

Figure 2: Hand degrees on the corresponding space straight angle.

3. System Implementation

Taking speed as a variable, the influence of movement speed on the use of intelligent devices is analyzed. However, the real situation is more detailed and specific. When the user moves in a certain movement state, his body shakes, and his visual and cognitive resources are scattered. Especially, the movement leads to the instability of the device screen, making the use of smart watches difficult. Therefore, this section will study the specific gait situation in detail and the influence of specific stages in stride length on the operation. In addition, previous studies mostly used preferred walking speed as the setting to control the exercise state, which can quantitatively measure the exercise state but is only applicable to the experimental environment on the treadmill. In the real environment or indoor obstacle environment, the user's walking speed is difficult to control. Therefore, psychological calibration will be adopted in this study to enable users to use smart watches in slow walking, normal walking, fast walking, and jogging. As for sensor signals, gait recognition based on spatial angle sensor data is seldom involved in previous studies. The reason for this is that studies typically use sensors attached to the waist or smart handheld devices carried in trouser pockets, which involve parts of the body that rarely measure changes in the angle of the leg and can only be analyzed using acceleration data. In addition, some studies have studied and measured the angle changes of all parts of the leg by measuring foot angle, ankle angle, knee angle, and crotch angle by placing multiple angle sensors on the leg. This method does reflect the gait stage better, but it is still at the laboratory level because it requires a lot of custom sensor equipment. It is still worth exploring to use the built-in angle sensor of ordinary wearable smart devices to measure gait.

the new smart wearable design scheme for the elderly aims to create a self-management mode dominated by the elderly users so as to better participate in the treatment of their own conditions through self-recording. The design concept includes three parts: user self-management, daily monitoring assistance, and personalized rehabilitation (prevention) plan. The evaluated amplitude is plotted in Figure 3, where it can be seen that the amplitude varies all the time. It should be noted that the amplitude is the evaluated value. All in all, the amplitude is around 0, which means its average value is near 0.

3.1. User Self-Management. Help users understand their pain characteristics, such as pain intensity, mode, trigger, and location, by self-recording pain. Essentially, for new and older users, acquiring the ability to do it yourself, to control their own health and treatment process, has an added incentive to treat chronic diseases. At the same time, physiological and physical activities are monitored and managed and finally presented in the form of reports, such as recent changes in blood pressure, so that they can keep track of their health status. They enjoy full control over the data until they choose to release it so that health data can be viewed by families and doctors not only to protect the personal privacy of the new elderly users but also to maintain the self-esteem of the new elderly.

3.2. Daily Monitoring Assistance. In the process of consultation, doctors manually input files into the computer according to the complaints of new and old users, such as pain degree, frequency, and other factors, and the information exchange between doctors and patients is only maintained in a short period of time during the consultation. On the one hand, through the establishment of personal

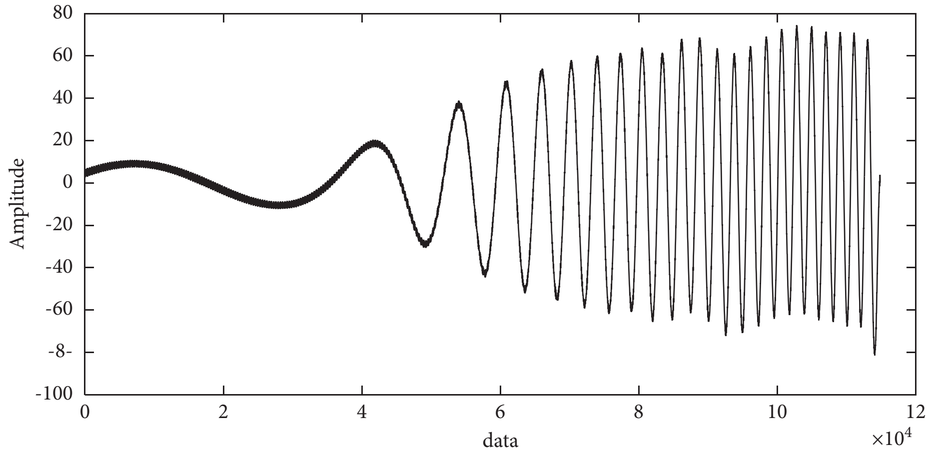

Figure 3: Evaluation of amplitude variation.

monitoring and postconsultation feedback platform, the daily health data collected by users can be generated into retrospective reports, which can be used to assist doctors in diagnosis and evaluation, and provide objective, accurate, and comprehensive patient information for medical purpose. On the other hand, new and old users are encouraged to carry out self-management, including physical health management and physical activity management, to help them better understand their own illness and, at the same time, to promote users to participate in planned activities. In daily life, wearable devices can detect and diagnose knee joint lesions at any time, so as to realize early detection of knee arthritis lesions and prevent further deterioration of knee joint lesions. By collecting health information of elderly users in real time, the frequency is simulated in Figure 4, where it can be seen that the frequency tends to be stable in the end. That is, if the signal changes with time and can be represented by amplitude, it has its corresponding frequency spectrum. When these physical phenomena are represented in the frequency spectrum, it can provide some information about the cause of this signal.

3.3. Individualized Prevention (Rehabilitation) Programs. As the disease situation of different new elderly users is different, personalized rehabilitation programs are needed. By monitoring physical pain data and activity, they are encouraged to engage in planned physical activity to ensure continuity of long-term effective rehabilitation exercise programs. The monitoring information will be shared with doctors, and doctors will make data-based diagnostic decisions, develop personalized rehabilitation plans, and inform new elderly users about their knee cartilage damage degree and rehabilitation plan, so that new elderly users can recover faster and easier.

When a user wears a smart watch loaded with the application designed in this paper, there will be no signal extraction and detection process in general walking or daily activities with low intensity. Once a fall or movement with high impact intensity occurs, the algorithm designed in this paper will be triggered when the acceleration reaches the set trigger point. A signal of about 4 s length centered on the moment of maximum acceleration impact is extracted.

When a trigger fall in the value is detected, the signal of original abnormal points out and a simple Gaussian filter is applied to extract the needed three distinguishing features. According to the corresponding logic compared with the threshold, if judging the fall after the event is suspected, smart watches display the pop-up warning information and vibration to remind and ask the user whether they are in good condition. If the user does not respond within 5 seconds, the location request will be triggered. In the following 5 seconds, the user will wait for the solution of location information and the return of subsequent remote processing results.

After the signal is extracted and the network is in good condition, the original data are sent through the network to the web server for http request. After receiving the request, the web server sends it to the corresponding Servlet for processing. The following points need to be explained. (a) Due to the uncertainty of the network, when data cannot be sent to the server or the judgment result of the server is not received within a specified time. The local fall monitoring results of the terminal shall prevail. (b) In the part of threshold judgment assisted by positioning information, if the acoustic signal positioning system cannot be used or does not return the location information within a specified time, the fusion decision result of the algorithm of the two parts shall prevail directly. If the network condition is poor, the previous decision shall be followed. (c) If the server receives the window signal and determines that the result cannot be returned in time due to the poor network condition after the fall, the branch will independently send a mild reminder, such as sending an e-mail to the medical staff. The frequency is compared in Figure 5. As we can see from the figure, the frequency varies in a wide zone. That is to say, spectral analysis is a technique for decomposing complex noise signals into simpler signals. Many physical signals can be represented as the sum of many simple signals of different frequencies. The practice of finding information about a signal at different frequencies (maybe amplitude, power, intensity, or phase) is spectral analysis.

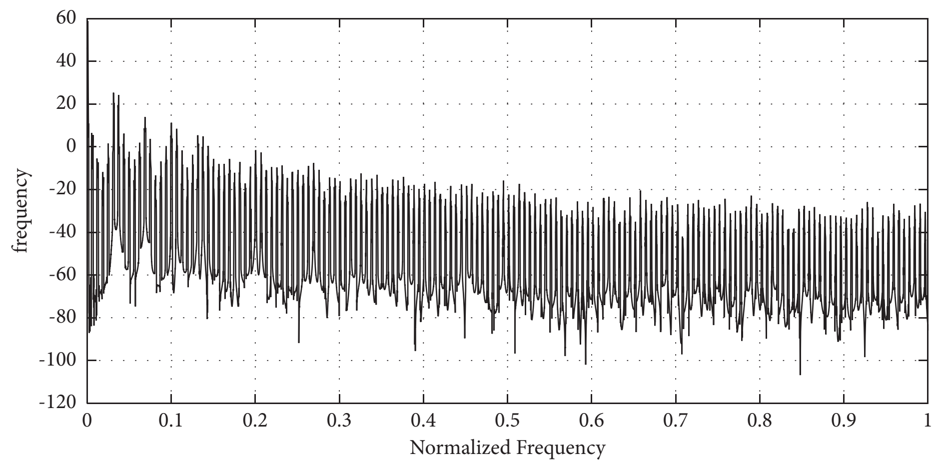

Figure 4: Frequency simulation results.

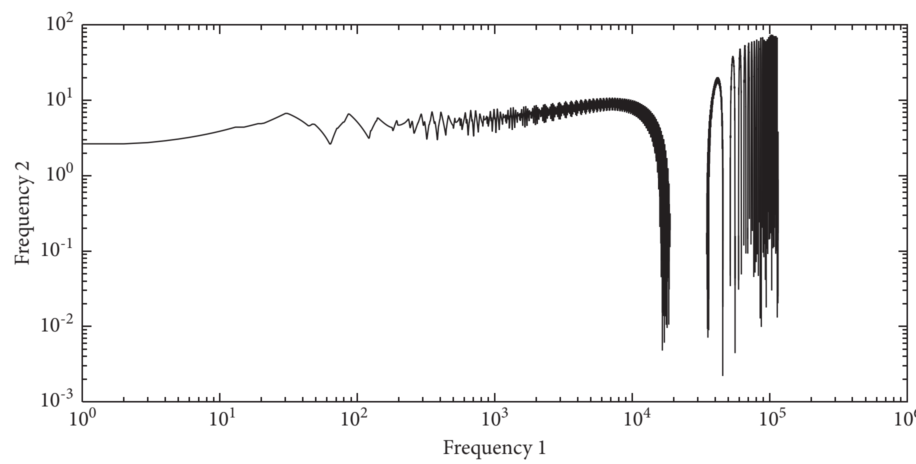

Figure 5: Frequency comparison predicted by the proposed method.

The indoor positioning module of an acoustic signal is mainly divided into two parts: one is the node network composed of beacon nodes, and the other is the target to be tested (smartwatch). Beacon node is mainly composed of microphone, loudspeaker, and communication module, which has a low cost and convenient layout. A beacon node network is formed between them according to a certain topology structure, and the distance between them is known. After receiving the user to locate request, one of the beacon nodes began broadcasting sound LFM signal TPSN interaction with the target under test, while the rest of the nodes in the listening state and the recording of all nodes in the local finished cross-correlation peak algorithm were used to calculate the time lag of information through the network sent back to the application of the target under test. Thus, the distance between each node and the target to be measured can be calculated. The user module on the target to be tested not only needs to process its own cross-correlation algorithm but also needs to accept the data sent from each node and then uses the positioning algorithm to obtain the positioning estimation result according to the obtained distance.

For linear frequency modulation acoustic signal (LFM), the low-frequency acoustic signal (3–8 khz) is selected here. Compared with the high-frequency acoustic signal, the low-frequency acoustic signal has stronger anti-attenuation performance in the propagation process, which helps to improve the SNR of the monitored audio signal, so that the ranging result is more accurate and the z-axis error is smaller. In addition, because the frequency band is audible to human ears, it can also serve as a reminder. First, when a fall occurs, it reminds other people in the room who are not immediately aware of the user's fall to provide timely assistance. However, if there is misjudgment case, it reminds that the user can cancel the follow-up program action in time.

As for the function of the product, the smart watch can monitor physical activity, heart rate, blood pressure, and other physiological indicators so as to increase the awareness of their own health status and pay attention to health management and activity management. Interestingly, whenever knee discomfort happens, it can be recorded through the watch, like a running account to manage their own pain, which can clearly feel their gradual recovery and virtually increase a lot of confidence. By exporting the generated report to the doctor, you do not need to bother talking to the doctor about your pain history, and the doctor can easily get your condition.

For the emotional design of the product, I think the dial is square for the wearing of the watch. It may be visually more comfortable without rectangles, but in terms of the content displayed, the fonts and charts are easy to see, and the information is easy to view. Participants also raised the same question about the wearing of knee joint wearable devices. They believed that if the devices were a little thick, they were more suitable for wearing in summer. For example, close-fitting thermal pants were required in winter, which were not very comfortable to wear inside. The control chart is plotted in Figure 6, where it can be seen that the plotted data are consistent with the analyses mentioned above.

As for the interaction design of the product, when pain occurs, people are usually impatient, so the participants expressed that a shortcut key could be added to record the pain quickly in special cases.

In this phase, researchers focus on the qualitative data of users. According to the two participants' feelings and thoughts on the use of the product, the author finds that the demand of the elderly users for the product has nothing to do with aesthetics. During the evaluation, they did not consider the device overly strange, did not fear negative reactions, and did not comment extensively on the material. On the contrary, in the evaluation stage, elderly users mainly focus on the functionality and comfort of the device, especially in the aspect of being able to move normally, which provides valuable insights and helps researchers define the design direction of further product optimization, including functional design, wearable design, and interactive interface design.

From the perspective of functional design, new and elderly suffering from knee osteoarthritis will suffer from pain symptoms such as redness, swelling, and pain. At present, knee wearable devices mainly monitor physiological data, that is, only collect signals from the knee. For new and elderly, when pain occurs, only the time and degree of pain are recorded on the watch, and the knee wearable device is only a monitoring device, which cannot alleviate or solve the current painful situation, and the pain still exists. Therefore, how to relieve the pain state when the disease occurs is one of the problems that the intelligent wearable iterative design needs to solve. The error is shown in Figure 7. As can be seen though there is still an error; however, it is only 0.3, which means we can get a good precision. Therefore, it also means the proposed method in this paper is useful and effective enough.

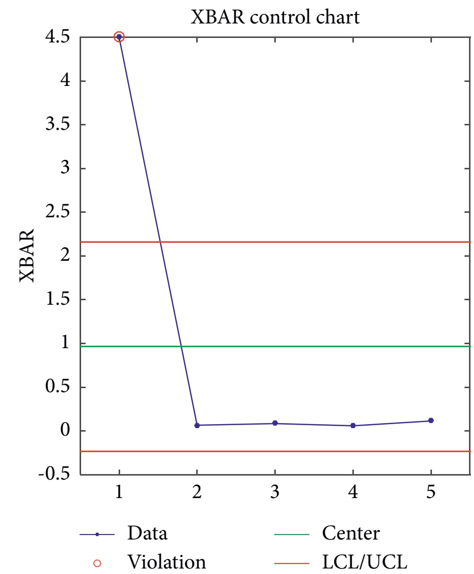

Figure 6: Variation of the control chart.

From the perspective of wear design, if the new and elderly with knee osteoarthritis suffer from knee redness, swelling, pain, and other symptoms, the monitoring equipment that is worn on the knee should be further considered in size or wearing mode. In addition, due to seasonal change, the wearing of the prototype knee wearable device will be limited due to the thickness of the clothing. The wearing of the knee device needs to take into account the existence of clothing, or whether the monitoring data can accurately collect knee data under the condition of spacing clothing. In the design of knee wearable devices, considering the state of elderly patients at the onset of disease, it is necessary to further reduce the wearing steps and increase comfort. Whether the wearing mode of knee wearable devices can be changed according to the seasonal wear will be a major difficulty in the optimization of the appearance design.

From the perspective of interactive interface design, new and elderly believe that most people are extremely agitated when they are in unbearable pain. In this case, it is difficult to input or select the other similar operations. Therefore, in the "pain recording" module, it is necessary to set a simple control mechanism such as shortcut keys, so as to avoid the difficulty of recording when the user is in pain. Through one-button operation, new elderly users can complete the pain recording quickly and accurately. The value variation is shown in Figure 8. As we can see, the value varies from 0 to 160, which is consistent with the prediction. That is, it also shows the effectiveness of the proposed method in this paper.

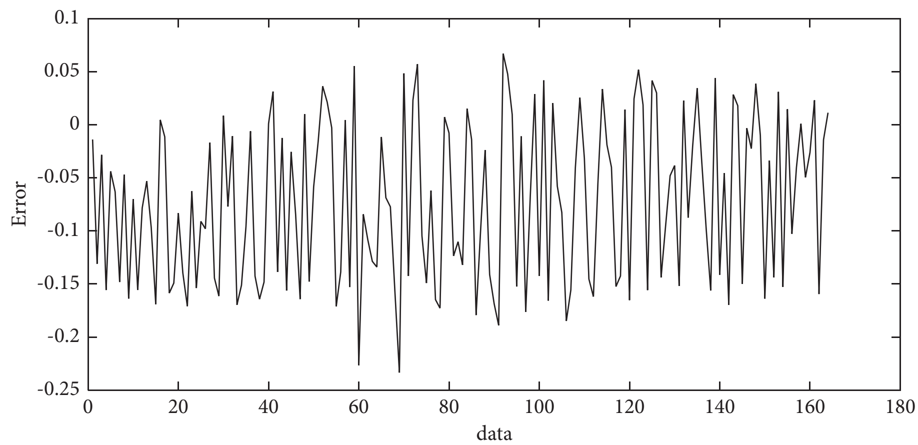

Figure 7: The existing error plot.

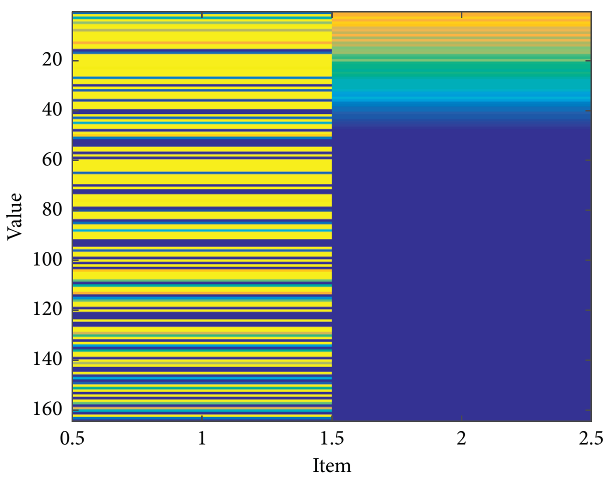

Figure 8: Value variation versus item.

4. Conclusion

This paper mainly studies several key technical problems of smart watches for emergency rescue of the middle-aged and elderly people, including failure rate detection algorithm, fall detection algorithm, and user group classification problem. Smart watch will collect a large amount of useful user behavior information and health information data and mine and analyze this information. By grouping and classifying users, it can understand users' interests and preferences and provide better services according to users' different needs in subsequent services.

This research hopes to attract more scholars' attention to new elderly users and plays a certain reference role in the design of smart wearable products for new elderly users in the future. The focus of the subsequent research will be on the usability test of products and the research level of ergonomics. Multiple tests will be carried out as much as possible to provide a scientific and powerful foundation for product iterative design with rigorous test data.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interests that could have appeared to influence the work reported in this paper.

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