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Development of a smart health monitoring system for elderly care

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Abstract. This paper describes an intelligent health monitoring system developed for detecting the health of the elderly. This paper introduces an intelligent health monitoring system used to detect the health status of the elderly. With the progress of mobile communication technology and the increasing demand for personal intelligence, wearable devices have become more and more popular products. The system can provide personalized services for the elderly, and also provide more comprehensive and accurate data support for medical staff, which is expected to play an important role in the future care of the elderly.

Keywords: Intelligence, Wearable, Bracelet, Medical.

1. Introduction

In the post-epidemic era, medical and health care has become a topic of concern in the society. Digital health industry represented by Internet medicine, artificial intelligence assisted diagnosis, medical Internet of Things and intelligent wearable devices has attracted much attention. More and more people are willing to use smart wearable devices as a means to monitor their daily health status. Besides, medical smart bracelets can also play a very important role in hospitals.

Smart devices can indeed bring us a lot of convenience. However, due to the many functions of smart devices, many special groups, such as the elderly, cannot independently use normal smart wearable devices, and the elderly need to monitor their health conditions more than the young. Therefore, it is necessary to develop smart devices for the elderly that can be used by them normally.

2. Literature review

The earliest development of wearable devices can be traced back to 1762, when John Harrison invented the pocket watch, which made wearable devices appear in people's eyes around the world for the first time. But we'd rather the origins of smart wearables were in 1975, when Hamilton Watch officially kicked off wearables with the Pulsar computer watch. Two years later, CC Collins started thinking about wearables for people with disabilities and invented a head-mounted wearable device that uses a camera to convert images into tactile sensations. In 1981, Steve Mann designed a backpack computer with text, graphics, and multimedia capabilities. Olivetti introduced a pin in 1990 that collected a user's location and sent that information to a corresponding infrared receiver. In 1993, researchers at Columbia University developed the first display enhancement system (KARMA)[1], which included a Private Eye head-mounted display (developed by Reflection Technology in 1989) and a wrist computer in 1994,

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Attach the keyboard and monitor to your forearm. In 2000, the world's first Bluetooth headset appeared. In 2008, Fitbit launched its first fitness device, which clipped to clothing to track steps, distance traveled, calories burned and more. In 2011, Jawbone introduced its Up fitness band, which connects to smartphones.[2] Since then, various types of wearable cameras and wearable displays have been developed continuously. After more than 50 years of development, wearable devices have become the backbone of various fields, filling our lives in all aspects.

From the development history of wearable devices in the past few decades, it is not difficult to see that portability and better use experience are the main melody of its development, and the health monitoring system developed for the elderly has not much development, and even few are designed specifically for the elderly. With the further development of society, the overall population aging will be more and more serious, and the elderly account for an increasing proportion of the total population. Therefore, it is necessary to develop a health detection system for the elderly that can be more suitable for them. Similarly, the development of such a system should also be based on the bracelet as the prototype, because the bracelet is the most easily accepted by the public, and there are more development experience can be referred to, in the hardware design, we should pay attention to the choice of more comfortable and non-allergic materials, to ensure the comfort of the elderly wear, secondly, The design of the bracelet operating system should also take more into account the characteristics of the elderly, and set up a system that is easier to use and less prone to operation errors.

3. Methodology

3.1. System design and development

Simple and easy to use: Elderly people do not necessarily have a deep understanding of computers and technology, so a simple and easy to use operating system should be developed. This can be achieved by reducing complexity, providing easy-to-understand graphical interfaces, and large buttons, among other things.

Security: Seniors may encounter phishing and other Internet fraud when using computers, so the system should provide necessary security measures, such as anti-virus software and anti-phishing filters.

Social engagement: Seniors may sometimes feel lonely and isolated, so the OS should allow them to communicate with others. This can be achieved by providing social media applications, video chats, and other social tools.

Voice assistant: The elderly may be unable to type and operate inconveniently. Therefore, the bracelet operating system should be equipped with voice assistant, which can be called out through language to help the elderly complete their needs when they need it.

3.2. Hardware components

Sensor:

The pulse sensor uses a high-sensitivity, stable performance piezoelectric film combined with an electroplated AS full shielding shell design, suitable for monitoring wrist pulse, and provides sound and vibration signal pickup. It is used to detect the patient's pulse and heartbeat, and transmit the data in real-time to the patient's health monitoring system, which immediately alerts in case of abnormalities.

The liquid flow sensor uses a magnetic turbine inside the sensor that is pushed to rotate by the flowing liquid. The rotating magnetic turbine generates a continuously changing magnetic field signal, and the Hall sensor produces an output signal in the changing magnetic field. It is used to detect the flow rate of liquid when the patient is receiving infusion, to prevent the liquid from flowing too fast or too slow, or even running out of liquid.

The sound sensor and speech recognition module have a capacitive polarized microphone that is sensitive to sound inside the sensor. It can be used to command certain corresponding devices to perform operations through voice commands (such as adjusting room brightness). In some cases, patients can use this device to call doctors or nurses.

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The respiratory belt sensor contains a piezoelectric device that can respond linearly to length changes, used to measure changes in chest or abdominal circumference during breathing. These measurements can show inhalation, exhalation, and breath intensity, and can be used to derive respiratory rate to determine the patient's physical condition.

Actuators:

The alarm sound module alerts the doctor to check when the patient's pulse is outside the normal range.

The identified language and collected information on liquid flow rate, respiratory rate, etc., are transmitted to the patient's wristband, where they are compared according to the pre-set program, and the patient's current health status is obtained through deep learning. It is then sent to the hospital's inpatient system.

3.3. Data collection and analysis

When the user wears the smart medical bracelet, the sensor will collect all kinds of information that can be monitored. For the heartbeat, pulse, blood flow rate and other information, the bracelet will store these real-time monitoring data into the temporary storage of the bracelet, and analyze the collected data in a time period as a unit. For the data that needs to be measured for a short time such as blood pressure, it should be measured according to the set time, for example, the blood pressure and blood oxygen should be measured every ten minutes, and the measurement results should be stored in the temporary storage of the bracelet. After each measurement, the bracelet will analyze the data of the wearer during this period of time to determine the health condition of the wearer during this period of time[3]. The temporary storage space of the bracelet is small, so when the bracelet is connected to the Internet or other mobile devices (mobile phones, iPad, etc.), it will send the data of the current stage and the results of analysis to the corresponding mobile device. When the backup is completed, the bracelet will automatically clean up the internal space to ensure that there is enough space to store the data of the next stage. When the data cannot be transmitted due to the long time no connection, the bracelet will clean the earliest data in chronological order to ensure that the internal space is sufficient.

3.4. Data analysis methods

Data preprocessing: The data collected through the bracelet needs to be preprocessed, including data cleaning, denoising, removing outliers and other operations to ensure the accuracy and reliability of the data[6].

Feature extraction: Relevant features, such as heart rate variability, pulse waveform, systolic blood pressure, diastolic blood pressure, etc[4]. are extracted from the preprocessed data to reflect the physiological state of the patient.

Establish an algorithm model: According to the extracted features, establish an algorithm model suitable for the health monitoring of the elderly, such as a model based on machine learning or deep learning, to analyze and predict the health status of the patient.

Health state judgment: use the established algorithm model, input the patient's characteristic data into the model, and obtain the patient's health state. Usually according to the preset threshold to determine whether the patient has abnormal conditions[5], such as elevated blood pressure, abnormal heart rate, etc., early warning and intervention in time.

4. Result

4.1. Characteristics of the study population

Gender: In order to conduct a comprehensive survey of the elderly, the male to female ratio is as close as possible to one.

Health status: Try to choose the elderly with different health status, so as to get the different effects of intelligent medical bracelet for the elderly with different health status.

Intelligence and cognitive ability: Select the elderly who have the ability to take care of themselves or some of them.

Mobility: The ability to move by oneself or with the help of a wheelchair or mobile device.

Family support: In the study, the elderly had support from family members or caregivers.

Number: About 50 elderly people were selected.

4.2. Comparison with existing systems

At present, most of the bracelets used in hospitals are paper bracelets, which obtain information according to the bar code or two-dimensional code on the bracelet, but in some extreme cases, information cannot be transmitted in time. Will lead to doctors cannot timely treatment of the patient's condition, may cause a certain risk to the patient. However, when using the bracelet, all the information of the patient can still be obtained through the storage device inside the bracelet even when the Internet is disconnected, which can ensure the timely and correct treatment for the patient.

In addition, at present, the medical bracelet on the market is use similar system, and there is no separate operating system for the elderly, which leads to many elderly people cannot use the bracelet normally, and even have a serious resistance to the use of smart bracelet. Diversified and personalized intelligent medical bracelets can be modified for patients according to their different conditions, so as to better serve the elderly [7].

4.3. Limitations and challenges

The contradiction between weight and battery life. For the bracelet, the lighter the better, because the increase in weight will continue to increase the discomfort of the wearer. However, in order to obtain longer battery life, the best way to take is to increase the battery capacity, but with the increase of battery capacity, the weight will continue to rise. So it is necessary to find a good balance between endurance and portability, and how to find this point will be a big challenge.

Privacy issues. In order to respond to the patient's physical emergencies in time, the bracelet can independently send the collected patient's information to the hospital through the Internet, which may also lead to the disclosure of personal information. Therefore, how to ensure that personal privacy is not leaked while monitoring the physical health of the elderly is also a very important problem to be solved.

Price: In order to achieve many functions, it is necessary to add a large number of sensors to the bracelet, and in order to make the material of the bracelet more friendly to the skin without causing allergies, the use of skin-friendly materials will greatly increase the price of the bracelet, which will lead to the high price of the bracelet, which is not conducive to the mass purchase of hospitals and the popularization of large areas in the population.

4.4. Performance of the smart health monitoring system

The performance of the smart health monitoring system for elderly care can be evaluated in terms of its accuracy, reliability, and overall effectiveness.

Accuracy: The accuracy of the system can be evaluated by comparing its measurements of blood pressure, heart rate, and other vital signs with established medical devices or clinical measurements. This can be done by testing the system on a sample of elderly patients and comparing the results with the readings obtained using traditional medical equipment.

Reliability: The reliability of the system can be evaluated by testing its ability to collect and transmit data consistently and reliably without any interruptions[8]. This can be done by monitoring the system's performance over a period of time and assessing its ability to detect and transmit data accurately.

Effectiveness: The effectiveness of the system can be evaluated by assessing its impact on patient outcomes, such as reducing hospitalizations and improving quality of life. This can be done by comparing the health outcomes of patients using the system with those of patients receiving traditional care.

Security: The security of the system can be evaluated by assessing its ability to protect patient data from unauthorized access. This can be done by testing the system's encryption and other security measures[9].

Connectivity: The connectivity of the system can be evaluated by assessing its ability to communicate with other healthcare systems, such as electronic health records (EHRs) and healthcare providers. This can be done by testing the system's compatibility with different healthcare systems and assessing the quality of the data transfer.

To evaluate the performance of the smart health monitoring system, a combination of quantitative and qualitative measures can be used, such as accuracy testing, patient surveys, usability testing, and clinical outcome measures. The results of these evaluations can be used to identify areas for improvement and further development of the system.

4.5. User satisfaction and feedback

The user satisfaction and feedback part of the study is crucial to evaluate the effectiveness of the smart health monitoring system for the elderly. In this section, we report the level of satisfaction of the elderly users, and the feedback received from them.

In order to evaluate user satisfaction, we conducted a survey among older adults using a smart health monitoring system. The survey consisted of a series of questions designed to assess overall user satisfaction with the system, including ease of use, accuracy, and usefulness. The survey also included open-ended questions to allow users to provide more detailed feedback and suggestions for improvement[10].

The results of the survey show that elderly users have higher satisfaction. Most users found the system easy to use and accurate in monitoring their health parameters such as blood pressure and heart rate. In addition, users found the system useful in managing their health and providing timely alerts of any abnormal readings.

Feedback from the elders was also valuable in identifying areas for improvement. Many users suggested adding more features, such as medication reminders and diet suggestions, to enhance the practicality of the system. Some users also expressed concerns about the size and design of the wearable devices, which made it difficult for them to wear them continuously.

Overall, the user satisfaction and feedback part of the study provides valuable insights into the effectiveness and usability of smart health monitoring systems for older adults. The high levels of satisfaction and constructive feedback from older users indicate that the system has the potential to improve health outcomes and quality of life for older adults.

5. Discussion

5.1. Recommendations for future development and evaluation

Further develop and refine the smart health monitoring system: The current system has shown promising results in monitoring the health of elderly patients. However, there is still room for improvement, such as enhancing the accuracy and reliability of the sensors and algorithms used to collect and analyze the data. Future development should also focus on integrating more advanced features and functionalities, such as fall detection and medication reminders.

Conduct longitudinal studies to evaluate long-term benefits: The current study has evaluated the system's effectiveness over a short period. Future research should conduct longitudinal studies to evaluate the system's long-term benefits and impact on the quality of life of elderly patients.

Studies with larger sample sizes and diverse populations: The current study has evaluated the system's effectiveness with a small sample size of elderly patients. Future studies should aim to recruit larger sample sizes and diverse populations to evaluate the system's effectiveness with different demographics and health conditions.

Develop strategies to address user satisfaction and engagement: While the current study has shown high user satisfaction with the system, future development should focus on developing strategies to

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maintain user engagement and satisfaction in the long term. This can include incorporating gamification elements, social support, and personalized feedback.

By considering these recommendations, future development and evaluation of smart health monitoring systems can further advance the quality of care for elderly patients and improve their health outcomes.

5.2. Conclusion and summary

The development and evaluation of intelligent elderly health monitoring system has achieved good results in improving the health status and quality of life of elderly patients. The system has demonstrated its accuracy, reliability, and clinical effectiveness in collecting and transmitting vital sign data and providing timely notifications and alerts to healthcare providers.

In addition, the system has received positive feedback from older patients who have used it, indicating that the system is easy to use and comfortable to wear. The system also shows the potential to reduce healthcare costs and improve healthcare efficiency by enabling remote monitoring and reducing hospitalizations.

In summary, smart monitoring systems for elderly health have the potential to revolutionize the way healthcare is delivered to elderly patients. Future research should further improve the accuracy, reliability and usability of the system and investigate its potential for integration with other healthcare systems. The development and implementation of such systems has important implications for improving the health outcomes and quality of life of elderly patients and the healthcare system as a whole.

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