ISSN 2616-7433 Vol. 6, Issue 1: 166-172, DOI: 10.25236/FSST.2024.060127

Wearable Health Remote Monitoring System for Elderly Outdoor Fitness

Lin Zhu[1,a,*], Yicun Gao[1,b]

[1]*School of Art and Design, Jiangsu Ocean University, Lianyungang, Jiangsu, China*
[a]*995759873@qq.com*, [b]*3052178252@qq.com*
[*]*Corresponding author*

Abstract: *How can the health status of the elderly be monitored and managed? The health status of the elderly is very important to their quality of life. The wearable health remote monitoring system provides a convenient monitoring and management solution for the elderly. The purpose of this study is to evaluate the effectiveness of the outdoor fitness wearable health remote monitoring system for the elderly. The participants included 50 elderly people, half of whom wore wearable devices for outdoor fitness activities, and carried out data transmission and analysis through the remote monitoring center. Through this system, the health data of the elderly such as heart rate, breathing rate, temperature and blood pressure can be monitored and recorded in real time, and the remote monitoring center can obtain the data in a timely manner, analyze and interpret it. The system shows real-time and convenience, and can provide timely health feedback and alerts to help the elderly understand their physical condition.*

Keywords: *Wearable Health Remote Monitoring System, Outdoor Fitness, Elderly Health, Data Analysis Feedback*

1. Introduction

Many researchers have begun to study the health monitoring of the elderly, because the current health monitoring system for the elderly is very backward, and the intensification of the aging trend of the population has become particularly important for the health care and management of the elderly. As an effective way of health promotion, outdoor fitness activities have a positive impact on the physical and mental health of the elderly. However, due to the special needs and physical conditions of the elderly, they may face some health risks and challenges during outdoor fitness. Therefore, the development of a wearable health remote monitoring system for outdoor fitness of the elderly to monitor the health status of the elderly in real time and provide personalized guidance has important research significance and application value.

The purpose of this article is to discuss the design, implementation and effect evaluation of the outdoor fitness wearable health remote monitoring system for the elderly. Through field surveys and data collection of the elderly, it can evaluate the feasibility and effectiveness of the system, and explore its potential in improving the health of the elderly and promoting healthy behaviors. The results of this study can provide valuable information and guidance for the field of health management of the elderly, and provide a reference for the design and promotion of the application of similar systems. This article first introduces the research background, including the health problems of the elderly and the importance of outdoor fitness. Then it describes in detail the design and function of the outdoor fitness wearable health remote monitoring system for the elderly. Next, it explains the research methods, including steps such as participant recruitment, data collection and analysis. The research results are then presented, and the effectiveness of the system is evaluated and discussed. Finally, the paper summarizes the contribution of research and look forward to the future development direction of this field.

2. Related Work

Many scholars have conducted research on remote health monitoring systems for the elderly. Liu Bo designed a portable monitoring system that can monitor the occurrence of falls in the elderly in real time and send location and alarm information to remote receivers. The system adopts a waist three-axis accelerometer to collect real-time human motion posture data. The experimental results show that the system has stable performance, high accuracy, and is lightweight and convenient, making it very suitable for elderly people to wear and use [1]. Wu Huirong used internet technology to design health monitoring software suitable for the elderly, monitoring chronic disease data with slow onset, long course, and difficult self-healing, and processing these data. He timely reported the health status of the elderly to his children based on daily monitoring data, playing a certain role in monitoring the health of the elderly [2]. Gao Han constructed an indicator system for elderly health monitoring needs from a systematic perspective, and used the AHP method to construct an importance evaluation model for elderly health monitoring needs, providing reference for the design of elderly health monitoring products. He constructed a systematic conceptual framework for elderly health monitoring needs and further designed an indicator system for elderly health monitoring needs [3]. Zhao Xin proposed a design of a health monitoring bracelet system for the elderly, which can monitor their exercise status in real time. When an elderly person falls, the system automatically sends a distress message through a mobile app, enabling them to receive timely assistance. After actual testing, the accuracy of fall monitoring and exercise step monitoring are above 90% and 95%, respectively [4]. Tang Yinsheng designed a wearable monitoring system consisting of wearable devices, monitoring terminals, cloud, and user terminals. It monitors the vital signs of the elderly and sends monitoring data to the monitoring terminals to assess their health status. If abnormal conditions such as falls are detected, real-time alarms can be triggered [5]. The above research provides great assistance for remote monitoring of the health of the elderly. This article can design a wearable health remote monitoring system to monitor the physical health of the elderly.

3. Method

3.1 Hardware Components of Wearable Health Remote Monitoring System

Wearable devices are embedded with multiple sensors to monitor the user's physiological indicators and activity, among which heart rate sensors are used to measure the user's heart rate and rhythm. The blood pressure sensor measures the user's blood pressure level, while the blood oxygen sensor monitors the user's blood oxygen saturation. Gyroscope sensors are used to detect the user's movement, steps, and posture, while temperature sensors measure the user's body temperature [6-7].

A data storage module has internal and/or external memory (such as an SD card) to store collected health data, which can be analyzed and processed later.

Communication module: Data transmission and remote monitoring are carried out with other devices through the communication module, and embedded Bluetooth is used for data communication with smartphones, tablets, or other Bluetooth devices. Wi-Fi is used to connect to the internet through a Wi Fi network and transmit data to remote servers. NFC transmits data to other compatible devices through close range wireless communication technology [8-9].

Power management module: It provides power and manages battery usage through a power management module, which includes the battery providing power to wearable devices and a charging circuit for charging the battery. Wearable devices may have different types of external device interfaces for connecting to other external devices or for data transfer, while USB interfaces are used to connect to computers and charging devices [10-11].

Equipment casing and fixing devices: In order to protect the equipment and ensure comfort and durability, wearable devices typically have specific casing designs and fixing devices. These shells typically have waterproof properties to adapt to outdoor sports environments [12-13].

3.2 Develop Software Systems for Data Collection and Transmission

Design a data acquisition interface that interacts with hardware components, communicates with different types of sensors and devices through the interface, and obtains various health data and can read sensor data in real time and transmit it to the software system. The collected health data needs to be processed and analyzed to extract useful information. The goal of processing and analysis is to generate relevant indicators and reports on the user's health status and activities [14-15].In order to achieve remote monitoring, the collected health data is transmitted to a remote server through different communication protocols and technologies. The software system has a user-friendly interface and interactive functions, which enable users to easily view and manage their health data, and has

ISSN 2616-7433 Vol. 6, Issue 1: 166-172, DOI: 10.25236/FSST.2024.060127

mechanisms for error handling and exception handling to ensure the stability and reliability of the system [16-17].

3.3 Data and Feedback Algorithms

Data analysis and feedback algorithms play a crucial role in wearable health remote monitoring systems, as they are used to process and analyze collected health data. The detection system designed in this article contains a very rich range of algorithms.

Real time data monitoring and alarm refers to the real-time monitoring and collection of health data, and issuing alarms based on preset thresholds or rules. When the heart rate exceeds the set upper limit or the blood oxygen saturation is below the set lower limit, the system can trigger an alarm to notify the user or relevant medical personnel.

Health indicator calculation is used to calculate a user's health indicators based on collected data, such as heart rate variability, exercise intensity, calorie expenditure, etc. [18]. These indicators can provide a quantitative assessment of the user's health status.

Sleep analysis is the analysis of a user's sleep quality and sleep stages. By processing accelerometer and heart rate data, it is possible to identify wakefulness, light sleep, and deep sleep, providing feedback on user sleep habits and quality.

Motion tracking and activity recommendations: This algorithm tracks user movements and activities by analyzing accelerometer and gyroscope data. It can calculate steps, distance, calories burned, etc., and provide personalized activity suggestions, such as reminding users to walk more, engage in appropriate exercise, etc. [19].

Heart rate variability analysis: Heart rate variability is an indicator used to evaluate the function of the autonomic nervous system. Related algorithms can calculate heart rate variability from heart rate data and analyze its relationship with the user's stress level, emotional state, and health status.

Data mining and pattern recognition: By applying machine learning and data mining techniques, potential patterns and trends are discovered from a large amount of health data, which are used to predict disease risk, provide preventive measures, and provide personalized health recommendations.

Health reports and visualization: This algorithm is used to generate user health reports and present health data in a visual manner, helping users better understand and manage their health status [20].

3.4 User Interface and Interaction Design

When designing the system interface of this article, it should be noted that the interface should be concise and clear, avoiding too many complex elements and information, and important functions and data can be highlighted to facilitate users to quickly find the required information and operate. The system interface uses charts, graphics, and visual elements to present health data and indicators to enhance users' understanding and analysis of the data. Data indicators and changes are presented in an easy-to-understand manner such as color coding, icons, and progress bars. At the same time, the consistency of interface elements, such as button styles and font choices, is maintained, allowing users to gain a sense of familiarity, reduce learning costs and improve predictability. The interface allows users to personalize and customize the interface according to their own preferences and needs. Users can choose the health indicators they are interested in for monitoring, and adjust the settings of reports and reminders. It provides intuitive operation and navigation methods, enables users to easily browse and use the various functions of the system, and uses clear labels, menus, and navigation buttons, as well as appropriate feedback and guidelines to help users quickly find the required functions.

4. Results and Discussions

The paper designed experiments to evaluate the accuracy, reliability and user experience of the wearable health remote monitoring system in outdoor fitness scenarios for the elderly, and whether the system can provide useful health feedback and suggestions. The environment of the experiment is set as an outdoor fitness venue to ensure that the environment is consistent with the actual use scenario in order to accurately evaluate the performance and feasibility of the system. 50 elderly people were recruited to participate in the experiment. Among them, 25 elderly people used the elderly outdoor fitness wearable health remote monitoring system as the experimental group for fitness monitoring, and

ISSN 2616-7433 Vol. 6, Issue 1: 166-172, DOI: 10.25236/FSST.2024.060127

the other 25 people used traditional health monitoring methods as the control group. 50 people performed the same outdoor exercise separately. After that, the two sets of data were analyzed, and the data accuracy, data generation time and system stability were used as the evaluation indicators of the experiment, and sufficient instructions and training were provided to ensure that participants correctly used the wearable health remote monitoring system. Before the experiment, 8 people were selected for health data monitoring. The monitoring results are shown in Table 1.

Table 1: Extracted Health Data for Elderly People

Name	Heart Rate (bpm)	Respiratory Rate (breaths/min)	Temperature (°C)	Blood Pressure (mmHg)
Elderly 1	78	16	36.5	120/80
Elderly 2	72	18	36.8	130/85
Elderly 3	80	14	36.6	135/90
Elderly 4	75	17	36.4	125/82
Elderly 5	70	15	36.7	118/78
Elderly 6	82	16	36.9	140/95
Elderly 7	76	14	36.3	122/80
Elderly 8	74	18	36.5	128/85

4.1 Data Accuracy

Data accuracy refers to the degree of consistency between the health data collected and reported by the system and the actual situation, which can reflect the accuracy and reliability of the system in monitoring and measurement. Figure 1 shows the experimental results, where I represents the experimental group and II represents the control group.

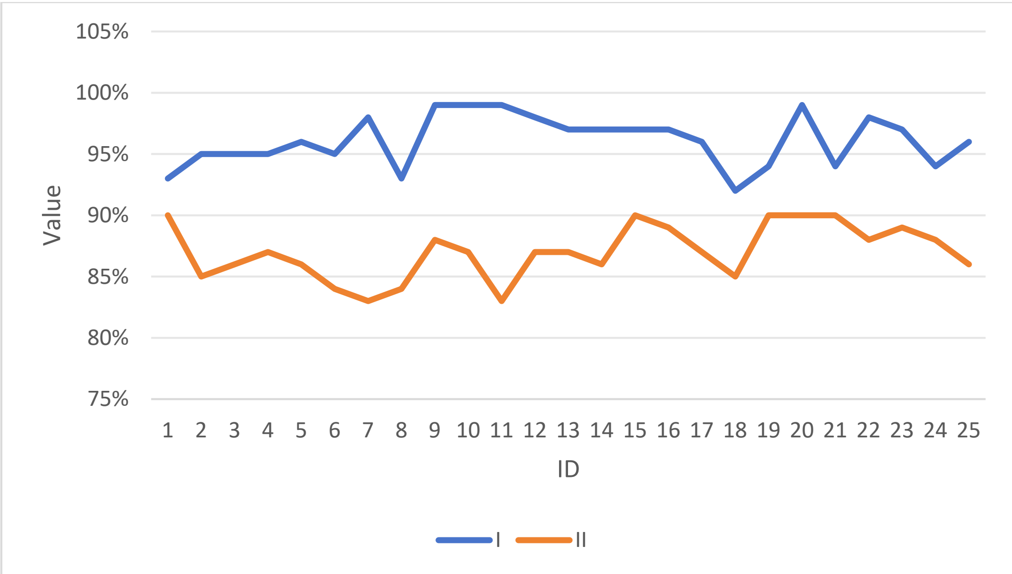

Figure 1: Data accuracy

In the measurement of health data, the accuracy of the experimental group in this article is between 92% -99%, while the accuracy of the control group is between 83% -90%. The wearable health remote monitoring system data in this article is more accurate than traditional methods, because the wearable health remote monitoring system can collect and transmit data in real time, providing continuous monitoring and recording. Traditional methods require manual recording with long time intervals, which can lead to omissions or omissions. So the real-time and continuity of wearable devices can provide more accurate data, reflecting the true health status of the elderly.

4.2 Data Generation Time

The time of data generation can reflect the real-time nature of the data, that is, the interval between the time of data generation and the current time. Real time is crucial for monitoring the health status and activities of elderly people. Because timely acquisition of data can help detect abnormal situations

ISSN 2616-7433 Vol. 6, Issue 1: 166-172, DOI: 10.25236/FSST.2024.060127

or take appropriate measures early, Figure 2 shows the test results.

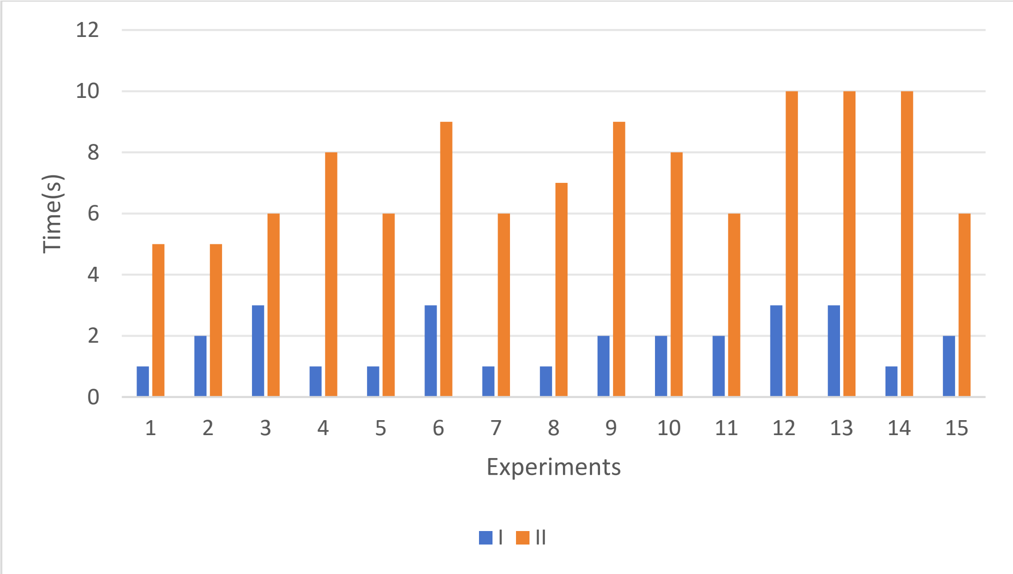

Figure 2: Data generation time

The data generation time for the experimental group in the test was the longest and shortest, with duration of 5 seconds and duration of 1 second. The generation time for the control group was the longest and the shortest, with duration of 10 seconds and 5 seconds. The experimental group has a more advantageous performance in terms of generation time. Analyzing the reasons behind this, the wearable health remote monitoring system can automatically collects and generates data without the need for additional efforts from the elderly. Its data generation process makes health monitoring more convenient and efficient.

4.3 System Stability

This article tests the stability of the system, and the test results are shown in Figure 3:

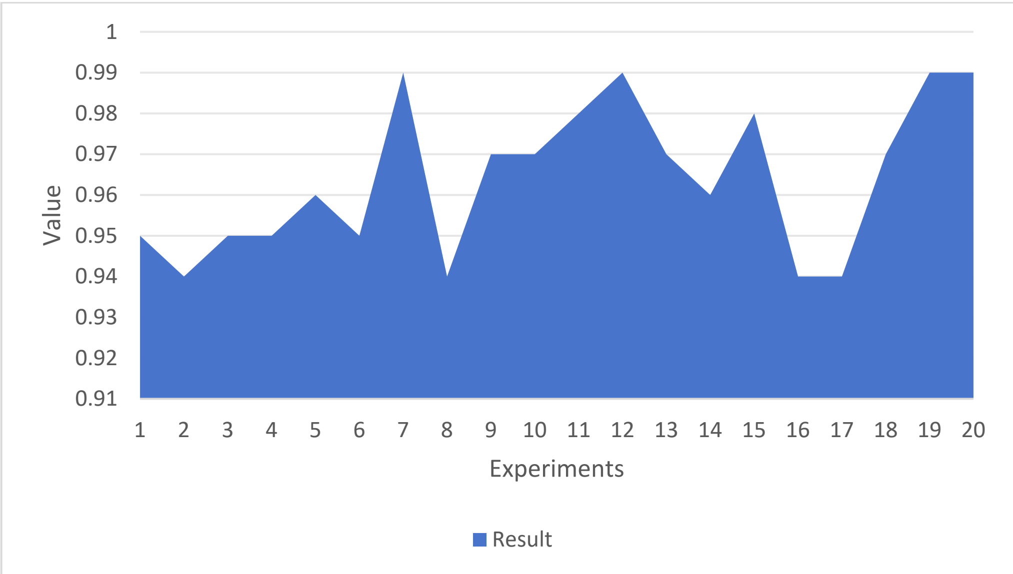

Figure 3: System stability

The stability of the experimental group in the test was between 94% and 100%. The stability of wearable devices is an important part of the system stability. In a system with high stability, wearable devices may have a low failure rate and be able to operate stably and collect health data, which means that the elderly can wear the device for a long time without frequent maintenance or replacement.

ISSN 2616-7433 Vol. 6, Issue 1: 166-172, DOI: 10.25236/FSST.2024.060127

5. Conclusions

Several tests were conducted on the three indicators of stability, data generation time, and data accuracy, and it was found that the index data of the experimental group was always better than that of the control group. Through experimental testing and data support, the elderly can wear wearable devices for fitness activities at any time, and monitor health data in real time in an outdoor environment. This real-time nature enables the system to provide timely health feedback and alerts to help the elderly better understand their physical condition. The outdoor fitness wearable health remote monitoring system for the elderly provides a convenient and reliable health monitoring and management program for the elderly through functions such as real-time monitoring, remote management and big data analysis. The application of this system helps to improve the health of the elderly, prevent the occurrence of diseases, and help medical professionals carry out timely intervention and personalized guidance, thereby improving the quality of life of the elderly. In the future, the application of artificial intelligence and machine learning algorithms can further enhance the system's data analysis and personalized guidance capabilities. Through the learning and pattern recognition of large amounts of data, the system can more accurately predict and identify the health risks of the elderly, and provide more personalized health management recommendations based on individual characteristics.

Acknowledgement

This work was supported by Jiangsu Province University Philosophy and Social Science Research Project “Research on Decision Model for Wearable Health Monitoring Product Design for the Elderly”, 2021SJA1736

References

[1] Liu Bo, Wang Mingwei, Chang Libo. Exercise status monitoring and fall alarm system for the elderly. Computers and Modernization, 2020, 0(5):101-105
[2] Wu Huirong, Wang Yujing, Ma Jindi, Zhou Zhongcan, Guo Liyuan. Research on health monitoring and chronic disease prediction software for the elderly. Fujian Computer, 2020, 36(9):81-83
[3] Gao Han, Xu Jifeng. Research on the systematic needs evaluation of health monitoring of the elderly based on AHP. Packaging engineering, 2021, 42(16):138-143
[4] Zhao Xin, Yu Fengqiao, Yuan Xiaoping. Design of a health monitoring bracelet system for the elderly. Electronic Design Engineering, 2022, 30(11):74-78
[5] Tang Yinsheng, Suter, Guo Lin. Design of elderly health monitoring system under cloud computing. Automation technology and application, 2020, 39(2):179-182
[6] Shamsabadi A R, Delbari A, Safari A, et al. Capabilities and requirements of the elderly remote health monitoring. Iranian Journal of Ageing, 2020, 15(3): 286-297.
[7] Souri A, Ghafour M Y, Ahmed A M, et al. A new machine learning-based healthcare monitoring model for student’s condition diagnosis in Internet of Things environment. Soft Computing, 2020, 24(22): 17111-17121.
[8] Kondaka L S, Thenmozhi M, Vijayakumar K, et al. An intensive healthcare monitoring paradigm by using IoT based machine learning strategies. Multimedia Tools and Applications, 2022, 81(26): 36891-36905.
[9] Chatrati S P, Hossain G, Goyal A, et al. Smart home health monitoring system for predicting type 2 diabetes and hypertension. Journal of King Saud University-Computer and Information Sciences, 2022, 34(3): 862-870.
[10] Raza H, Abbas N, Amir S, et al. An IoMT enabled smart healthcare model to monitor elderly people using Explainable Artificial Intelligence (EAI). Journal of NCBAE, 2022, 1(2): 16-22.
[11] Marlinda L, Widiyawati W, Widiastuti R, et al. Expert system for monitoring elderly health using the certainty factor method. Sinkron: jurnal dan penelitian teknik informatika, 2020, 5(1): 72-77.
[12] Wang X, Song Y. Edge-Assisted IoMT-Based Smart-Home Monitoring System for the Elderly with Chronic Diseases. IEEE Sensors Letters, 2023, 7(2): 1-4.
[13] Wu Q, Chen X, Zhou Z, et al. Fedhome: Cloud-edge based personalized federated learning for in-home health monitoring. IEEE Transactions on Mobile Computing, 2020, 21(8): 2818-2832.
[14] Alshamrani M. IoT and artificial intelligence implementations for remote healthcare monitoring systems: A survey. Journal of King Saud University-Computer and Information Sciences, 2022, 34(8): 4687-4701.
[15] Utchuru S, Jaswanthsai A, Maheshbabu S, et al. Elderly People's Smart Medical Box for Health

ISSN 2616-7433 Vol. 6, Issue 1: 166-172, DOI: 10.25236/FSST.2024.060127

Care Integrated by the IoT Systems. Journal of Communication Engineering and its Innovations, 2023, 9(1): 29-40.

[16] AlShorman O, AlShorman B, Alkhassaweneh M, et al. A review of internet of medical things (IoMT)-based remote health monitoring through wearable sensors: a case study for diabetic patients. Indonesian Journal of Electrical Engineering and Computer Science, 2020, 20(1): 414-422.

[17] Nezhkina N, Sokolovskaia S, Fomin F, et al. The state of vegetative status and adaptive reserve to physical activity in the elderly. Journal of Physical Education and Sport, 2022, 22(11): 2688-2693.

[18] Pant D, Bhattarai S, Poudel S. Smart Care: Body Area Sensor Network Conceptual Architecture for Elderly and Non-Critical Patient Care. International Journal of Advanced Networking and Applications, 2021, 12(5): 4706-4713.

[19] Martinho D, Carneiro J, Corchado J M, et al. A systematic review of gamification techniques applied to elderly care. Artificial Intelligence Review, 2020, 53(7): 4863-4901.

[20] Gu Z, Xiong H, & Hu W. Empirical Comparative Study of Wearable Service Trust Based on User Clustering. Journal of Organizational and End User Computing, 2021, 33(6): 1-16.