

Research Article

Optimization of a Wireless Sensor Network-Based Smart Elderly Location Management System

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Received 12 October 2021; Revised 28 October 2021; Accepted 1 November 2021; Published 17 November 2021

Academic Editor: Guolong Shi

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In this paper, wireless sensors are used to design and build a location management system for smart aging, and the optimization of this system is analysed. The function and structure of the positioning system are designed and implemented. Next, the system commissioning process and field implementation results are summarized and analysed to guarantee the reliability and integrity of the system. Finally, the system requirements and implementation are integrated to realize the basic requirements of the IoT-based elderly positioning management system and reserve the interface for later expansion. Finally, the system excellence and functional usability tested through unit testing as well as comprehensive testing. In this paper, a theoretical analysis of the prediction algorithm is carried out for the disease prediction module in the health monitoring software of the smart senior care system. To improve the accuracy of the prediction, the traditional BP neural network algorithm is optimized using DS evidence theory, thus fusing multiple sets of prediction results obtained from the BP neural network into a more accurate set of data, and the performance of the algorithm before and after the improvement is compared. The IoT-based home health management for the elderly starts from the health service demand of the elderly, explains the basic concept of IoT technology and home health management for the elderly, and analyses the feasibility of home health management for the elderly and the advantages of IoT technology in-home health management for the elderly; through the field research, the IoT-based home health management platform for the elderly is carried out from three aspects of users, business, and technology. The design covers the platform architecture and functional modules of the IoT-based senior home health management platform, which can solve the problem that the elderly can spend a comfortable life in their old age without going home.

1. Introduction

With the rapid development of IoT, big data, and wearable technology, intelligence and automation provide a new direction for solving the elderly problem, and the concept of smart aging is increasingly understood. With the development of the network as well as wireless sensor technology, IoT technology is playing an increasingly important role in people's daily life [1]. The Internet of Things (IoT) refers to the integration of various information sensing devices and systems, such as sensor networks, bar codes, RF tag reading devices, GPS, QR code devices, and other "thing-to-thing"-based communication modes- (M2M-) based short-range wireless

self-organizing network system, through various access networks and the Internet to form a huge intelligent network [2]. Through IoT technology, we can combine intelligent sensing and recognition technology with artificial intelligence technology, thus breaking the traditional elderly care mindset by interacting various sensor devices with mobile Internet networks, allowing young people to understand the daily activities of the elderly in real-time through the network, and to be notified in time when the elderly have abnormal conditions, to give them precise care [3]. The direction of medical care, spiritual comfort, life entertainment, etc. has changed, becoming increasingly diversified and diversified, which has led to a series of elderly care including health care

products, medical institutions, elderly health care institutions, elderly physical examinations, and elderly tourism. In industry development, this new type of elderly care system that combines the Internet of Things and artificial intelligence is known as the Smart Senior Care System. This system not only enables the elderly to receive timely and accurate care in nursing homes but also improves the living experience of the elderly in nursing homes, fully satisfying the needs of the elderly for the services and management provided by nursing homes, and allowing young people to rest assured that they will be placed in nursing homes for the rest of their lives. The number of the elderly population is gradually growing, the development and progress of economic and technological level, the improvement of quality of life, which makes the demand of the elderly for health and old age gradually expand from the previous single demand for health care services to the direction of health care, spiritual comfort, live entertainment and so on, more and more diversified and diverse, thus driving the development of a series of senior care industries including health care products, medical institutions, health care institutions for the elderly, and medical check-ups for the elderly. This has led to the development of a series of senior care industries, including health care products, medical institutions, health care institutions for the elderly, medical check-ups for the elderly, and tourism for the elderly [4]. In addition, the health needs of the elderly are also subdivided into different levels according to their physical health, economic status, living environment, etc. The diversified development of the health needs of the elderly has put forward more health service needs for the elderly to the society, and the demand gap for the elderly is expanding, and how to age healthily has become a key concern of society today.

The continuous development of healthy aging, coupled with the expansion of intelligent technology into the field of senior care, has further raised the expectations of the elderly for senior care services, and the smart senior care service platform is the core part of smart senior care, which controls the connection between senior care service supply and senior care demand, and is the current form of smart senior care realization strongly advocated by the government [5]. The smart senior care service platform uses advanced Internet of Things, communication, and remote technology to provide senior care services for the elderly. It is based on individual families and communities and provides real-time monitoring services for the elderly through monitoring devices, external wearable devices, and so on, to make the daily life of the elderly safer and worry-free, or provide timely assistance in case of emergency. The development of the smart elderly service platform makes old people's later life safer and healthier, fully reflecting the significance of the development of healthy aging.

Based on the development history and development status of the smart senior care service platform, the development stages of the smart senior care service platform and the development of policy, technology, and demand changes under each stage are analysed to provide optimization suggestions for the construction of the smart senior care service platform. Studying the health needs of the elderly makes

society understand the necessity of the elderly problem, accelerates the efficiency of the government's elderly service, and can also drive the further development of the elderly industry. With the increase of the proportion of the elderly, the elderly and their families have greater consumption potential, and it is the intelligent elderly care that stimulates the consumption potential of the elderly and their families, which is conducive to expanding domestic demand, stimulating the innovative vitality of elderly care enterprises, promoting the further optimization and upgrading of intelligent elderly care products and equipment, and accelerating the sustainable and healthy development of elderly care service industry and high-tech industry. At the same time, optimization suggestions are made on how to better build a smart senior care service platform according to the health needs of the elderly. From the perspective of healthy aging theory and supply and demand theory, the first consideration of the smart senior care service platform is to meet the healthy senior care needs of the elderly, and from the perspective of human-computer interaction, the development of the smart senior care service platform is to find more effective senior care methods so that the elderly can continue to realize their value, that is to say, to match and analyse the smart senior care platform, the health needs of the elderly and the smart senior care products, and to use the relevant supply and demand matching analysis, using theories related to supply and demand matching to conduct research and analysis. The thesis uses the theory of healthy aging, the theory of hierarchy of needs theory as the theoretical support and uses human-computer interaction, supply and demand matching, and other related theories to better build the smart senior care service platform and enriches the connotation and extension of these theories.

2. Status of Research

In terms of technology, foreign research in information management of elderly institutions also started early, and the relevant mature systems are generally higher than those in China in terms of performance, functions, and expansion needs. Foreign elderly management systems have adopted a lot of IoT technologies, such as the Inter-Home in Europe and the United States and the IT machine care system in Japan, all of which are designed to achieve all-round monitoring of the elderly through real-time monitoring of all aspects of their daily lives and health data [6]. At the same time, multilevel care services are realized for different categories of elderly people, such as those with dementia, disability, or emotional impairment. However, a reasonable response to the elderly problem is another opportunity for national economic transformation and industrial model upgrading. As a new industry, the elderly care industry has great potential [7]. We can fully learn from the successful experience in the elderly care system in Asia, Japan, Europe, and the United States developed countries, combine our national conditions and industry direction, and build a socialist elderly care security system with Chinese characteristics [8]. The development of the ZigBee-based elderly care system is a large practical innovation based on existing

management systems and applications. The traditional information management system is organically combined with a wireless self-assembly network, and the resources are reasonably allocated to provide diversified, multilevel, and highly reliable positioning management services following China's current stage of elderly care design requirements [9]. The implementation of the system can significantly improve the standard of elderly care services and reduce the cost of social elderly care and provide more reliable, safe, and swift care and health monitoring services for the elderly. The design and application of elderly care systems based on ZigBee wireless network positioning technology have great application and social value in both academic and practical aspects and have great academic research significance in elderly care industry exploration and service innovation [10].

In the study, an intelligent apartment is envisaged in which the elderly does not need any caregiver and have full autonomy and privacy [11]. Sensors, as well as communication and location facilities, are installed in such an apartment incorporating IoT technology. When the elderly need to go out, the sensors in the room will detect and alert the caregivers; when the elderly have an accident, the sensors on the floor will also detect and react accordingly; when the elderly need to take medication on time, the sensors installed on the elderly will alert the elderly and report the medication taken to the caregivers through the communication chip. Most of the nursing homes do not have professionally trained personnel or the quality of the industry is mixed, and most nursing homes are constrained by economic costs and space, so it is difficult to achieve one-to-one elderly care staff [12]. Therefore, intelligent management of nursing homes is inevitable. There are already relevant research units and enterprises in China developing intelligent nursing home management systems, which detect the physiological status of the elderly through various functional sensors [13]. Given this, an intelligent IoT nursing home management solution combining Bluetooth Mesh technology and sensor technology is the goal of this design.

The objectives of smart elderly care services are proposed to make full use of primary health care, reduce the waste of resources in health care facilities, and facilitate access to elderly care services in familiar places of residence. Using the rooting theory to study the living environment and convenient facilities of the elderly, it is pointed out that increasingly elderly people prefer to live in places with care communities to improve their safety and quality of life in their later years. Foreign studies generally agree that the most dominant elderly care service in the future is smart community elderly care. A framework for a dependency-based smart elderly care service system has been proposed, using this framework to assess the elderly to determine the right time to serve them and provide them with humane services. The Singapore government highly advocates diversified smart elderly care services, and to ensure the smooth implementation of smart elderly care services, a series of laws and regulations have been formulated based on a high degree of community autonomy to provide policy protection for the development of smart elderly care.

3. Optimization Analysis of Smart Aging Location Management System with Wireless Sensor Network

3.1. Design of Smart Aging Location Management System with Wireless Sensor Network. A nursing home is a place with complete facilities mainly for the elderly, providing them with comprehensive accommodation, entertainment, catering, and medical services. Different levels of nursing homes in different places generally use management systems developed for their business characteristics to help them manage their services, so that they can better protect the safety, physical, and mental health of the elderly, the reasonable deployment of various resources in the home, as well as to ensure the level of care services and work efficiency, to do a good job of elderly care services. Intelligent positioning call management system consists of system server, system terminal, hub, wireless gateway, wireless locator and wireless locator card, and other equipment [14]. The direction of medical care, spiritual comfort, life entertainment, etc. has changed, becoming increasingly diversified and diversified, which has led to a series of elderly care including health care products, medical institutions, elderly health care institutions, elderly physical examinations, and elderly tourism. In industry development, the system is designed with a B/S structure, and the network composition includes two parts: basic Ethernet and wireless Internet of Things. The basic Ethernet is used to connect the system server and each system terminal, as well as to reach out to other systems, using the existing network lines of the elderly care centre. The wireless IoT is used to connect each wireless positioning device and is the base network of the intelligent positioning help system. The devices that make up this network use the internationally accepted ZigBee wireless communication protocol. The protocol has the characteristics of short distance, low power consumption, low cost, strong anti-interference, support for a variety of network topologies, automatic networking, large capacity of node devices, signal collision detection, safety, and reliability, etc. In the intelligent positioning call management system, the wireless communication protocol used by each wireless positioning device is the complete implementation of the ZigBee wireless communication protocol. Based on these features, the wireless locator can be installed and deployed without additional wiring and can be automatically networked by taking power nearby; the wireless locator card can work reliably for several years under the battery-powered model.

$$\begin{aligned} \text{net}_j &= \sum_{i=1}^n w_{ij}x_j + a_i, \\ h_j &= f\left(\sum_{i=1}^n w_{ij}x_j + a_i\right). \end{aligned} \quad (1)$$

The collection, storage, and use of data from the Intelligent Location Call Management System are implemented through a database server [15]. The database server is the

provider of all web-based data services. The data sources mainly involve wireless positioning device information, building layout information of the elderly care centre, association information of the elderly and positioning cards, basic staff information, basic system information of system users, role permissions and other system information, and system parameter information. The data source of the positioning call management system mostly collected by the system itself, and only when it is linked with the video monitoring system and access control system, it is necessary to obtain part of the data from these systems, and the way to obtain it can be operated by directly accessing each other's data source or using each other's communication pipes. When the mobile alarm moves within the network, the signal strength of the communication between the mobile alarm and each positioning base station changes with the distance between them. Since there is a certain correspondence between the signal strength and the distance and the location coordinates of each positioning base station are known, the location of the mobile alarm can be calculated after knowing the signal strength between the mobile alarm and multiple positioning base stations. The topology of the positioning call system is shown in Figure 1.

Each positioning algorithm has its characteristics; there is no best algorithm, only the most suitable algorithm combined with the actual field needs and working environment. Referring to the introduction of positioning algorithms and the research area of this paper, the most suitable positioning algorithm and deployment method are selected by combining the environmental characteristics and functional requirements of the senior care industry. Both the positioning system and the algorithm require an ideal wireless communication environment and reliable network node devices.

The real environment is often complex, and there are problems such as node failure or excessive distance or angle measurement errors caused by node hardware limitations, so the positioning system and algorithm must be highly fault-tolerant and adaptive, capable of correcting errors through automatic adjustment or reconstruction, fault management of the wireless sensor network, and reducing the impact of various errors [16].

This makes the daily life of the elderly safer and more worry-free or provides timely assistance in the event of an emergency. The development of the smart elderly care service platform makes the old age life of the elderly safer and healthier and fully reflects the development significance of healthy aging. The management function design of the intelligent positioning helps the system fully consider the actual management business characteristics of elderly institutions, combines the management mode and business processes, and develops a system function architecture scheme that can meet the business needs. At the same time, it considers the development trend of information technology and fully considers the business expansion interface. The system is custom-developed for elderly institutions. User rights management, part of the data dictionary, and basic information of the elderly can be shared with the intelligent business management system.

$$y_k = \sum_{i=1}^n w_{ij} h_j + b_i, \quad (2)$$

$$E = \frac{1}{2} \sum_{k=1}^M e_k^3.$$

Video surveillance linkage is used when a call for help is generated; the system tries to obtain the signals of nearby available video surveillance probes based on the location of this wireless locator card and then displays them simultaneously to increase the amount of information. The related management operations include location information entry of the video probe, association with the wireless locator, interception display of the video signal, and automatic control of the advanced probe, such as rotation, zoom in, and zoom out. Access control linkage is used to collaboratively obtain control information of nearby access control as needed when the call for help is generated. In addition, when the access control in the generation of card swipe operation, intelligent positioning help system can be based on the location information of the access control to calibrate the wireless positioning card location information. Related management operations include access control location information entry, association with the wireless locator, and data interaction with the access control system.

$$\text{bel}(A) = \sum_{B \in A} m(B) * -E \frac{1}{2} \sum_{k=1}^M e_k^3. \quad (3)$$

Commonly used data preprocessing strategies are divided into four main categories: data clarity, data integration, data transformation, and data statute. Among them, the role of data cleansing is to remove irrelevant data, duplicate data, handle outliers, handle missing values, and smooth noisy data from the original data. The role of data integration is to merge multiple data sources and store the merged data in a consistent data warehouse. Data transformation is mainly for the appropriate processing of data that is not in a standardized format and converting it to a uniform format to accommodate algorithms that have different requirements for data sources. Data statute is to reduce the size of a larger data set but at the same time ensure the integrity of the data set. Data statutes can effectively reduce the impact of invalid and anomalous data on model building, improve the accuracy of modelling and reply to reduce the time required for modelling, and can reduce the cost of storing data.

$$K = \sum_{A \cap B \neq \emptyset} m_1(A) m_2(B). \quad (4)$$

For the elderly health model building, we choose to use a supervised machine learning algorithm combined with the daily location data of the elderly to build the elderly health status, prediction model. Since the supervised machine learning algorithm requires expected output

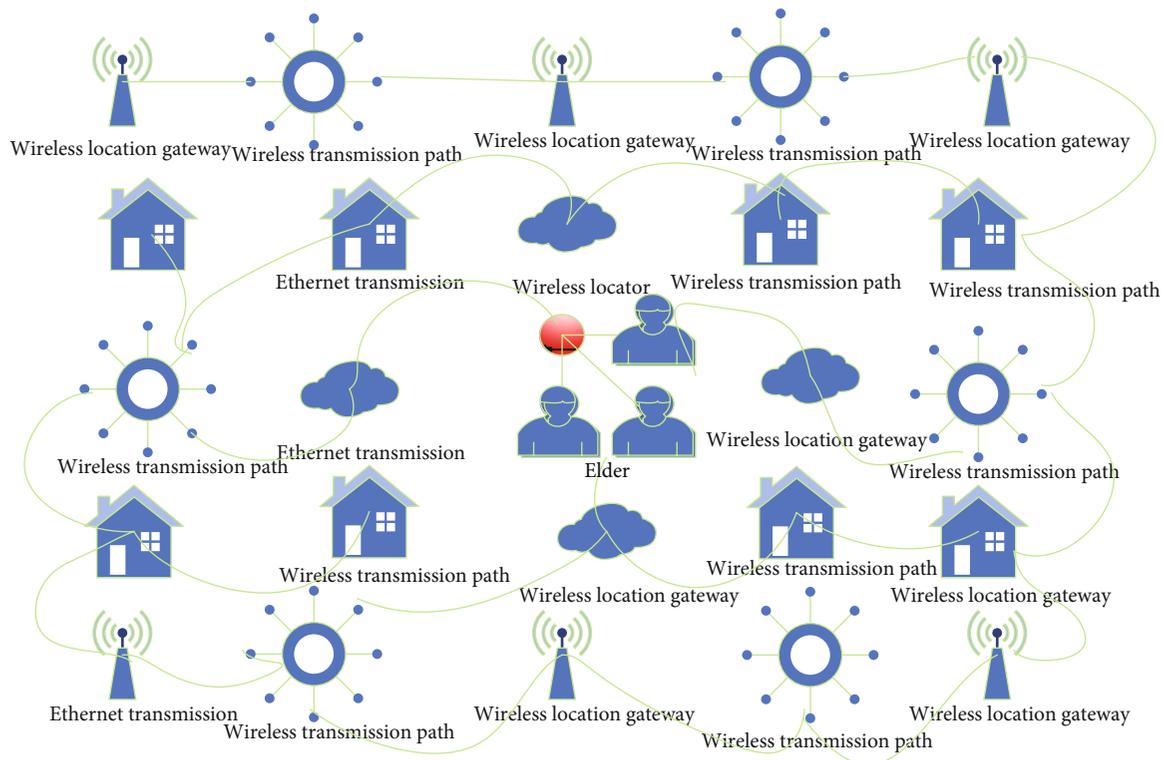


FIGURE 1: Location call system topology.

labels, in practice, we need to have specialized medical personnel to make basic assessments of the health status of the elderly in nursing homes daily, such as “healthy,” “cold,” and use the assessment data as the corresponding labels for the training of the elderly health state prediction model. After that, the health state prediction model can be used to predict the health state of the elderly in combination with the location data of the elderly. As a result, the workload of health care workers in nursing homes can be effectively reduced. When the smart elderly system detects the abnormal state of the elderly, it can notify the health care personnel in time through the app, to provide timely and accurate care services for the elderly and prevent problems before they occur, as shown in Figure 2.

In the nursing home management, needs to increase the hardware facility mainly include the wristband, the information read-write, the data transmitter, the computer, and the server. Among them, the wristband is worn by the old man and records the corresponding information, the information read-write carries on the read-out of this information, the data transmitter carries on the centralized collection to the information read-write in its range and transmits to the corresponding computer, to carry on the daily information implementation record and the information inquiry and so on the operation. And the server carries on the storage to the information, for the external network inquiry, and so on. The wristband is an important device for information collection and transmission for the elderly; a well-functioning wristband should include the following functions. The wristband writes the information of the elderly into the book to carry out the identification of the

elderly information. The wristband has a built-in chip, which can be used to locate the information accurately through GPS so that the location information of the elderly can be checked easily and the real-time management of the elderly can be realized [17]. The wireless Internet of Things is used to connect various wireless positioning devices and is the basic network of the intelligent positioning help system. The devices that make up the network use the international ZigBee wireless communication protocol. Through the wristband to the elderly to carry out relevant information tips, including activity tips and daily service information, the first thing is to determine what is the goal of system tuning, if the application has now met the demand, there is no need to do system tuning; after all, without going through a system process, it is impossible to determine whether the system performance, operability, and other indicators of adjustment done tuned the performance, whether it did not cause other problems in the application, so it is very important to determine the goal of tuning.

First, we have information on the daily habits and case history of the elderly. Knowing the past habits of the elderly is equivalent to predicting the emergence of diseases in advance. Secondly, a risk assessment made regarding the current health of the elderly. The type and controllability of the disease are analysed so that solutions can be analysed sooner. Some controllable risk factors can be controlled through simple matters such as exercise and meals, and health that is not a controllable risk can be regulated through interventions to reduce the tendency of its aggravation, control the deterioration of the disease, and achieve further improvement. The essence of the intervention is to monitor

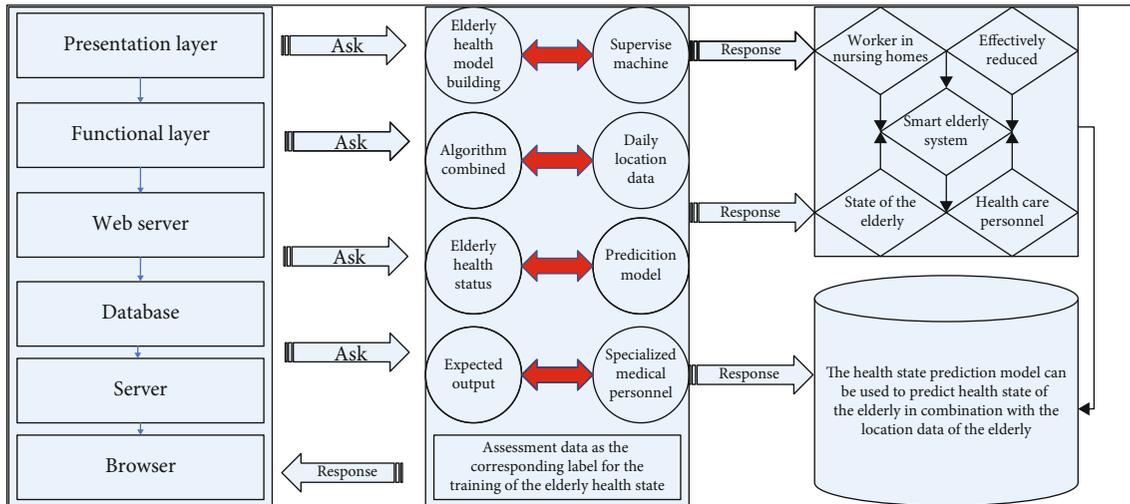


FIGURE 2: Architecture of the B/S model.

and check the occurrence of diseases through continuous interventions, and to guide them through education and awareness while abandoning the approach of enforcement. After the four stages of health management are completed, the cycle of health management starts from the first level of physical examination, which is repeated to slowly change the bad habits of the elderly and further improve the standard of living of the elderly in managing their health at home.

3.2. Optimal Analysis and Design of the Intelligent Elderly Positioning Management System. The main types of mobile communication devices are special mobile communication gateways and mobile phones for the elderly; however, the mobile terminal watch-type health manager can provide users with timely heart rate detection services while being able to conduct automatic search and data transmission, safe and synchronous monitoring of the elderly's real-time physical health, warning of abnormalities in the elderly while providing professional guidance on the physical health assessment of the elderly, the home health. It can also provide professional guidance on the health assessment of the elderly and interflow with the database of the home health management centre to improve the plan of the elderly's different dishes and physical health interventions. Some devices in the home such as blood glucose meters and lipid meters can be connected to smartphones through their Bluetooth function for public body sign data collection. Part of the data obtained from these systems can be obtained by directly accessing the data source of the other party or using the communication channel of the other party to operate. When the mobile alarm device moves within the network, the signal strength of the communication between the mobile alarm device and each positioning base station will change as the distance between them changes. They can collect and track information such as signs about the family as well as different individuals at any time and place and create a health profile with this information [18]. The devices can automatically alert in case of abnormalities. Also, as the

needs of the customer base are constantly changing, smartphone-related sensory features are being developed and innovated.

The staff of the health management platform for the elderly is kind enough to prepare a health file for each member as well as the emergency contact information of the platform, and this file corresponds to the information management of the corresponding health terminal. For the elderly to achieve at-home use can use the corresponding health management terminal system, such as blood glucose meter, weight meter, blood pressure meter, and other devices to transmit personal data, to detect the physiological parameters of the elderly information, and will be through the relevant devices such as smart TV, computer, and mobile phone, into the health management platform. Whether the elderly is outside or at home, whether they are using smartphones or the newly developed watch type manager, they can realize the transmission of their physical health data easily with the push of a button, and when the data is transmitted to the health management platform, the management centre will be able to always monitor the health of the elderly. After receiving the information from various devices, the senior home health management platform will record the information of the elderly in normal condition into the file, but there are also some out of normal value, which requires professional medical personnel to determine whether the abnormal value is dangerous. For some information identified as health abnormalities, the system will automatically start calling the seats and handing the information to the professionals. The elderly person is contacted in time to ask about the situation or their family members are contacted and sent to the hospital for urgent health checks. The senior home health management platform can develop good health plans based on the long-term health information of the elderly, provide the best quality health services for the elderly, and hold healthy community activities from time to time. The health management centre can also use the positioning system to grasp the specific situation of the elderly in real-time, to make it more convenient to

serve the elderly and create a safe, comfortable, and healthy living environment. Various hospitals have partnership with the management platform, and they can make appointments online to see a doctor, and even remote treatment and inquiries, making complete preparation for the physical and mental health of the elderly [19]. If the elderly urgently needs to be rescued, the senior home health management platform can provide doctors with the most comprehensive health information about the elderly, as well as relevant files, increasing the success rate of successful resuscitation, as shown in Figure 3.

Based on IoT technology, the application framework of elderly home health management carriers is divided into several levels, data integration application, data integration layer, data collection layer, etc., while it can be divided into three levels due to the features of the function. The main task is data collection, which includes device collection and data entry of various smart devices. Through various systems such as websites, mobile phones, and home appliances, the collection of physical health data of the elderly is completed. And these data will be collected and stored centrally in the health management work platform. The data construction layer mainly includes the data sharing and business collaboration between the second- and third-level medical institutions and community medical service centres about the physical health records of the elderly. This application layer is mainly a portal facing the elderly residents to realize the integration of health records and monitoring data of the elderly, mainly including chronic disease prevention and assessment, health education, prediction and trend analysis, health monitoring, and early warning.

The data processing layer includes a basic information database, GIS database, and business sharing database, to provide data support for the application layer. The data processing collects complex health big data about the elderly through the platform, stores this huge and scattered information in the system's database, and mines this data information to provide data analysis for active matching services for the elderly. Real-time management of the elderly was realized. Relevant information prompts for the elderly through the wristband, including activity prompts and daily service information. The first is to determine what the goal of system tuning is. If the application now meets the requirements, there is no need to do system tuning. The data processing layer not only collects and analyses information about the elderly but also provides data on medical institution information and medical staff information. The data processing centre can also process data based on mutual feedback between the elderly and service providers and provide better services for both parties. Big data mining of the platform can provide a clear direction for smart elderly services. The changing health needs of the elderly are in line with the economic level and social development, and these needs include low-level survival needs as well as high-level self-actualization needs. Demand drives supply, thus driving the development of a series of elderly care industries such as medical institutions, health care products, and smart appliances. And with the continuous progress of the times and the continuous innovation of technology, more demands

for elderly health services will be put forward to society, and the smart elderly service platform will also change with the changing health needs of the elderly, as shown in Figure 4.

With the improvement of living standards, the demand for elderly education and mental health has become more obvious, while most of the services provided by the platform are on care needs, and there is a gap between the supply of services and the demand for services. Improving the service content of the smart senior care service platform from the health needs of the elderly is a problem that must be considered for the better development of the smart senior care service platform [20]. At the same time, the various systems of smart senior care are complex, each system is independent of each other, lacking effective communication and connection, and resources not integrated, which is not conducive to the integrated management of the platform of smart senior care services, and the scheduling optimization and effective use of senior care service resources. The recognition of the elderly population to the wisdom senior care service products also remains at a low stage, and a good interaction model cannot be formed yet. The services provided by the smart senior care service platform are mainly reflected in the passive response to the health needs of the elderly, while the intelligent control technology is used to carry out remote real-time monitoring of the daily actions, living conditions, physical functions, and other data of the elderly analyse the service needs of the elderly and actively provide services for the elderly, and the intelligent level of smart senior care is not high.

4. Results and Analysis

4.1. Performance of Smart Aging Location Management System with Wireless Sensor Network. With age, the elderly will experience physiological decline, and their ability to accept and adapt to the surrounding environment and information decreases, which will also be accompanied by slow reaction and poor acceptance. The platform should be built according to the different health needs of different elderly people, integrate the elderly service resources, and connect medical institutions and service organizations for the smart elderly service. The construction of the smart senior care service platform is generally combined with senior care service institutions and medical institutions, and in order to attract more resources, the platform should also be modified according to the requirements of service institutions and medical institutions to make it its own smart senior care service platform, so the smart senior care service platform should be improved in terms of software facilities and hardware facilities, not only need to build a more intelligent and safe platform, develop suitable senior. Therefore, the smart senior care service platform should be improved in terms of software facilities and hardware facilities, not only to build a smarter and safer platform, develop wearable devices suitable for the elderly but also to renovate and upgrade the smart senior care service items and systems, so that the service items and systems are flexible and elastic, in addition to improving the professionalism of senior care services,

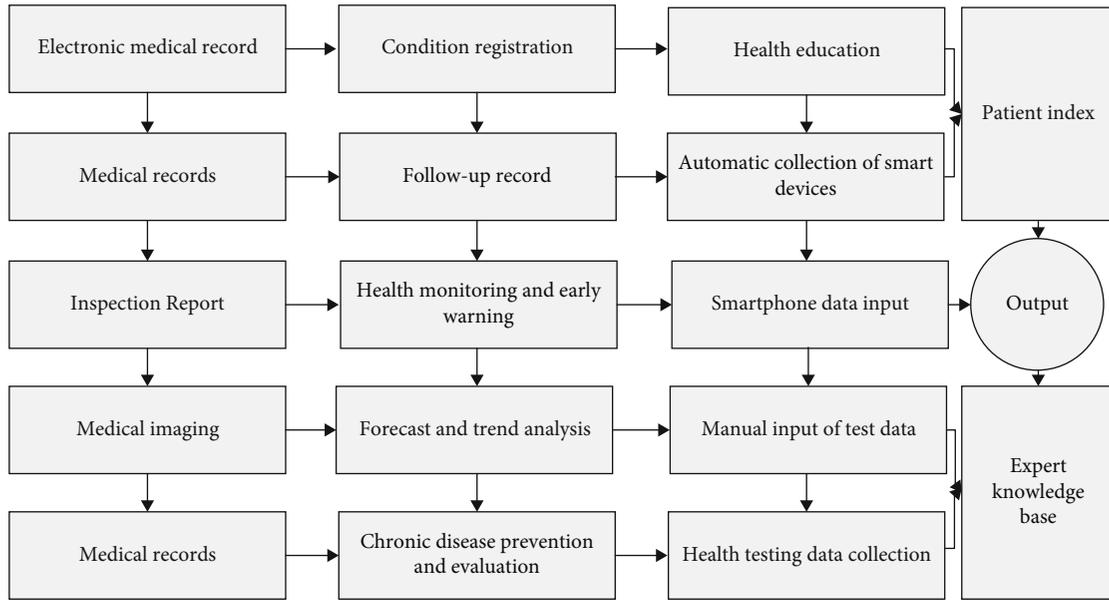


FIGURE 3: Framework of the physical health management work platform for older persons at home.

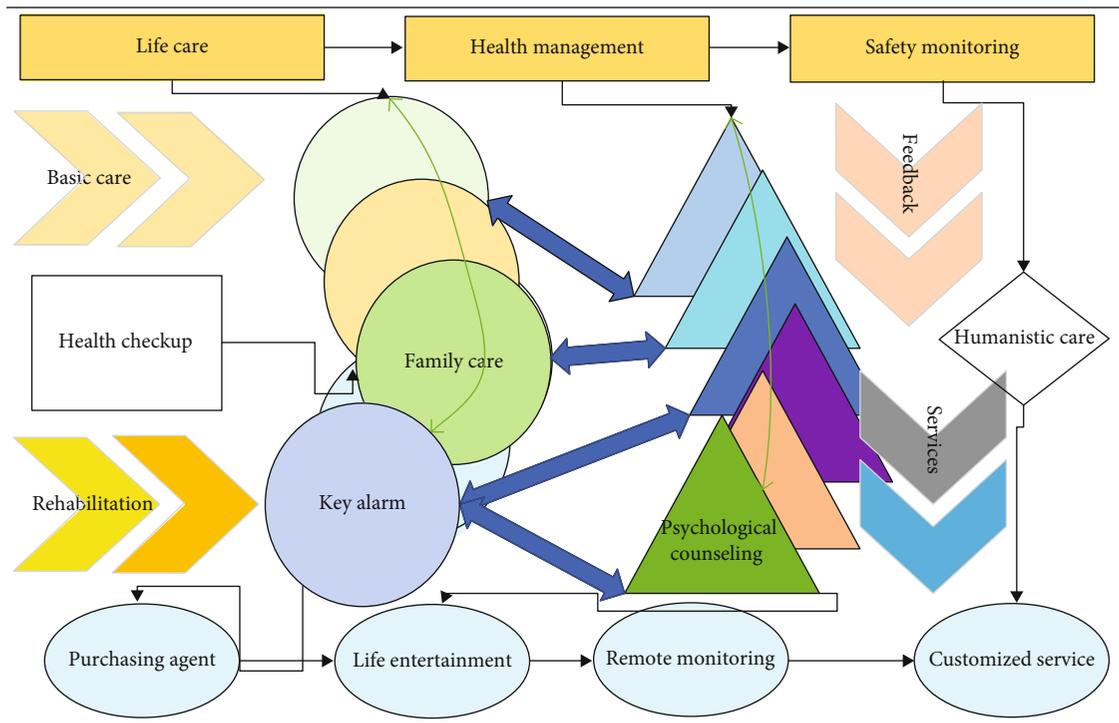


FIGURE 4: Service content of the smart senior care service platform.

providing personalized and customized services and health management plans for the elderly to meet their health needs to the maximum extent, as shown in Figure 5.

The sharing of resources for the elderly is reflected in the following: firstly, the sharing of resources for service personnel, who should serve every elderly person equally, and the elderly should also enjoy the services equally. Medical resources can play an important role in the services for the elderly, and the elderly can physically examine using medical

testing equipment, and the doctor will then make a good record of the data so that there is no differentiation in the treatment of the elderly. Finally, the data sharing of all platforms, including the existing information platform of health information and elderly service information, to establish a standardized interoperable information common data-sharing system, so that all kinds of elderly service institutions, medical institutions can data sharing, these information data can be effective to the development, to provide

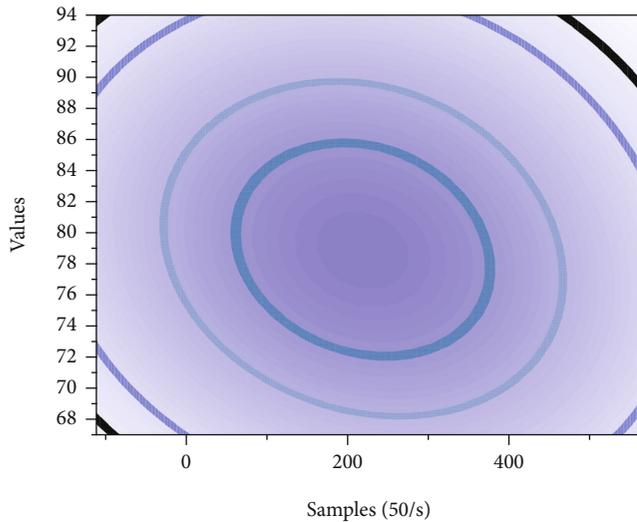


FIGURE 5: Change in acceleration during a fall.

data support for the elderly services, to promote the sharing and integration of health and elderly big data. There are also docking elderly users who have signed up with family doctors, family doctors because they have been with the elderly for a long time, understand the habits and physical condition of the elderly, have professionalism and target, and will analyse the health needs of the elderly and the elderly services needed from a professional perspective. We are also working to expand the coverage of basic public services, improve the quality of life of the elderly in need, and develop community-based elderly care services, such as elderly care homes, which combine elderly care and day-care, and provide elderly care services to the elderly in the surrounding communities to expand the scope of radiation. The development of smart senior care service platforms has changed from “point clustering” to “surface dispersal,” which means that the development of smart senior care service platforms has changed from focusing on hardware investment in the past to focusing more on “software services” nowadays. This means that the development of the smart senior care service platform has changed from focusing on hardware investment in the past to focusing more on “software services” to continuously meet the multilevel health and senior care service needs of the elderly, as shown in Figure 6.

In the case of using only acceleration as the basis for fall judgment detection, the fall judgment is more accurate, but the judgment miscalculation rate is higher for daily actions, including walking, sitting, and lying down, so a more rigorous judgment basis needs to be introduced. The angular velocity value is used for joint judgment to improve the accuracy of the system, while in the actual judgment, the angular velocity only takes the value of the z -axis direction. Through the experimental analysis, the two actions of walking and sitting down, the SVM may produce larger values, but at this time the z -axis angular velocity is relatively small within $40^\circ/\text{s}$, and the lying down action is the opposite result SVM value is smaller, the angular velocity reaches $220^\circ/\text{s}$ or more, while in the actual fall, the human body collides with the ground SVM and z -axis angular velocity reach the peak

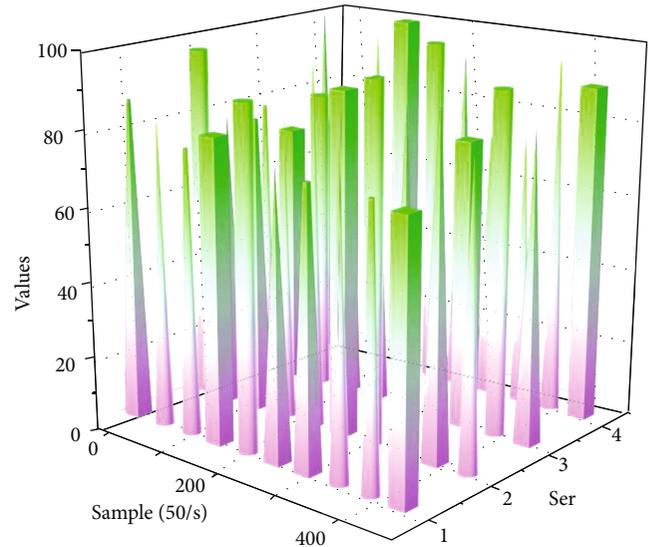


FIGURE 6: Network communication test results.

at the same time, respectively, 2.7 g and $227^\circ/\text{s}$. Therefore, the SVM threshold of the system was finally set to 2.5 g and the z -axis angular velocity threshold was set to $210^\circ/\text{s}$.

4.2. Systematic Optimization of Aging Positioning Results.

The purpose of system user management is to ensure the security of the system, and its functions include doctor user management, elderly user management, personal information modification and audit management, and user rights management. Users can only perform other secondary operations after successful login. It is possible to collect and track the sign information about the family and different individuals at any time and place and establish this information into a health file. The device can automatically alarm when an abnormality occurs. At the same time, as the needs of customer groups are constantly changing, the related perception functions of smart phones are also constantly being developed and innovated. To ensure the authenticity of user information, the administrator will have unified assign accounts after reviewing user applications and has the authority to modify user information, and only users who have been approved by the administrator can use the system. The health monitoring module is the core module of this monitoring software, mainly including two submodules of real-time monitoring and history recording. Real-time monitoring means that the hardware device uploads the physiological data collected from the elderly to the server, and the elderly can view the real-time data by logging into the mobile client; history record means that the software shows the elderly the average value of the daily health data measured within a specified period in the form of lists and charts. Through the trend changes reflected in the graphs, the elderly can intuitively understand whether their physiological data is in a relatively stable range and roughly judge their current health status with their actual feelings. In addition, the history also includes the medical examination records and consultation records of the elderly in the

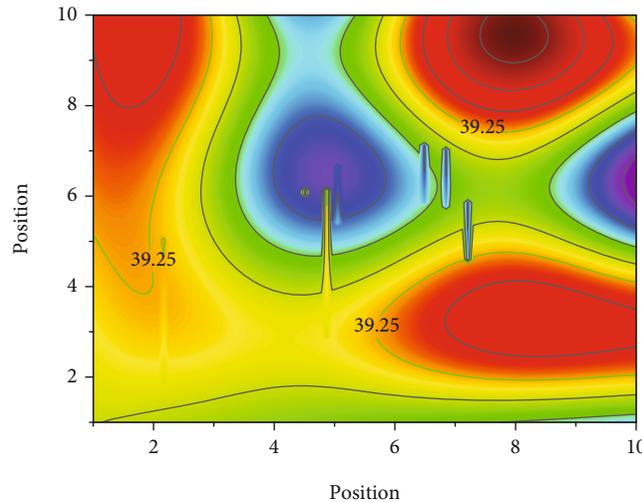


FIGURE 7: Historical positioning data.

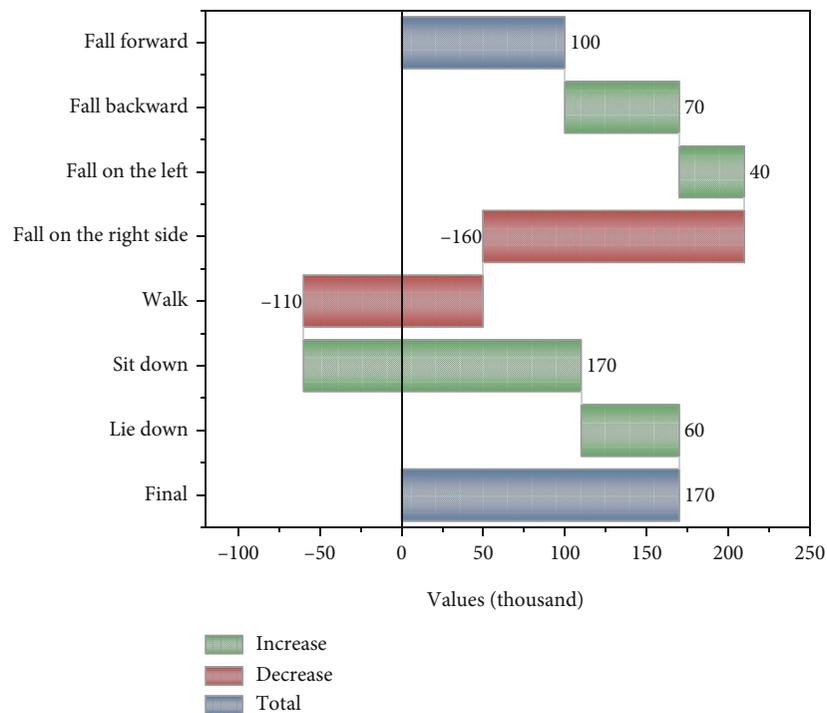


FIGURE 8: Fall test data.

community hospital, so that the elderly can have comprehensive control of their health, as shown in Figure 7.

Testers 1 and 2 experienced positioning jitters when approaching 3, 4, and 5. The analysis showed that the received RSSI jumped when the bracelet was judging the position due to factors such as occlusion or interference from indoor personnel. The results of the test met the expectations, and the testers were able to suppress the positioning jitter better when they gathered, and the real-time performance was also guaranteed due to the loose setting of the filtering parameters.

The emergency rescue module provides a data anomaly alarm and a one-touch call for help. Abnormal data includes

location data and health data. The abnormal alarm based on location data means that the client uses the relevant services of Baidu Map to obtain the current location of the elderly, and the system administrator will notify the elderly’s family in time after receiving the warning message; the abnormal alarm based on health data means that when the measured physiological data of the elderly exceeds the normal range; the system will notify the administrator in time and send a push reminder to the elderly’s mobile phone. The one-touch call for help function means that when an elderly person encounters an emergency and needs help; he or she will click the one-touch call for help button and the client will jump directly to the dialling interface of the mobile phone

to contact the previously set emergency contact or the senior service centre and request help. The doctor-patient communication module used community elderly and community doctors, helping the elderly and doctors to communicate directly. Seniors can use the online message function to ask their doctor about their health, and the doctor will reply base on the message. In addition to the online message, the elderly can also call the doctor directly for a detailed consultation, as shown in Figure 8.

From the waveform, we can see that the waveform is complete and recognizable in the stationary state, and the heart rate value can be calculated more accurately; while the curve fluctuates more when walking and talking, and because it is measuring the wrist, there may be a situation that the bracelet moves when walking, and the peaks and valleys cannot be accurately recognized. To solve this problem, by analysing the working principle of heart rate sensor during the movement of many bracelets with heart rate collection function on the market, we adjust the program logic of the bracelet, increase the judgment of acceleration sensor data during heart rate detection, suspend the sensor data collection if there is a large acceleration fluctuation, delay the detection time, and wait until the bracelet is in a more static situation before heart rate and blood oxygen detection to reduce unnecessary. This reduces unnecessary data errors and misjudgement of the management system.

5. Conclusion

In this paper, we studied the key technologies involved in the IoT nursing home management system and determined the technical direction; then, we collected existing nursing home management system solutions, fully analysed and understood them, summarized the pain points solved in these systems, took the essence of their elderly management and business management, and combined them with the needs of the nursing home management system designed in this paper to develop the overall design plan, hardware. The overall design plan, hardware design plan, and software design plan are formulated; then, the hardware design and software design and development work are carried out, and the hardware devices such as hand ring, relay node, and gateway in the system are selected with chip sensors and hardware circuit design, and the Bluetooth Mesh network communication plan, Bluetooth Mesh-based indoor positioning plan, sensor acquisition plan, and management system upper computer software development plan are designed; finally, after the completion of the above hardware devices and upper computer software, the system is developed. Finally, after completing the hardware equipment and the software, the software and hardware testing environments are set up in the actual scenario to test the key technologies in the system: Bluetooth Mesh communication, indoor positioning, heart rate, and oxygen saturation collection and calculation, body temperature collection and calculation, and the elderly fall detection function, and the performance and error of each test item are analysed in detail with the test data and improvement suggestions and solutions are given. The construction of the smart elderly

service platform should be based on and solve the current situation of the aging problem, and constantly alleviate the contradiction between the health needs of the elderly and the shortage of service supply. The smart elderly should be improved and designed through the overall system of the government, society, and millions of families, and, finally, achieve the goal of smart elderly with effective use of resources and high efficiency and intelligence. It will relieve the pressure on the elderly, make every family have a better life, and make the elderly live a healthier life in their old age.

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 known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This work was supported by the Key project of Fuzhou Social Science Fund in 2017, A Study on the Accurate Supply of Home-based Community Elderly Care Services in Fuzhou City (2017FZB10).

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