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Smart Pension System Based on Big Data Mining Algorithm

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Abstract: With the increasingly prominent problem of aging in our country, it has become an urgent task for our society to establish and improve a good old-age care system. At present, a new type of community smart elderly care model is gradually emerging, and has been actively explored and improved. In order to meet the needs of community elderly care services, big data mining algorithms are used to process data, and the smart elderly care system is connected with mobile APP and computer server equipment. Open source WebGIS technologies such as OpenLayers/Cesium, PostgreSQL/PostGIS, GeoServer, etc. are used as core supports, combined with front-end And back-end development technologies such as Vue and SpringBoot, etc., developed a mobile smart pension app and a web smart pension system based on open source WebGIS. This system can be more in line with my country's current smart elderly care service system, and accelerate the construction process of my country's intelligent elderly care.

Keywords: Smart Pension System, Big Data Mining Algorithm, WebGIS, Vue, SpringBoot.

1. Introduction

With the increasingly severe aging problem in our country, establishing and perfecting the old-age security system has become an urgent task of our society. However, we are currently facing the following two practical challenges: First, although the construction of the elderly care service system has achieved initial results, the quantity and quality of service supply still cannot meet the actual needs. With the intensification of the population aging trend, the birth rate continues to decline and the total population growth is zero or even negative, making China likely to enter a stage of negative population growth, which will have a profound impact on the high-quality development of labor supply and consumption levels. Therefore, the most important issue to consider at present is how to maintain a long-term balanced development of China's population, which has a profound impact on the high-quality development of labor supply and consumption levels[1].

Since entering the 21st century, the Internet revolution is one of the most important technological revolutions in human society. The rapid development of the Internet has enabled industry and service industries to penetrate and integrate with each other. The rapid development of electronic technology and Internet technology has jointly promoted the development of new service industries including elderly care services and the innovation of service models. Smart technology has been widely used in home, community and institutional elderly care, and has achieved deep integration, gradually forming a new elderly care service system under the smart elderly care model, and realizing the digital, electronic and informational construction of the elderly care service system.

2. Main Function Introduction

The smart pension system is a real-time online monitoring platform with high reliability and stability. The system can obtain the health status of the monitored person in time, and start corresponding online health services through remote collaboration. At the same time, the system can also send alarm information to guardians to maximize the protection of the health and safety of the elderly. The smart elderly care online monitoring system realizes multiple functions such as elderly information management, daily monitoring management, medical doctor's order management, and accident management under the elderly account mode, and has relatively comprehensive services. The system mainly includes three user roles, namely administrator, elderly and children[2].

2.1. Main Functions of the Administrator Module

2.1.1. Elderly Information Management

This module mainly realizes the management of the basic information of the elderly by the administrator account, including the functions of adding, viewing, modifying and deleting the information of the elderly, and can also add and manage the accounts of the elderly and children.

2.1.2. Daily Monitoring and Management Functions

This module aims to realize the collection and monitoring of physiological data of the elderly, including heart rate and blood oxygen data collection, monitoring of spatial displacement changes of the object to be measured, real-time recording of geographic location information in abnormal situations, and abnormal physiological data alarm. When the health of the monitored person is abnormal, the system will promptly send information about the abnormal physical condition to the monitoring platform, and store and manage the data. At the same time, supervisors can remotely control terminal equipment on the monitoring platform, including setting environmental safety thresholds and turning on equipment, to ensure the stability and safety of the system operating environment.

2.1.3. Doctor Order Information Management Function

The function realized by this module is to add, view and delete the medical order information of the elderly.

2.2. Elderly Module Function

The main functions under this module include the elderly viewing the administrator's records of their daily behavior; the doctor's order viewing; and the management of their own accidents; functions involving accidental addition, viewing, and deletion.

2.3. Child Module Function

The main function of this module is to enable children to view the information of the elderly, and to know the health status and daily activities of the elderly at any time, including daily monitoring information viewing, medical doctor's order viewing, and accident information viewing[3].

3. Realization of Software Functions of Smart Pension System

During the development of this project, we used Vue and SpringBoot technologies, and used MySQL database for the entire data design. In the stage of designing the database, we carefully analyzed the requirements and designed the following six data tables: administrator password table (t_admin), elderly information record table (t_dengji), daily monitoring management table (t_jiankong), medical order management table (t_yizhu), accident management table (t_yiwai) and child information management table (t_zinv). The administrator has the highest authority of the system, and can add and delete the information of the elderly, manage daily monitoring, and manage medical orders. When the administrator logs into the system with his own account, the function menu options will be displayed on the left. The administrator can click the menu option, select the required operation module in the right interface, and further perform corresponding submenu operations.

3.1. Elderly Information Management Interface

In this interface, the administrator user can add the basic information of the elderly, including name, gender, age, phone number, address and login password. The elderly number will be automatically generated, which is the login account of the elderly user. When adding elderly information, you must ensure that the information is filled in completely, and any information cannot be empty, otherwise it will not be able to save and an error will be prompted. The main method is to check whether the user input data is empty through onsubmit="return checkForm()" to ensure the integrity of the data. After adding the elderly information, the administrator user can jump to the child information management interface through the child management button on the elderly information management interface. The system queries all the children's information of the elderly through the children's Action class, binds these data to the request for jumping, returns the corresponding JSP interface to display the detailed information of the children, and can also delete the children's information[4].

3.2. Daily Monitoring and Management Module

After the administrator user logs in to the system, he can select "daily monitoring information management" in the left menu to open the monitoring information management interface. The background of the system will automatically call the Action class of the daily monitoring information to find the recorded daily monitoring information, and transmit the data to the foreground to display all the current daily monitoring information, so that the administrator can manage and view it.

3.3. Medical Order Information Management Module

After the administrator logs in to the system, he can open the medical order management interface by clicking the "Medical Order Management" module in the left menu. In this interface, the system will automatically call the Action class of the medical order to query all the added medical order information, and encapsulate the information into a list data set. Then, the system turns the page to the JSP page corresponding to the Action class, and the front end will display all the medical order information that has been stored in the database. Administrators can manage medical order information on this interface.

3.4. Modify Login Password Interface

After logging in to the system, the administrator can select the "Change Login Password" option in the function menu on the left to modify his own login password, which helps to prevent information loss caused by password leakage. When changing the login password, you need to provide the original password to operate.

The purpose of the system test is to find out the errors in the program and the problems that may occur during the operation of the system in the process of simulating the actual use of the system. During the development of the system, the experimental data in the early stage is only added to test the development completion of the function. During a full system test, all previously recorded data is cleared. The administrator account type has higher authority. During the test, each module will be tested in detail to ensure that the function can achieve the design effect. Ultimately, the test results should show that all functions work well.

4. Hardware Composition Structure and Algorithm Realization of Smart Pension System

4.1. Implementation Process of Detection Alarm Algorithm

The combined use of the main control processor MCU and MEMS multi-axis acceleration module in the smart watch (or the components in the mobile phone) can realize the detection of the elderly's body movement, tilt, fall, vibration, swing and other states. MMA7260Q three-axis acceleration sensor, as a micro-electromechanical intelligent sensing system, can quickly capture and start responding to sudden radio frequency signals in smart wearable devices within 1.0ms, including blood pressure, blood sugar, blood oxygen, pulse, heart rate and Collect data such as ECG, and convert different body monitoring accelerations into voltage output. There are mainly the following aspects in the implementation process of the fall detection algorithm for the elderly group during exercise[5].

The eigenvector of the human body during motion mainly includes acceleration (m/s2), acceleration vector amplitude, absolute average value of acceleration differential, and human body postures such as pitch angle (pitch), yaw angle (yaw), and roll angle (roll) horn. When high-intensity and violent

movements occur in the elderly group, the SVM peak value will continue to increase, and the acceleration vector amplitude is defined as: $SVM = \sqrt{a_x{}^2 + a_y{}^2 + a_z{}^2}$ (x, y, z-axis acceleration respectively).

The acceleration vector amplitude SVM of the elderly when they fall is usually SVM≥1.8gn, so the critical value of the first-level fall detection is set as SVM=1.8gn. Later, when the elderly are running fast, the acceleration vector amplitude SVM in the smart wearable device will also be greater than 1.8gn. At this time, it is necessary to set the absolute average value of the acceleration differential MADS as a secondary fall for the elderly group. Detection threshold. When the general old people fall, the absolute mean value of the acceleration differential MADS≥0.36g/s, the absolute mean value of the acceleration differential is defined as(T:time period):

$$MADS = \frac{1}{T}\int_0^T |SVM|\,dt$$

Under the constraints of the above two fall detection critical values, through the calculation of the relationship between the acceleration of the human body in the x-axis, y-axis, and z-axis space, and the gravity of the human body, the pitch angle (pitch) and yaw angle (yaw), the horizontal inclination angle θ1 and the vertical inclination angle 2 are used as the critical value of the third-level fall detection, and the definition of the human body posture angle is:

$$pitch = \arctan\left(a_y / \sqrt{a_x{}^2 + a_z{}^2}\right)$$

$$yaw = \arctan\left(a_y / \sqrt{a_x{}^2 + a_y{}^2}\right)$$

4.2. Functional Information Detection Module and Algorithm Implementation

In the smart elderly care system for residents, the monitoring system composed of intelligent sensor data measurement module, reader, wireless data repeater, embedded web server, etc., can realize the collection of blood pressure, blood sugar, pulse, body temperature and other data of the elderly and monitoring. Among them, the monitoring modules in smart wearable devices and handheld mobile devices include a variety of serial port/network protocols, test chips, and blood pressure, blood sugar, body temperature, pulse detection sensors and data transmission modules. Through GSM/GPRS communication technology, the collected data is transmitted to the community remote monitoring center for processing and analysis, and the final monitoring results are displayed on the control page. When the elderly have abnormal physical conditions, they can notify the nursing management staff through the one-key call system to carry out corresponding medical and nursing work. In this system, the reader and the wireless data repeater connect the smart wearable device and the embedded Web server, and the embedded Web server receives the transmitted human body information, and automatically executes the make fifo statement of the monitoring program, and converts different channel variables The dynamic numerical value is converted into a CGI file. When the user issues an access request for stored data such as blood pressure, pulse, body temperature, blood sugar, etc., the main program executes the submit command to transmit the values of various variables to the user port, thereby realizing the user's data access requirements. Through the organic combination of smart wearable devices, embedded Web server and GSM/GPRS communication technology, the elderly group physical condition monitoring system can realize remote monitoring and management, and provide safer, more comfortable and convenient home care services for the elderly.

In the process of implementing this algorithm, the main program needs to use the switch statement to perform data transmission and control of different network interfaces. The algorithm of the gateway main program is implemented as follows:

```
int main(int argc, char * * argv){
    int up;
    int oldcarebaojing;
    int fd;
    if (argc!=3 || sscanf(argv[1],"%d", &oldcarebaojing)
!=1 || scanf(argv[2]," %d",&up)!=1 ||up< 0 ||up>1
|| oldcarebaojing< 0 || oldcare baojing> 3){
        fprintf(stderr,"WRUPG\n");
        exit(1);
    }
    fd=open"( /dev/oldcare_ oldcarebaojings", 0);
    if (fd<0) {
        fd=open"( /dev/oldcare_ oldcarebaojing", 0);
    }
    if (fd<0) {
        perror"( open device oldcarebaojing");
        exit(1);
    }
    ioctl(fd, up, oldcarebaojing);
    close(fd);
    return 0;
}
```

According to the main program of the gateway above, it can be concluded that oldcarebaojing represents the type of alarm, 0 for no alarm, 1 for alarm, and the switches are respectively represented as Up and Close. With the help of fd=open"(/dev/Oldcare_oldcarebaojings",0) program, you can open and view the transfer files of different devices, and through ioctl(fd,up,oldcarebaojing), you can realize the control of input and output I/O pins of various devices. Afterwards, the caregivers of the intelligent elderly care system will take relevant measures to provide medical, nursing or first aid services for the elderly in the community based on the alarm information of different gateway main programs.

5. Application and Promotion of Smart Pension System

In this project, we completed the design and implementation of the smart elderly care system, and tested it. Although the system works well in a lab environment, there is still a lot of room for expansion, and we can consider the following:

1) The location data modeling method for the elderly used in this project is just a simple processing method for location data. In the future, we can use other data preprocessing methods to reconstruct the location data of the elderly.

2) In the input data of model training, environmental factors (such as temperature and humidity) in nursing homes can be added as influencing factors.

3) In practical applications, doctors can be asked to classify the health status of the elderly in more detail (such as "cold", "fever", "insomnia", etc.), and then combined with machine

learning algorithms for modeling.

4) In addition to supervised learning algorithms, we can also use unsupervised learning algorithms (such as KNN) to cluster data, observe the accuracy of prediction results and discover new activity characteristics of the elderly.

5) The system requires a large-scale user trial to optimize system performance and fine art design for the user interface.

6) Apply wireless sensor technology to home care, use Bluetooth and wireless wifi technology to make sensor information collection devices wireless, standardized, and low-cost, so as to broaden product audiences and consumer groups.

7) Extend the health status prediction algorithm from specifically targeting the elderly population living in nursing homes to other populations (such as patients with Parkinson's disease). More types of sensor devices can be used to collect more types of user sign data to expand Scope of application of health status prediction models.

6. Operating/Running Environment

CPU: Intel Core i7-13700KF 5.4GHz;
Running Memory: 4G and above;
Operating System: Windows11;
Browser: Chrome browser;
Programming Software: Microsoft VSCode;

7. Summary

With the gradual increase of the aging population of urban and rural residents in our country, a nursing system covering location positioning, path tracking, vital sign detection and call alarm service will be constructed under the guidance of "big data mining algorithm" to monitor the elderly population at any time According to the living environment, physical condition, fall situation and location of the elderly, rescue and care for emergencies and accidental injuries of the elderly. In addition, based on Vue/SpringBoot, a smart elderly care system based on big data mining algorithms is designed and implemented, which can analyze and warn of various elderly body information, and solve the medical or nursing problems of urban and rural residents' elderly care management.

In the future, the system will be researched in conjunction with the medical Internet of Things. According to the top five medical Internet of Things (IOMT) applications published by NIX Solutions on August 5, 2021, such as Wearable Biosensors, Automated Insulin Delivery, Connected Inhalers, Smart Thermometers (Smart Thermometers) and virtual hospitals/wards (Virtual Hospitals/Wards) meet medical needs.

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