Research on Smart Elderly Care Health Monitoring System Based on Data Analysis Algorithm

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Abstract: With the development of society, people have higher and higher requirements for living standards, and at the same time, the problem of aging in our country is becoming more and more serious. In such an era with a large population base, good economic conditions and a variety of pension options, our country's pension problem is particularly prominent. The physical and mental health of the elderly often brings a huge burden to the society. Therefore, how to effectively utilize these resources has become an important issue that needs to be considered and solved. Smart city is a new type of community construction model and management concept. It integrates traditional public medical service system and advanced information technology to provide more humanized, convenient and safe services for the elderly while meeting the needs of the elderly. This paper takes the smart elderly care health monitoring system as the research object, and introduces it in detail in combination with the current development status of smart community construction. Firstly, a data analysis algorithm based on the decision tree algorithm is proposed to build a complete, efficient, safe and reliable smart city integrated management system, and the data analysis based on the decision tree algorithm is analyzed and studied. Secondly, the related technologies implemented by this system are described. Finally, the design and implementation of the smart old-age health monitoring system are studied.

Keywords: Data analysis algorithm. Decision tree algorithm. Pension health monitoring system

1 INTRODUCTION

In recent years, China's economic development has become faster and faster, and the problem of population aging has become more and more serious, which means that the society has an increasing demand for elderly care services. The lack of social pension service supply capacity makes our country face enormous pressure in the development of smart pension[1]. At present, the traditional home care model can no longer meet the service needs of elderly care. Therefore, the construction of smart elderly care in our country is in the development stage, and its demand is also expanding. The smart old-age health monitoring system is a system that integrates smart old-age care, home care and health management. It is supported by data processing technology and can obtain information on the physiological state (such as blood pressure, etc.) of the elderly in real time. And it responds accordingly according to the self-monitoring, analysis and evaluation of the elderly's own physical condition[2]. It has high reliability and real-time characteristics and is widely used in the medical and health field, and can timely understand the

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physical condition and changing trends of the elderly and respond accordingly, which can provide patients with better services. At the same time, the smart elderly care health monitoring system can also monitor and analyze the data changes of the elderly's physiological state (such as blood pressure, blood flow, etc.) in real time. Based on the introduction of the smart elderly care health monitoring system, this paper analyzes and researches its system architecture, hardware and software[8].

2 DATA ANALYSIS BASED ON DECISION TREE ALGORITHM

2.1 Data preprocessing

Data preprocessing refers to the analysis, extraction and transformation of the obtained raw information into a usable mathematical form. It includes two processes: acquiring and storing a large number of valid coding sequences and their subspaces, and then building a classification model based on these eigenvalues. In order to achieve this goal, it is necessary to first determine which type parameters can be used as the sample data set or standard to be tested, and preprocess them, and then obtain the parameter according to the number of samples and feature types of the data set or standard. Secondly, select a suitable measurement method (such as ultrafiltration) to process the obtained raw data and remove irrelevant data, and then change the data, discretize the data, and finally form the data required for this mining task.

(1) Data extraction. Data extraction is a common analysis technology, which can be classified according to different needs. In the database, by extracting and converting the information to be queried, data that meets the requirements and needs to express clear and visible results can be obtained. In the process of integration, the analysis of the relationship between query results and demand information is finally realized. Data extraction. Data extraction is a common analysis technology, which can be classified according to different needs. In the database, by extracting and converting the information to be queried, data that meets the requirements and needs to express clear and visible results can be obtained. In the process of integration, the analysis of the relationship between query results and demand information is finally realized, then proceed to modeling, classification and regression process[3].

(2) Data cleaning. The purpose of data cleaning is to identify, extract and classify the processed information, transform it into a certain characteristic or attribute, and maintain that characteristic in the process. Since the smart elderly care health monitoring system adopts an object-oriented web page model, when providing service requests to users, it will involve a large number of user needs from different fields and high data quality requirements for database access. At the same time, the integrity and consistency, correctness and availability of the processed information should also be guaranteed. At present, our country's smart elderly care health monitoring system is mainly user-centered, using data analysis-based technology, and obtaining corresponding results after collecting, processing and classifying a large amount of information[4].

(3) Data transformation. The goal of data transformation is to compare the original input with the new output to determine which metrics reflect current information and which factors reflect future states. In practical applications, the model of unsupervised structure (such as user requirements) is used. This method mainly uses storage media such as databases and text files

to realize data conversion, and provides corresponding data processing functions. The process of converting the output into a data sequence is called information transformation. In this process, it is necessary to discretize the data sequence, and obtain the original information through a certain transformation method.

2.2 Decision Tree Classification Method

Decision tree classification algorithm is a multi-attribute data mining method based on the combination of probability learning and statistical analysis. Its purpose is to summarize and classify a large amount of input information. It divides the knowledge with the same characteristics or regularity in different types and different categories into multiple subsets (classes), and gradually trains it into a regular or unsupervised classifier, so as to realize the processing and prediction of massive data. The decision tree classification model consists of two subsets: the first one is to divide a rectangular frame with a distance from the point on the existing sample set, and determine the weight between each rectangular frame according to the distance within the frame, that is, the point is divided into the first target column in each sample[5]. The second subset is to divide the sub-columns with the same distance as the point in each rectangular box, and calculate the influence of all elements on each sub-column on the value of the objective function.

The classification method based on decision tree is a supervised learning method, which can predict the learning result, thereby improving the efficiency of decision-making, the disadvantage is that it requires computation and tree classifiers to support parallelization, multiple input, and data mining methods. The learning decision tree classification model adopts a top-down recursive method, starting from the root node to learn one by one, and then in the middle of the tree, the weights and decision variables are continuously adjusted according to the relationship between different nodes. The judgment process from the root node of the decision tree to the leaf node corresponds to a rule. The set of all the rules of the decision tree constitutes the entire classification rule, and the target node is judged by the result of the classification output. In practical applications, neural networks have strong self-organization, fault tolerance and robust performance, and can optimize input patterns[6]. The decision tree learning process is shown in Figure 1.

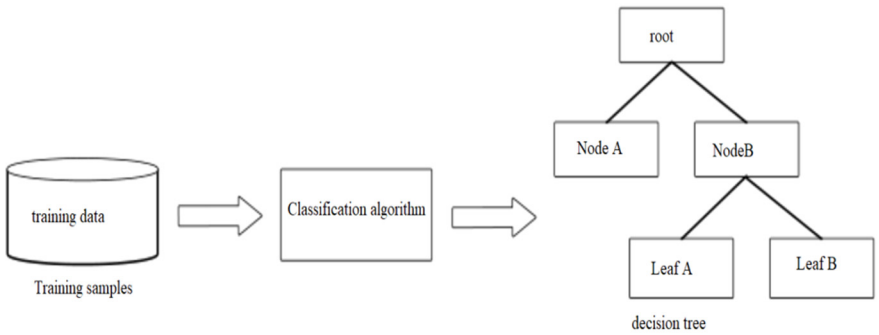

Figure 1. Decision tree learning process

2.3 Introduction to Decision Tree Algorithms

In 1986, machine learning researcher J.R. Quinlan published the earliest decision tree algorithm, the ID3 algorithm, in the Journal of Machine Learning, which uses information gain as a splitting criterion for attributes to generate decision trees. This algorithm is the earliest intelligent optimization problem for big data analysis. After that, the researchers improved the algorithm and got the algorithm C4.5. The algorithm can simply adopt the new attribute splitting criterion and can combine in multiple dimensions, and can obtain the optimal solution of multiple attributes.

The original ID3 algorithm uses information gain as the splitting criterion for selecting attribute V when dividing data set T, where information gain is based on the concept of succession in information theory, and information gain is based on the concept of weights, it is not only represented on the dataset, but also reflected in each attribute, with different affiliations for different properties of a category or an object. With the development and maturity of intelligent algorithms and embedded system technologies, and the application of technologies such as networking and broadband access to the smart elderly care health monitoring system, its functions have been greatly improved. Therefore, ID3 selects attributes with large information gain for splitting each time the data set T is split.

Let |T| be the number of samples in the data set T, freq(Ci, T) be the number of samples belonging to Ci in T, and the calculation of the training sample set T is shown in formula (1):

$$\inf o(T) = -\sum_{i=1}^{k}\left(\left(\frac{freq(C_i,T)}{|T|}\right)\cdot\log\left(\frac{freq(C_i,T)}{|T|}\right)\right) \tag{1}$$

The data set T is split according to the attribute V, and the calculation of the expected information is shown in formula (2):

$$\inf o_{\mathrm{V}}(T) = -\sum_{i=1}^{n}((|T_i|/|T|)\cdot\inf o(T_i)) \tag{2}$$

The information gain is the difference between the direct descendant and the expected information, and the calculation of the calculation formula is shown in formula (3):

$$Gain(V) = \inf o(T) - \inf o_{\mathrm{V}}(T) \tag{3}$$

There is a problem with ID3's use of information gain as a splitting rule, which is biased towards attributes with more values. In order to overcome this defect of the ID3 algorithm, the researchers improved the algorithm and obtained the algorithm C4.5. The calculation of the training sample set T under this algorithm is shown in formula (4):

$$Split\_\inf o(V) = -\sum_{i=1}^{n}((|T_i|/|T|)\cdot\log_2(|T_i|/|T|)) \tag{4}$$

The calculation of the information gain rate is shown in formula (5):

$$Gain\_ratio(V) = Gain(V) / Split\_\inf o(V) \tag{5}$$

3 SYSTEM IMPLEMENTATION RELATED TECHNOLOGY

3.1 B/S Model

B/S model structure is a typical object-oriented programming method. The model takes the data as the core, through the structural decomposition of the system, a complete system composed of multiple sub-modules is constructed, and it is connected with the real data, and each function in the system is realized by calling the sub-modules. B/S model structure is a three-layer network structure consisting of presentation layer, business logic layer and database service layer. In practical applications, it can realize automatic data transfer and facilitate users to operate the database. However, due to its complex model structure, large computational load, and high real-time requirements, this method is difficult to apply to the smart elderly care health monitoring system[7]. The B/S model structure is shown in Figure 2.

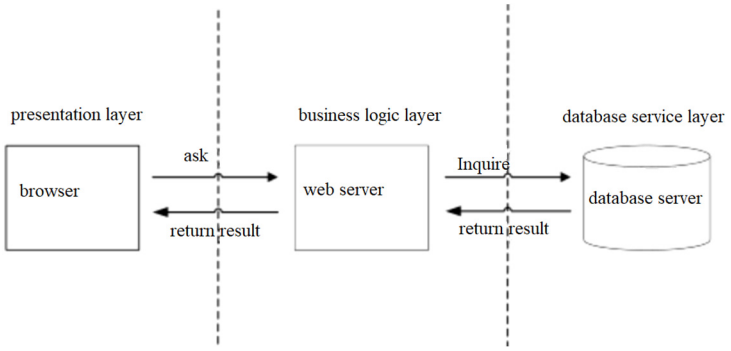

Figure 2. B/S model structure

3.2 MVC Design Pattern

MVC (Model-View-Controller) is a classic software design pattern, and its model is shown in Figure 3. Based on computer, it inherits the traditional design pattern and technology and realizes a new system combined with modern information technology. This kind of system is composed of multiple different functional modules, each functional module has its corresponding specific goals, the modules are interconnected, and each functional module has its corresponding goals, so as to achieve the overall optimization and performance improvement of the system.

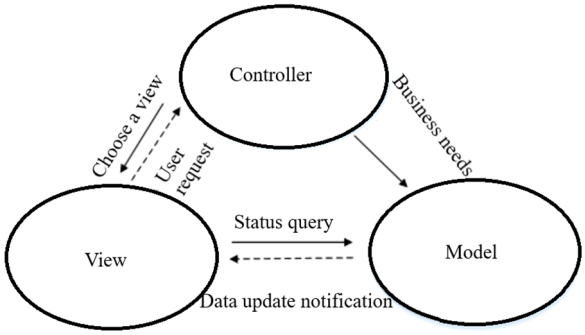

Figure 3. MVC model

The MVC design pattern exists between the server and the presentation layer. It is an interactive system that takes data representation and processing as its core and has a high degree of flexibility in the entire system. The health monitoring software established under the ARM framework can realize real-time management, monitoring and analysis of elderly users. The management system can judge whether the elderly need to check in or leave according to their physiological state (heart rate value), and at the same time, it can remind the elderly to use safety measures and other operation processes through the voice prompt function, so that the elderly have a good living environment and psychological support system, so as to promote the harmonious development of society and play an important role in the process of building our country's socialist civilized society[9].

3.3 ASP.NET Technology

At present, ASP.NET technology is mainly used in our country's smart elderly care system. This technology is an object-oriented encapsulation method, which has the characteristics of fast encapsulation, easy expansion, and easy maintenance. It mainly stores the original data, and then performs intelligent processing according to the needs of different users, and finally obtains a complete, reliable and safe elderly care system. The language can separate, classify, process, abstract and generalize data to realize the modular design and development of database information management functions, and can establish general or custom types according to the differences in corresponding data types and characteristics in different application environments. It can also complete the corresponding system functions by calling the relevant interface code. This can effectively avoid the phenomenon of data redundancy in the process of use, and realize the improvement of the operation efficiency and security of the system database information management.

4 DESIGN OF SMART ELDERLY CARE HEALTH MONITORING SYSTEM

4.1 System Function Module Design

After an overall analysis of the needs of the smart elderly care system, drawing on the current research results of nursing information systems in domestic elderly care institutions, the smart

elderly care system is mainly divided into six functional modules. The design of the system functional modules is shown in Figure 4.

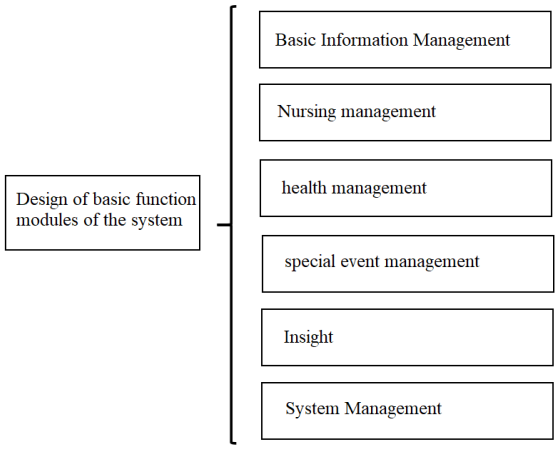

Figure 4. System functional design

4.2 Network Topology

In the health monitoring system based on data analysis, the network topology mainly refers to the equipment needed to realize the functions of remote medical diagnosis, monitoring and management. The system consists of two parts: client and server. In the process of data analysis, we need to effectively connect the two parts to realize the functions of remote medical diagnosis, monitoring and management. The network topology of the system is shown in Figure 5.

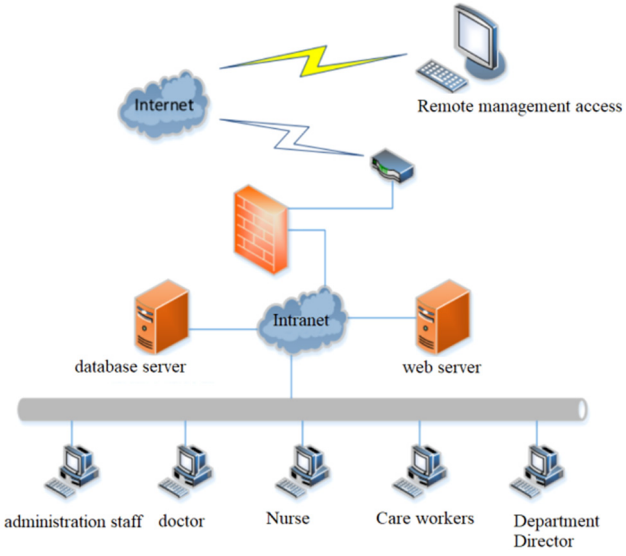

Figure 5. Network topology of the system

5 IMPLEMENTATION OF THE MAIN FUNCTIONAL MODULES OF THE HEALTH MONITORING SYSTEM

The main modules of this system include some functional modules such as basic information management, health management and system management, and the data mining scheme is verified by the data mining tool SPSS Modeler, and a smart elderly care health monitoring system based on data analysis is obtained. This paper uses the SPSsp3.0 platform to research and verify it, and combine the results with other intelligent terminal equipment to realize a complete intelligent health monitoring system. Functions such as user login, management and information query are realized through hardware modules, and each sub-interface is divided according to software modules, and data variables corresponding to different parameter values are selected in the corresponding input box on the main page for analysis and processing. At the same time, the system can also be used to establish a model to simulate and optimize the elderly health care, so as to obtain a smart elderly care system based on data analysis[10].

6 CONCLUSION

To sum up, the construction of smart cities in my country is in the development stage, and there has been a certain degree of progress in informatization and intelligence. However, due to China's large population and serious aging problems, the phenomenon of population aging is serious. In the process of smart city construction, how to efficiently use existing resources, improve residents' living standards, and ensure the safety of the elderly has also attracted more and more attention. Based on the decision tree algorithm and data analysis algorithm, this paper builds a set of intelligent maintenance and monitoring system. Through the data analysis of the system, a set of intelligent health monitoring terminal is established, which can provide residents with more humanized, more perfect and comprehensive elderly care services.

REFERENCES

[1] Bryzgunova, O. E.,Zaporozhchenko, I. A.,Lekchnov, E. A.,Amelina, E. V.,Konoshenko, M. Yu.,Yarmoschuk, S. V.,Pashkovskaya, O. A.,Zheravin, A. A.,Pak, S. V.,Rykova, E. Yu.,Laktionov, P. P..Data analysis algorithm for the development of extracellular miRNA-based diagnostic systems for prostate cancer[J].Plos one,2019(1):55-59.

[2] Eckstein, Jens,Mutke, Markus.Smart mobile devices in health care—smart enough to detect atrial fibrillation[J].Journal of Thoracic Disease,2018(S3): 227-228.

[3] Ha Manh Do, Minh Pham,Sheng, Weihua,Yang, Dan,Liu, Meiqin.RiSH: A robot-integrated smart home for elderly care[J].ROBOTICS AND AUTONOMOUS SYSTEMS,2018(01):84-92.

[4] Kang, SunYoung,Kang, SeungAe.Smart Care to Improve Health Care for the Elderly[J].IT CONVERGENCE AND SECURITY 2017, VOL 2,2018(2):54-58.

[5] Luo, Li.Data Acquisition and Analysis of Smart Campus Based on Wireless Sensor[J].Wireless Personal Communications,2018(5):56-61.

[6] Muangprathub, Jirapond,Boonnam, Nathaphon, Kajornkasirat, Siriwan,Lekbangpong, Narongsak, Wanichsombat, Apirat,Nillaor, Pichetwut.IoT and agriculture data analysis for smart farm[J]. Computers and Electronics in Agriculture, 2019:467-474.

[7] Natgunanathan, Iynkaran,Mehmood, Abid,Xiang, Yong,Gao, Longxiang,Yu, Shui.Location Privacy Protection in Smart Health Care System[J].IEEE INTERNET OF THINGS JOURNAL,2019(5):3055-3069.
[8] R Damaševičius, G Vasiljevienė. [Communications in Computer and Information Science] Information and Software Technologies Volume 920 (24th International Conference, ICIST 2018, Vilnius, Lithuania, October 4–6, 2018, Proceedings) || Data Analysis Algorithm for Click Fraud Recognition[J]. 2018, (Chapter 36):437-446.
[9] Wang'an, Tao Yangxu, Qiu Xueleng, et al. Discussion on the construction of emergency service system for the elderly based on smart wearable devices [J]. Primary Health care in China, 2022,36 (11): 6.
[10] Sim, Hyun Sik.Big Data Analysis Methodology for Smart Manufacturing Systems[J]. International Journal of Precision Engineering And Manufacturing,2019:973-982.