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Early Diagnosis of Alzheimer's Disease Based on Face Recognition Using M-Health Technology

Tiexing He[1], Xueping Zhang[2] and Limin Zhu[3]*

[1] *General Education Department, Hangzhou Medical College, Hangzhou 310053, China*
[2] *Geriatrics Department, Hangzhou Seventh People's Hospital, Hangzhou 310013, China*
[3] *The First Ward of Leaders, Hangzhou Third People's Hospital, Hangzhou 310009, China*

The traditional methods used for the diagnosis of early Alzheimer's disease have high technical requirements, are expensive, require invasive diagnosis, and cannot be widely used in clinical practice. Therefore, a method for the diagnosis of early Alzheimer's disease based on face recognition by means of medical technology is proposed. Firstly, an M-health app for the diagnosis of early Alzheimer's disease is designed and applied to the elderly Then, the facial features of elderly people with sleep disorders are extracted, and then are compared with all the feature vectors stored in the database, so as to determine whether the elderly subject has a sleep disorder. If this is not the case, it is concluded that the person does not suffer from Alzheimer's disease, and there is no need to carry out the next step. If there is indication of a sleep disorder, it is preliminarily diagnosed that there may be early Alzheimer's disease. Hence, further diagnosis is needed through the early Alzheimer's disease diagnostic system which mainly includes the checklist test module, the data analysis module and the query analysis and feedback module. In the data analysis module, the Bayesian network is used to make the early prediction and early diagnosis of the patients before the onset of the disease. The experimental results show that the proposed method has high diagnostic accuracy and strong practicability

Keywords: M-health technology; face recognition; early; diagnosis; Alzheimer's disease

1. INTRODUCTION

The problem of an aging population is becoming more and more serious in China. Statistics show that by the end of 2015, the number of people aged 60 and above was 212 million, the proportion of the total population was 15.5% [1], and the number of people aged 65 and above was 144 million, accounting for 10.5%. According to the data provided by National Health Planning Commission, the prevalence of Alzheimer's disease in China is increasing year by year [2]. China has gradually become a country with an increasing number of Alzheimer disease (AD) victims, with aging being an important and critical factor in AD patients. A large number of research results show that early detection and early prevention can significantly delay the development of Alzheimer's disease, and significantly postpone the time when hospitalization is needed [3, 4]. Therefore, early screening and diagnosis of Alzheimer's disease is of great significance for the early prevention or intervention of Alzheimer's patients and the improvement of their quality of life.

The clinical diagnosis of Alzheimer's disease is based mainly on the clinical symptoms, confirmed by laboratory test results. However, early Alzheimer's patients do not have the clinical symptom of dementia, or have only mild cognitive

*Email of Corresponding Author: hanfeng227@sina.com

and behavioral decline. Therefore, early clinical diagnosis of Alzheimer's disease is very difficult. At present, there are several basic methods used to determine the presence of Alzheimer's disease.

In the literature [5], "performance test performance measures" and scores are used to diagnose Alzheimer's disease, and the scores are compared with the normal values that have been established. This method is used to compare individuals of similar age, and the scores change with the passage of time; however, unless there is a previously-determined benchmark data, the score cannot be provided for patients with clinically documented changes in cognitive ability and whether these interfere with daily activities. In addition, a simple performance test" may be biased by age, race, sex, education and socioeconomic status.

In the literature [6], an "informant interview" was used. Caregivers provided information regarding and change in patients' cognitive ability, and whether this interfered with their daily activities.

In [7], the performance-based screening tool was used. In assessing cognitive function, the mini-mental state examination (MMSE) test was used in the preliminary assessment of AD. If more than one score decreases over time, its sensitivity increases. Although MMSE is fast and manageable and can track the overall progress of cognitive decline, it is not the best test for diagnosing AD.

In the study conducted by [8], the Montreal cognitive function list was used, which helped the attending doctors to detect and evaluate MCI, and was recognized because of its sensitivity improvement and the removal of susceptibility to cultural and educational bias. However, it is more complex and requires more extensive diagnosis

It is not widely used in clinics because of the complex, expensive, and invasive diagnosis. Therefore, developing an M-health management platform with early screening function for Alzheimer's disease is of great significance for the early detection and/or early prevention of Alzheimer's disease, improving the quality of life of elderly patients and reducing the burden on family and society.

2. STUDY OF THE EARLY DIAGNOSIS OF ALZHEIMER'S DISEASE BASED ON FACE RECOGNITION USING M-HEALTH TECHNOLOGY

2.1 Design of M-Health Technology

2.1.1 M-Health Technology and its Design Guidelines

The predecessor of M-health is telemedicine. Telemedicine is the use of computer technology, remote sensing technology, and remote control technology, to give full play to the advantages of excellent medical institutions in medical technology and equipment, for remote medical and patient communication, diagnosis and treatment of patients whose health is poor or unstable [9]. In the late 90s, the rapid development of virtual reality technology and communication technology has seen an equally rapid development of the mobile Internet [10]. Coupled with the popularity of smart phones, it has created a broad space for mobile health development. In 2003, the mobile health (M-health) concept was proposed as a kind of telemedicine application in the mobile Internet era. Because it eliminates network constraints, it is more convenient and quicker to use, and its range of functions and applications is becoming broader.

In recent years, with the development of science and technology, the emergence of mobile Internet and the popularity of smart phones, people are more and more aware of the convenience and efficiency of health care services accessed through smart phones. The development of mobile health APP market has broad prospects. The review of a large amount of relevant literature yields the design guidelines summarized below, which can be used to determine and standardize the mobile health technology for early diagnosis of Alzheimer's disease.

(1) Experience

For mobile health APP which is used for the early diagnosis of Alzheimer's disease, experience is essential; that is, users can experience some functions before they register or view the functional interfaces of the software. Because users' initial understanding of software is acquired only from the description provided by the vendor, prior to opening the software, only by registering can users experience more content.

(2) Clarity

Whether it is the user's actual use or experience, clarity is the primary design criterion. Firstly, the structure of functions, both primary and secondary, should be clear so that users can quickly understand the functions included in the software, and also reduce user learning costs. Secondly, the text and information on the interface should be clear and easy to follow, and its visual elements should be attractive. Users should be able to quickly browse the contents of the interface, find the target function and have a satisfy ing user experience.

(3) Efficiency

Apart from having a simple functional structure and a clear and appealing interface, the APP should ensure that the user can apply it efficiently. First of all, the operation process and function settings should be consistent with user's usual operation habits. It should also maintain consistency and ensure that users feel a sense of familiarity, so that they can operate it immediately and efficiently without having to think about or intuit the process. Secondly, during operations, the APP needs to give users appropriate feedback quickly in order to shorten the user's waiting time, or make waiting time more interesting so as not to lose users.

(4) Aesthetics

On the one hand, the interface elements themselves must be attractively designed, to ensure that they are strategically positioned, have hierarchical text information, are easy to read, and have easy-to-identify icons and graphics. On the other hand, the overall layout and

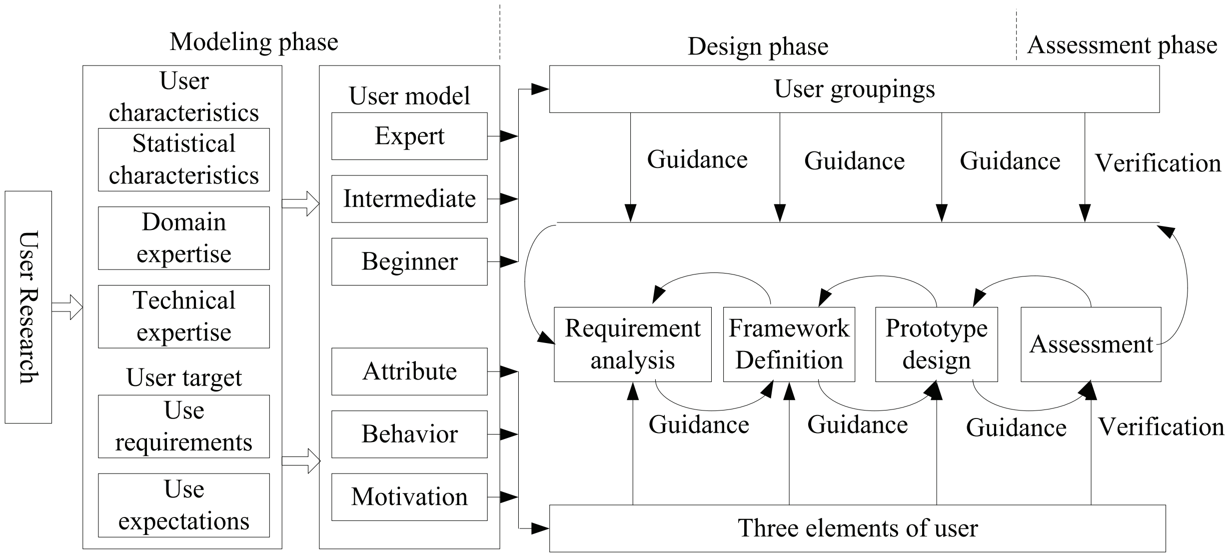

Figure 1 Design process of mobile health app

style of these interface elements should be beautiful and unified. Aesthetics not only give users the visual enjoyment of beauty and reduce their cognitive burden, but also make users' visual experience more smooth and efficient, so that they can quickly find target functions and improve their user experience.

2.1.2 Design Process of Mobile Health APP

Based on the above research, the characteristic factors that affect patient compliance are introduced in this section, to define the specific process of establishing user models, and summarize user research methods that should be applied to different design stages. Hence, this section examines the influence of the user model on the entire design process, as shown in Figure 1. The purpose of establishing a user model is to identify the user's needs, so the user modeling results can be used at various stages of the design and evaluation processes. During the requirement analysis stage, a solution that will achieve user goals is proposed. Combined with the corresponding research results and specific functions, we make breakthroughs to address the shortcomings of existing research. In the design stage, the functional modules according to the user goals are divided in order to identify the main users who use different modules, and design the different functional modules according to the users' characteristics and habits. In the evaluation stage, combined with the design goal, the functional usage of different groups of users is analyzed, and whether the function design of the software can meet users' needs is verified through qualitative research.

2.2 Implementation Method of Mobile Health Technology

2.2.1 Implementation Object

Mobile health technology for the early diagnosis and safety monitoring of Alzheimer's disease can be used for the daily health monitoring of healthy elderly people with a high risk of this disease (75–84 years old, with a family history of Alzheimer's disease, obesity and low level of education). Early, objective and scientific discovery of gradual cognitive decline of the elderly and early intervention can reduce the incidence of Alzheimer's disease. Early detection and timely implementation of nursing intervention can effectively prevent and delay the onset of Alzheimer's disease.

2.2.2 Preparation Before Implementation

(1) Preparation of the place. Mobile health care needs to be deployed in the homes of the elderly (especially elderly people living alone).

(2) Preparation for use. In mobile health systems, sensors, wireless networks and mobile phones are important monitoring tools. In many monitoring systems, sensors area key technology in the application of the Internet of things. It is a detection device that can detect and measure information. According to certain rules, it can transform information output to electric or other signals according to the requirements for information transmission, processing, storage, display, record and control. It has the advantages of being low cost, not very intrusive and with strong durability, to name a few Video sensors are often not recommended because they involve the issue of privacy.

2.2.3 Implementation Steps

Through the sensor, the mobile health technology can monitor the elderly person's daily behavior in relation to cognitive areas, and transfer the data to the terminal equipment through the wireless network (mobile phone, tablet, etc.). Finally, the caregivers can obtain the cognitive and safety status of the elderly through the simple interface of terminal equipment. The steps required for the implementation of health monitoring technology are explained below:

(1) Ensuring an environment conducive to monitoring: the core of mobile health technology is cognitive behavior,

which can indicate early cognitive-related behaviors of the elderly. Therefore, continuous monitoring is essential, making mobile health technology most suitable for elderly people living alone.

(2) Understanding the habits of the elderly: because of the differences in people's daily activities and habits, it is essential to understand the everyday habits of the monitored people in the interests of sensitivity and accuracy. If the subject of the monitoring is 75 years old for the elderly, the infrared sensor can be installed at the house door to show when the person leaves the house and returns. The device can be fitted with sensors to know when the elderly are cooking and washing. It can also monitor the switching states of the devices so as to prevent the gas from being forgotten. A pressure sensor can tell when the elderly sleep, get up and so on.

(3) The preparation and installation of the object: wireless networks can be set through Wifi routers and so on. The terminal device is with the mobile phone carrier or other caregivers. As the sensor has the advantages of being small, inexpensive and posing no privacy concerns, it can be placed in any convenient position. For example, the pressure sensor is placed under a mattress or cushion.

(4) Caregivers receive data: the sensor collects data, the wireless LAN transmits data, and the terminal device cell phone receives the data.

2.2.4 The Monitoring Dimension of Mobile Health for the Diagnosis of Early Alzheimer's Disease

At present, essential to mobile medical treatment for patients with early Alzheimer's disease is the recognition of cognitive decline. Therefore, in order to identify patients with early Alzheimer's disease, various scholars have monitored the onset of early Alzheimer's disease in terms of different symptoms, one of the main neuropsychiatric symptoms being sleep disorders. There is a difference in the sleep state of the early Alzheimer's patients and that of unaffected elderly Most of the patients with early Alzheimer's disease have obvious sleep disorders, and their sleep latency is shortened. Sleep disorders in early Alzheimer's patients occur significantly earlier than does their cognitive decline. Mobile health diagnosis is based on the condition of abnormal sleep in patients with mild cognitive impairment, and the abnormal state of sleep is indicated by face recognition.

(1) Total sleep time: usually a healthy person sleeps between seven and nine hours. However, cognitive decline may lead to sleep disorders, and sleep disorders will increase cognitive decline. This interactional phenomenon leads to a decrease in the amount of sleeping time of early Alzheimer's patients.

(2) The number of night waking times: the number of times that people wake at night is an indication of the quality of their sleep. Usually, people wake up only once or twice, but most of the patients with early Alzheimer's disease wake up more frequently, and the quality of sleep is decreased.

(3) Sleep efficiency: if it is less than 85%, it may be a symptom of Alzheimer's disease. The sleep efficiency of early Alzheimer's patients is lower than that of the healthy elderly

(4) Other symptoms: early awakening, taking a longer time to fall asleep, excessive daytime sleepiness, restlessness or wandering at night, etc.

2.2.5 Face Recognition and Judgment of Sleep State

In this section, a face recognition technique is used to determine whether the sleep of the elderly is abnormal. First of all, a large number of training samples are used to extract the facial features of the elderly when they have sleep disorders, so that a sleep disorder can be recognized. In this section, the Global Feature (GF) is used to extract the facial features of the elderly who may have sleep disorders.

In face recognition, the feature vectors are extracted from the input image and compared with all the feature vectors stored in the database. The input image is allocated to the category of the image that has the minimum distance from the feature vector in the database to determine whether the elderly have sleep disorders, so as to achieve an early diagnosis of Alzheimer's disease.

In order to describe more effectively the global characteristics of facial images of elderly people, a new global feature descriptor is proposed, which maps the input image G to different scales and directions. Then, in each scale (expressed in c) and in the direction (expressed in p), the global information is extracted and defined as a value. The general form of the descriptor GF is as follows:

$$GF_v(G) = f * h_v(G) \tag{1}$$

Among them, h_v is a function for mapping the input image G to the scale and direction v, and f is another function that maps the image with describing by a Zernike moment. In transformation such as Wavelet, PCA, Hadamard and Gabor, it can be applied to function $h_v(G)$. In this section, Gabor transform is used, and Gabor has the advantage of correctly controlling the parameters of scale and direction.

The Gabor transform enables multiresolution analysis by transforming the input image G into image $G'_{c,p}$ with different filters which has direction (p) and scale (c) . The representing method of $G'_{c,p}$ is:

$$G'_{c,p}(x,\ y) = B_{c,p}(x, y) * G(x,\ y) \tag{2}$$

The operators $*$ in the formula (2) represent the convolution. $G(x,\ y)$ represents the brightness of the image at pixel $(x,\ y)$, and $B_{c,p}(x, y)$ indicates the Gabor core at the direction p and scale c.

$$B_{c,p}(x,\ y) = \frac{\delta^2}{\sigma^2} e^{\left(\frac{u^2\delta^2}{2\sigma^2}\right)} \left(e^{(i\delta u)} - e^{\left(\frac{\sigma^2}{2}\right)}\right) \tag{3}$$

In the formula (3), u is a column vector consisting of coordinates x and y, expressed as $u = |x, y|^{\mathrm{T}}$; σ represents the standard deviation of Gauss function of Gabor core; δ is a row vector represented by the direction parameter p and the scale parameter c, which is represented as $\delta = [2^{-c}\cos(p),$

$2^{-c}\sin(p)$]; i is the imaginary unit. Although the Gabor transform enables the multi-dimensional analysis of images, it cannot be used directly as a global feature description of the input image because of its high dimension. This section uses another function, f, to describe each filter image of the Gabor transform. One of the best choices of function f is the operator based on moments, and the Zernike moments have good ability to describe facial features. Therefore, Zernike moments are applied to function f.

The Zernike moment is a moment function which is used to map digital images to a set of complex Zernike polynomials. Since these Zernike polynomials are orthogonal, the image features can be described without redundancy or overlap when the information is converted between different moments. Calculating the Zernike moments of input images involves three steps: computing radial polynomials, computing Zernike basic functions, and mapping input images to Zernike basic functions. The first step in obtaining the Zernike moment from the input image is to calculate the one-dimensional Zernike radial polynomial $S_{N,M}(d)$, which is defined as:

$$S_{N,M}(d) = \sum_{c=0}^{(N-|M|)/2} (-1)^c \frac{(N-c)!}{c!\left(\frac{N+|M|}{2}-c\right)!} d^{N-2c} \quad (4)$$

Where, d is the distance between the image center and the corresponding point $(x,\ y)$, N is the non-negative integer representing the radial polynomial order, and M is the specified integer of the azimuth repeats, and it must satisfy the following relations: $N - |M|$ equals even numbers, and $|M| \leq N$. In the case of digital images, the basic function of Zernike can be transferred to Cartesian coordinates, and the basic function of the two-dimensional Zernike is defined as:

$$Z_{N,M}(x, y) = S_{N,M}(d_{xy})e^{-jM\beta_{xy}} \quad (5)$$

The formula d_{xy} for calculating the distance between the image center and the corresponding pixel point (x, y) is:

$$d_{xy} = \frac{\sqrt{(2x - N' + 1)^2 + (N' - 1 - 2y)^2}}{N'} \quad (6)$$

The phase calculation formula of the pixel $(x,\ y)$ is as follows:

$$\beta_{xy} = \tan^{-1}\left(\frac{N' - 1 - 2y}{2x - N' + 1}\right) \quad (7)$$

In order to create an image that cannot generate a center, and to correctly calculate the moment, N' in formula (6) and formula (7) must be an even number, and the image size is $N' \times N'$ pixels.

Finally, by applying the discrete form of Zernike moments to the υth filtered images of the Gabor transform (G_υ), it can obtain the υth GF global structural features of facial images in elderly patients with sleep disorders. The final formula is:

$$GF^{\upsilon}_{N,M} = \left| \frac{N+1}{\varepsilon} \sum_{x=0}^{N'-1} \sum_{y=0}^{N'-1} G_\upsilon(x,\ y) S_{N,M}(d_{xy}) e^{-jM\beta_{xy}} \right| \quad (8)$$

Here, ε is a normalization factor, and $\varepsilon = 2\pi N'/4$ is set for an image with a size of $N' \times N'$. By using the GF descriptor, the global features of the input image can be obtained by means of rotation and scale invariant, and there is no redundant or overlapping information. By selecting the direction parameter p and the scale parameter c of Gabor transform ($K = p \times c$), and by optimizing the order parameter N and the angle repeat parameter M of the Zernike moment, this feature can be applied to any kind of image.

Face recognition has three directions (p) and three scales (c) in the Gabor transform, that is, $K = 3 \times 3$. It performs best when the order N in the Zernike moments equals 4 and the angle repeatability M is 0. The results of the Gabor filter and the corresponding value G are calculated for each filter image. Due to the direction and scale of Gabor filter selection, 9 filtered images are generated. By applying Zernike moments to each of them, 9 dimensional global eigenvectors are obtained as:

$$\vec{G} = \{GF^1_{4,0}, GF^2_{4,0},\ \cdots,\ GF^9_{4,0}\} \quad (9)$$

2.3 Early Diagnosis System for Alzheimer's Disease

2.3.1 System Function

This project has designed and developed an early prediction expert system for AD. The expert system integrates the functions of interpretation, diagnosis, prediction, planning and control. It is an integrated expert system. The data obtained from the checklist experimented is subjected to reasonable explanation and processing and then used to establish the diagnostic model and the training of the reasoning machine. The reasoning machine is used to diagnose, store the prediction results in the comprehensive database, and give the corresponding treatment plan according to the prediction results by the neurology experts, and also has the functions of query and analysis.

2.3.2 An Overview of the Function of System

The functions of the expert system are shown in Figure 2.

In this system, the "knowledge" is the experimental data used for training the inference engine to determine the state of the subjects. The knowledge acquisition part involves the process of using the checklist experiment to collect data about the subjects. These data are stored in the knowledge base after reasonable preprocessing, which is used to train the reasoning machine and establish the diagnostic model.

2.3.3 Implementation of System

The system uses J2EE as the development framework, and Struts as the presentation layer framework. It comprises a checklist test module, data analysis module, query analysis module and feedback module.

(1) The checklist test module.

This module is mainly used to complete the function of the checklist test. The subjects need to register, log in and submit basic information automatically, then complete the test. The whole process is shown in Figure 3.

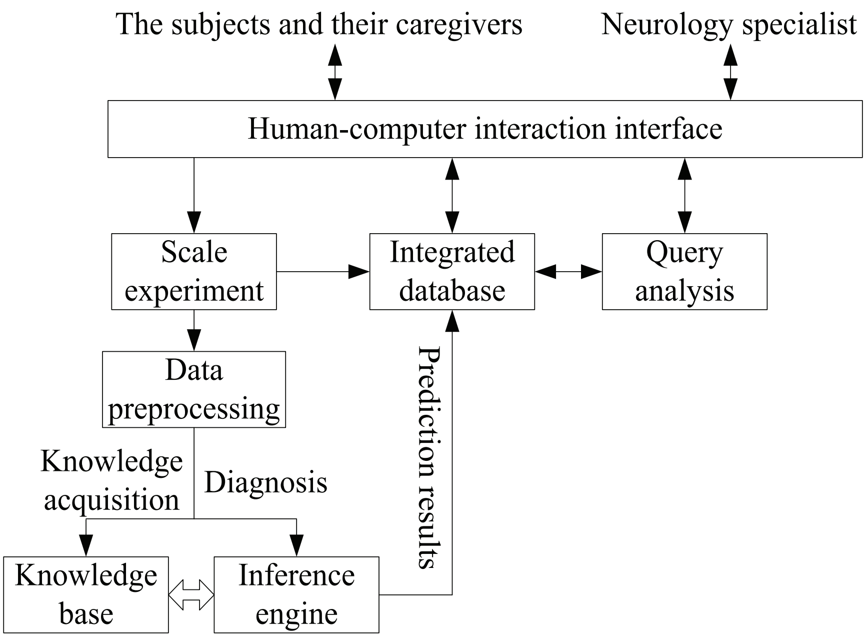

Figure 2 System function

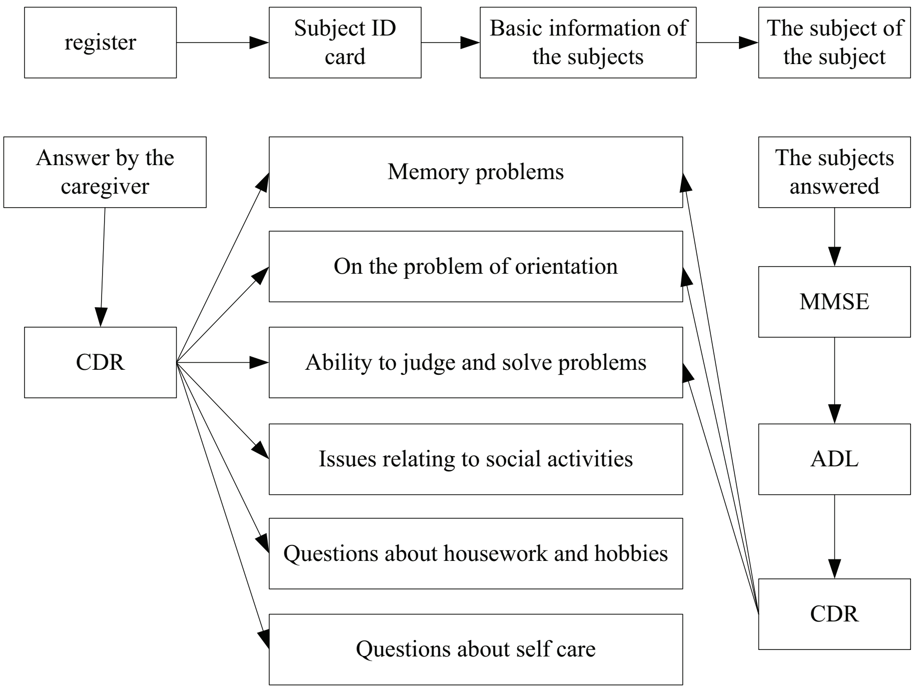

Figure 3 The module of checklist test

The design system in the checklist module, uses the dynamic page generation technology.

The basic information of each checklist is stored in the sheet table. The content of the question is stored in the question table, and the question options are stored in the qoption table. For comparing the question and answer types, the checklist and question to be compared are stored in the compare table. In addition, because the answer to the next question is based on the answer to the previous question, the relevant jump information is stored in the method table. The answers of the subjects and their caregivers are stored in the result table. The final scores of the scales calculated according to the answers of the subjects and their caregivers are stored in the score table. As the whole test process is related to the participants and their caregivers, basic information about the subjects and their caregivers is recorded in the patient table.

If data is added to the checklist, only the information in sheet tables, question tables, qoption tables, compare tables and the corresponding contents of the method tables increases; hence, this dynamically increases the checklist without affecting the application program, maintaining the logical independence of the database design and application programming.

(2) Data analysis module.

In the system, Bayesian inference technology is used for the early prediction and early diagnosis of patients before the onset of the disease. The data of the subjects are preprocessed, and the resultant data and related functions are used as the input nodes, and the Bayesian network is constructed.

The Bayesian network is built in order to show how the characteristics of behavioral data affect and interact with each other in diff erent clinical states. This method is diff erent from the univariate analysis that focuses only on the designated area. A Bayesian net can ascertain the relationship between multiple characteristics related to early Alzheimer's disease.

Therefore, the morphological change of clinical variables can be used as a node to construct a Bayesian network, a multivariable model of probability distribution. The greatest advantage of building a Bayesian network is:

(1) The correlation of the linear and nonlinear probability between variables can be expressed.

(2) It can form a reasoning machine and offers a stronger possibility of hidden variables being predicted. A Bayesian network and reasoning can: (i) show how the behavior attributes of MCI interact with each other, (ii) make an accurate and early prediction and diagnosis of patients, and (iii) extend the prediction and diagnosis to non-dementia symptoms.

Bias estimation is an effective estimation method based on known mathematical information. It is realized by taking the random variable α as a random variable with a known distribution $\pi(\alpha)$, and $\pi(\alpha)$ is called a priori probability. First of all, the Bias estimation principle is analyzed. When the sample space is Q, the posterior probability $\pi((y|Q)$ can be obtained by a priori probability $\pi(\alpha)$, which is based on the Bias theory

$$\pi(\alpha|Q) = \frac{\pi(Q|\alpha)\pi(\alpha)}{\pi(Q)} \tag{10}$$

Supposing a random variable of normal distribution $x \in Q$, and $x - N(V, \ \phi)$, of which the expectation V is unknown, the variance σ is known, and the corresponding formula (1) has $\pi(x|\alpha) - N(V, \ \sigma)$. Assuming that $\pi(\alpha)$ is also a normal distribution, that is, $\pi(\alpha) - N(V_0, \ \phi_0)$, then the posterior distribution is also normal, there are:

$$\pi(\alpha|x) - N(V_1, \sigma_1) \tag{11}$$

Since $\pi(x)$ is a numerical value, so on the basis of formula (11), it can be seen that $\pi(\alpha|x)\infty\pi(x|V)\pi(V)$, and ∞ is a positive proportional symbol, that is:

$$\pi(V|\alpha)\infty \exp\left\{-\frac{1}{2}\left|\frac{(x-V)^2}{\sigma} + \frac{(V-V_0)^2}{\sigma_0}\right|\right\} \tag{12}$$

Two parameters of the posterior distribution can be obtained by the upper formula:

$$\sigma_1 = (\sigma_0^{-1} + \sigma^{-1})^{-1} \tag{13}$$

$$V_1 = \sigma_1(V_0/\sigma_0 + x/\sigma) \tag{14}$$

A Bayesian network provides a way to visualize knowledge and maps for graphical representation of probabilistic relationships between variables, and is a probabilistic inference technology The Bayesian network is visually represented as a complex assignment causal map. Each node in the graph represents the event discussed in the problem domain. The arc between nodes represent probabilistic dependencies between events, which makes the uncertainty reasoning in logic clearer and easier to understand.

Given the Bayesian network $W\langle W_s, W_y\rangle$, it contains a set of random variables $X = \{X_1, X_2, \cdots, X_n\}$. Among them, W_s is that the structure of Bayesian network which is a directed acyclic graph with n nodes, each node in the graph represents a variable X_i , corresponding to the value of the variable node state. The directed edge in the graph represents the conditional (causality) dependence between the nodes (variables); W_y is a conditional probability distribution table (CPT) set for Bayesian networks, the conditional probability distribution of each variable X_i is $P(X_i|R)$, among them, R is the set of the parent nodes of X_i.

A Bayesian network can provide a complete description of the domain. The general items in the joint distribution are assigned a specific value Y to each variable, and the probability information in the network can be calculated using W_y namely the CPT of Bayesian network node. Symbol $P(X_1, \ X_2, \ \cdots, \ X_n)$ is used as a simplified representation of the probability, there are:

$$P(X_1, \ X_2, \cdots, \ X_n) = \prod_{i=1}^{n} P(X_i|R(X_i)) \tag{15}$$

Each item in the joint probability distribution can be expressed as the product of the appropriate element in the CPT. Therefore, CPT provides a decomposition representation method of joint probability distribution.

(3) Query, analysis and feedback modules

The module shown in Figure 4 can be used by neurology experts or administrators. It completes the query and analysis of subjects' data and shows the subjects and their caregivers the treatment plan recommended by experts.

3. ANALYSIS OF EXPERIMENTAL RESULTS

3.1 Source of Research Objects

In this study, 23 cases of early Alzheimer's disease were collected. The subjects had been admitted to the Department of Neurology in a hospital from September 2017 to January 2018, and all of them met the hospital's criteria for inclusion in the experiment. Seventeen subjects were used for the healthy control group.

The criteria for the admission and grouping of patients with possible early Alzheimer's disease were as follows:

1) General information:

There were 23 patients in the group, comprising16 males and 7 females, ranging in age from 65 to 85, and with an education level of junior middle school and above.

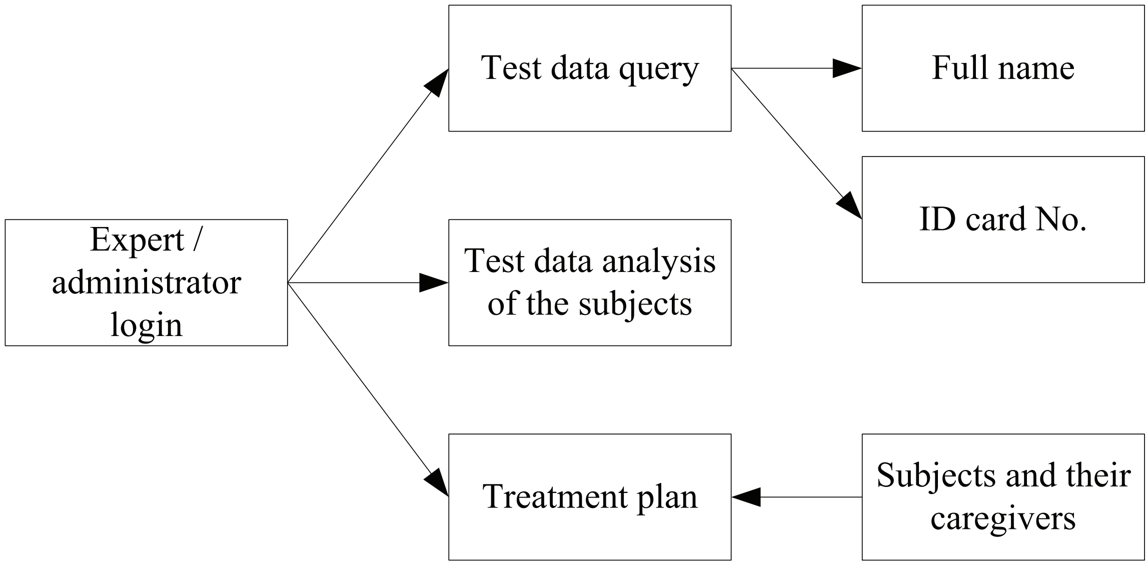

Figure 4 Query analysis and feedback module

2) Inclusion criteria:

   a. Patients had been selected by clinicians for early AD diagnosis in accordance with the AD diagnostic criteria: Mini Mental Scale (MMSE) standard, Huggins ischemic score (Hachinski) of American academy of neurology, speech disorders in Alzheimer's disease and associated disorders (NINCD S-ADDA).
   b. Other brain diseases were excluded, such as metabolic endocrine diseases, nutritional deficiency diseases, toxic diseases, and so on.
   c. No contraindications by NMR were found.

3) Exclusion criteria

   a. Cognitive impairment caused by trauma and surgery
   b. Cognitive dysfunction caused by brain tumor and cerebral vascular disease.

The criteria for inclusion and exclusion of the healthy control group are as follows:

(1) General information:

   a. it has been proved to be 17 healthy older people. There are 10 males, 7 females and they are 65–85 years old. The level of education is junior middle school and above.
   b. . Their Huggins ischemic score is $>$ 18.
   c. There is no contraindication in MRI, and all the subjects give informed consent.

(2) Inclusion criteria:

   No cerebrovascular disease, no cognitive impairment, no head operation, trauma, and family history of disease.

(3) Exclusion criteria:

   a. Subjects have different degrees of cognitive impairment.
   b. Subjects had a history of surgery and brain disease.
   c. Subjects cannot tolerate scanning for a variety of reasons.

3.2 The Diagnosis Results Obtained by the Proposed Method

The proposed method was used to diagnose early Alzheimer's disease. The results of diagnosis are shown in Figure 5 where the blue circles represent the training data, the green are the check data, and the red squares show the diagnosis result for indications of early Alzheimer's disease.

By analyzing the diagnostic results of early Alzheimer's disease in the proposed method, we can see that this method can diagnose 20 of the 23 early Alzheimer's patients. After verification, the patients diagnosed by means of the proposed method are all early Alzheimer's disease patients, and the diagnostic accuracy is high.

3.3 The Results Compared With Those Obtained by Other Methods

In order to verify the effectiveness of the proposed method, the method in literature [5] were compared with the method in literature [7] and the proposed method. Hence, three methods were used to diagnose the patients with early Alzheimer's disease, and the accuracy of the three methods was compared. The results are depicted in Figure 6.

Analysis of the diagnostic accuracy of three methods shows that although the diagnostic accuracy of three methods will fluctuate, the diagnosis precision curve of the proposed method is significantly higher than the other two methods. The results show that this method has high practicability,

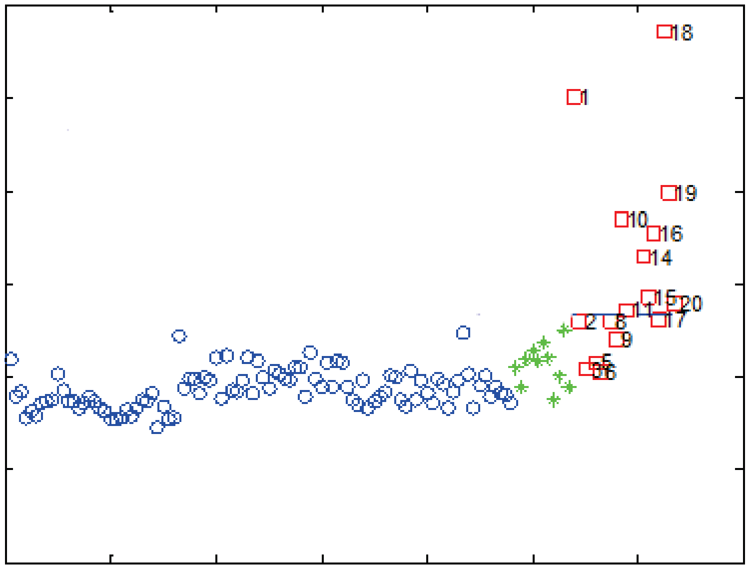

Figure 5 The diagnosis results of the proposed method

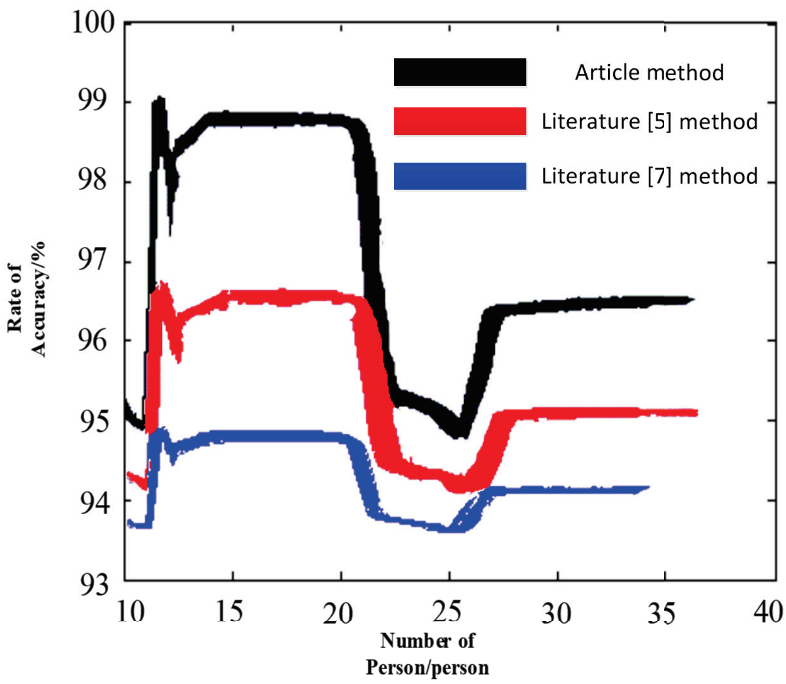

Figure 6 Comparison of the diagnostic results of three methods

which can further verify the effectiveness of the proposed method.

4. CONCLUSIONS

The main contents of this research are as follows:

(1) M-health care: M-health App is an important carrier and user window of M-health system, just like the HIS system of hospitals for medical informatization, and the web end of medical services for online healthcare.

(2) Early diagnosis through the implementation of face recognition technology: face recognition is used to determine the existence of sleep disorders in the elderly; if there is no sleep disorder, then further screening is not required. If there is a disorder, M-health app will automatically enter the next diagnostic expert system.

(3) Establishment of early diagnosis expert system to prevent Alzheimer's disease: according to the data in the evaluation and analysis table, an early feasible warning system is established in order to enable patients to receive the necessary treatment, care and help as soon as possible so that they can live independently.

The degree of theoretical innovation of this paper: the application of M-health technology to the early diagnosis of Alzheimer's disease. To the best of the researchers' knowledge, no previous study has been conducted on the prevention of early Alzheimer's disease by means of face recognition. This paper has made bold innovations and attempts in this respect.

The practical value of this paper is that it expands the application of mobile health technologies in medicine; in this project, a simple and cheap system has been developed to assist with the diagnosis of Alzheimer's disease, the application of which can be extended to the general population. Based on this research, we find and create a new way of making an early diagnosis, and preventing Alzheimer's disease, thereby making a positive contribution to the early prevention and control of Alzheimer's disease.

In the future, we hope to propose a more simple and effective method for the early diagnosis of Alzheimer's disease.

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REFERENCES

1. Guerrero J M, Peraita H. Diagnosis of Cognitive Impairment Compatible with Early Diagnosis of Alzheimer's Disease. A Bayesian Network Model based on the Analysis of Oral Definitions of Semantic Categories. Methods ofInformation in Medicine. 2016; (01) 42–49.
2. Azimzadeh M, Nasirizadeh N, Rahaie M, et al. Early detection of Alzheimer's disease using a biosensor based on electrochemically-reduced graphene oxide and gold nanowires for the quantification of serum microRNA-137. Rsc Advances. 2017; (88) 55709–55719.
3. Nasrolahzadeh M, Mohammadpoory Z, Haddadnia J. A novel method for early diagnosis of Alzheimer's disease based on higher-order spectral estimation of spontaneous speech signals. Cognitive Neurodynamics. 2016; (6)1–9.
4. Delkhahi S, Rahaie M, Rahimi F Design and Fabrication a Gold Nanoparticle-DNA Based Nanobiosensor for Detection of microRNA Involved in Alzheimer's Disease. Journal of Fluorescence. 2016; (2) 1–8.
5. Olsson B, Lautner R, Andreasson U, et al. CSF and blood biomarkers for the diagnosis of Alzheimer's disease: a systematic review and meta-analysis. Lancet Neurology 2016; (7) 673–684.
6. Kobashi S, Morinaga N, Hirano S, et al. Computer aided system for the diagnosis of Alzheimer's disease. Electrical Engineering in Japan. 2015; (4) 32–41.
7. Bhateja V, Moin A, Srivastava A, et al. Multispectral medical image fusion in Contourlet domain for computer-based diagnosis ofAlzheimer's disease. Review of Scientific Instruments. 2016; (7) 1–4.
8. Wang J, Wang Z. M, LiX. M, et al. Synthesis and evaluation of multi-target-directed ligands for the treatment of Alzheimer's disease based on the fusion of donepezil and melatonin. Bioorganic & Medicinal Chemistry 2016; (18) 4324–4338.
9. Li BF, Tang YD, Han Z. Face recognition algorithm based on improved NMF Computer simulation. 2016; (3) 428–432.
10. Choi B Y, Blumberg C, Williams K. Mobile Integrated Health Care and Community Paramedicine: An Emerging Emergency Medical Services Concept. Annals of Emergency Medicine. 2016; (3) 361–366.