Architecture design for an Artificial Intelligence based medical and healthcare system

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Content

1 Introduction

1.1 Introduction to artificial intelligence

Artificial intelligence is a new technology science that researches and develops theories, methods, techniques and application systems for simulating and extending human intelligence[1]. Its structure is similar to pyramid structure: the upper layer is the algorithm, the middle is the chip, and the third layer is various The hardware and software platform, the bottom is the application. Research in the field of artificial intelligence began formally in 1956, when the term "artificial intelligence" was officially used at a meeting held at Dartmouth University. In the following decades, people have conducted extensive research on artificial intelligence. As a branch of computer science, it attempts to produce a new intelligent machine that responds to the human brain by mining the essence of intelligence. Applications for technology include robotics, image recognition, speech recognition, natural language processing, data mining, pattern recognition, and expert systems.

1.2 Artificial intelligence and medical links

According to the characteristics of artificial intelligence, in the medical field, any "repetitive, regular, and can be calculated by big data" can be replaced by artificial intelligence, so some repetitive work or labor in medical treatment will be given priority. Artificial intelligence is replaced. Therefore, the goal of exploring the application of artificial intelligence in the medical field is to use artificial intelligence to better present the medical profession and promote the development of medical disciplines[2].

2 Research status at home and abroad

The trend of deep penetration and integration of artificial intelligence in the field of medical and health has become very obvious, bringing disruptive changes in the fields of innovative drug research and development, medical image recognition and analysis.

2.1 Medical image processing

Artificial intelligence technology can improve the quality of medical image imaging, help doctors to screen lesions, and easily extract key information in medical imaging with diagnostic and therapeutic decision-making value, which plays a key supporting role in the detection, diagnosis and treatment of subsequent diseases.

2.2 Medical data analysis mining

The emergence of artificial intelligence can help doctors to carry out statistics on pathology, physical examination reports, etc., record the patient's treatment data through computer, analyze and excavate the patient's medical data through big data and deep mining techniques, and automatically identify the patient's clinical[3]. Variables and indicators make it easy for patients and doctors to refer to and analyze patient data at any time.

3 Demand analysis

Develop a medical diagnostic system based on artificial intelligence. The system is mainly for patients and medical management personnel who go to the hospital for treatment.

For patients, we offer the following features:

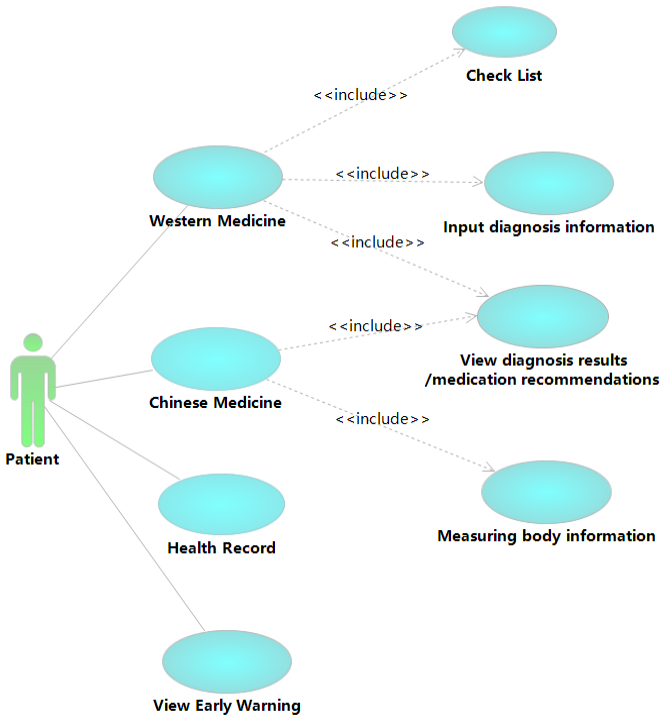

Figure 3.1 Patient use case diagram

When entering the hospital, the patient can enter the system for diagnosis. The patient can choose Chinese medicine or Western medicine diagnosis by himself[4]. The system will adopt different diagnosis procedures according to the user's choice, and finally give the patient the diagnosis result and medication recommendation; the patient can view his health file. And check if there is a warning alert. The patient's visit procedure is as follows:

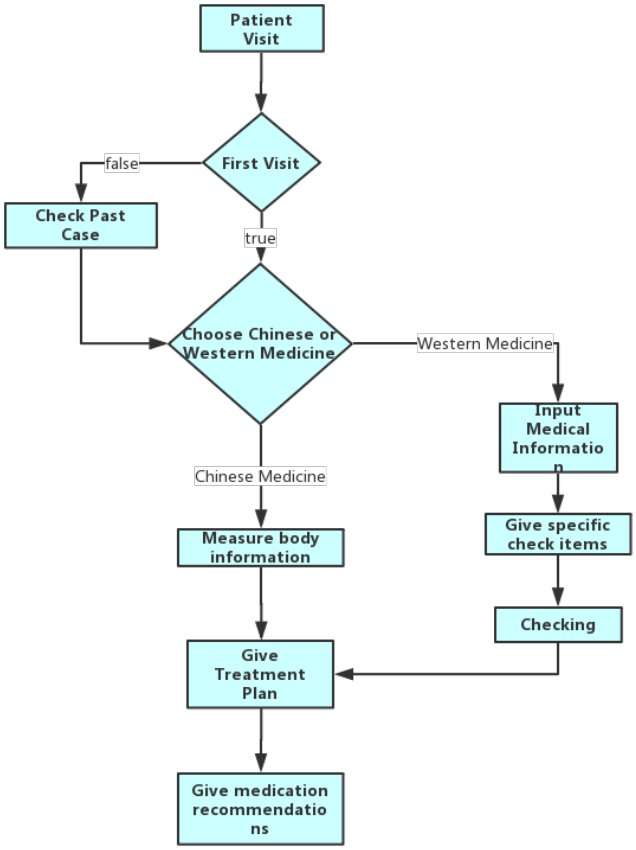

Figure 3.2 Patient diagnosis flow chart

For medical information managers, the system provides the following features:

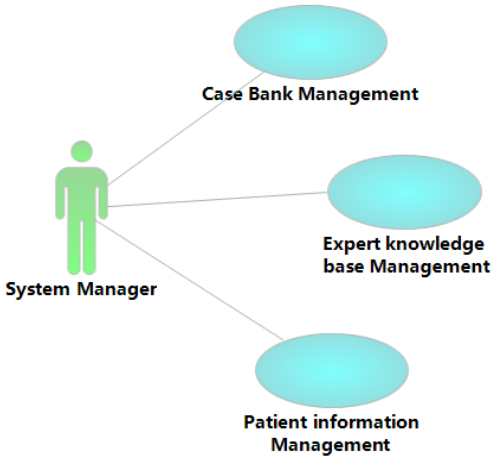

Figure 3.3 System Manager Use Case Diagram

System administrators can be hospital system maintenance personnel who can use the system to manage the case base to analyze the overall trend of the disease; update the expert knowledge base to provide the latest expert system; and manage patient information.

4 Architecture design

4.1 System requirements

We define a medical diagnostic system based on AI as a medical platform to provide a self-service AI medical diagnostic device that can be placed in a hospital. We analyzed the architectural requirements for AI-based medical diagnostic systems, including the following:

- Data communication with other hospital equipment is possible through the Internet of Things.
- The patient's condition information may be input or the patient's examination data in the hospital may be analyzed to obtain a condition-assisted diagnosis result and medication recommendation.
- A personal medical health database can be established for the patient to provide a health warning based on the patient's data.
- Case storage management can be performed using cloud storage[5].

The quality attributes required for the system include availability, standardization, accuracy, ease of use, maintainability, and flexibility.

4.2 System architecture

The following figure (overall architecture diagram) shows the interaction of this system with other devices.

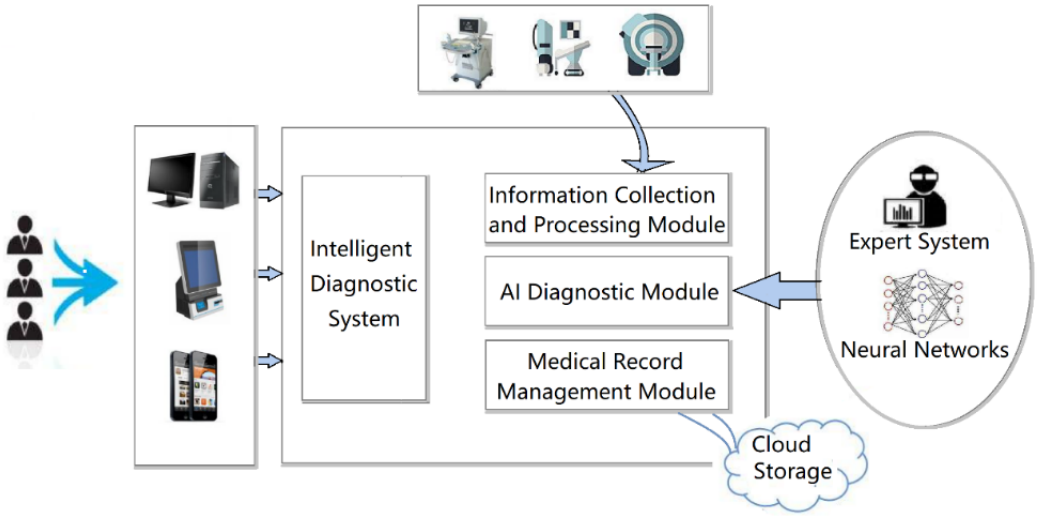

Figure 4.1 Overall architecture diagram

4.2.1 Information collection and processing module

We define the information acquisition and processing module to implement the information input function of the system. The patient selects the part to be diagnosed according to the button provided by the platform, such as the endocrine system, the digestive system, etc. When the user selects the western medicine diagnosis, the patient describes the condition, and when the user selects the diagnosis of the Chinese medicine, the patient connects the medical equipment to collect the body information. The system sends the disease description to the Chinese medicine/Western medicine diagnostic sub-module for AI diagnosis according to the diagnosis mode (Chinese and Western medicine) selected by the user.

4.2.2 AI diagnostic module

The AI diagnostic module consists of two parts. The first is the TCM diagnostic sub-module. The core technology is the expert system. The idea is to integrate the expert's knowledge extraction into a knowledge base. When the disease is introduced from the information collection and processing module, the knowledge base is used to infer. Diagnostic results, the diagnosis results are output to the user, and the medication system is called to give medication recommendations.

The second is the Western Medical Diagnostic Sub-module. The core technology used is the nervous system. The checklist is listed according to the information sent by the information collection module. The results of the patient's examination in the hospital are transmitted to the diagnostic system through the existing information management system of the hospital. According to the checklist, the diagnosis system calls the neural network-based Western medical diagnosis subsystem to give a treatment plan. The treatment plan calls the western medicine drug system to synthesize the current development status of the western medicine and the clinical manifestation effect of each drug, and give the drug recommendation.

4.2.3 Medical record management module

Nowadays, every hospital in China has generated a large amount of data every day since its establishment. The medical record of each patient is very important data. The state requires that the hospital medical record is kept for 30 years, and the outpatient medical record is kept for 15 years. The more Larger, long-established hospitals generate more data, which requires large-capacity storage and requires large-capacity backup devices.

Regarding hospital medical record data, the system uses an electronic medical record (EMR) based on cloud storage for recording. All medical record information, picture information, and inspection information are stored in the same platform. The reliability, scalability, and security of the cloud storage system just meet this requirement. At the same time, cloud storage has completed

the support of the medical record data system, and completed various application requirements for scientific research teaching, historical medical record browsing and data statistics, ensuring the safe storage and efficient use of medical record data.

4.3 Layered system architecture

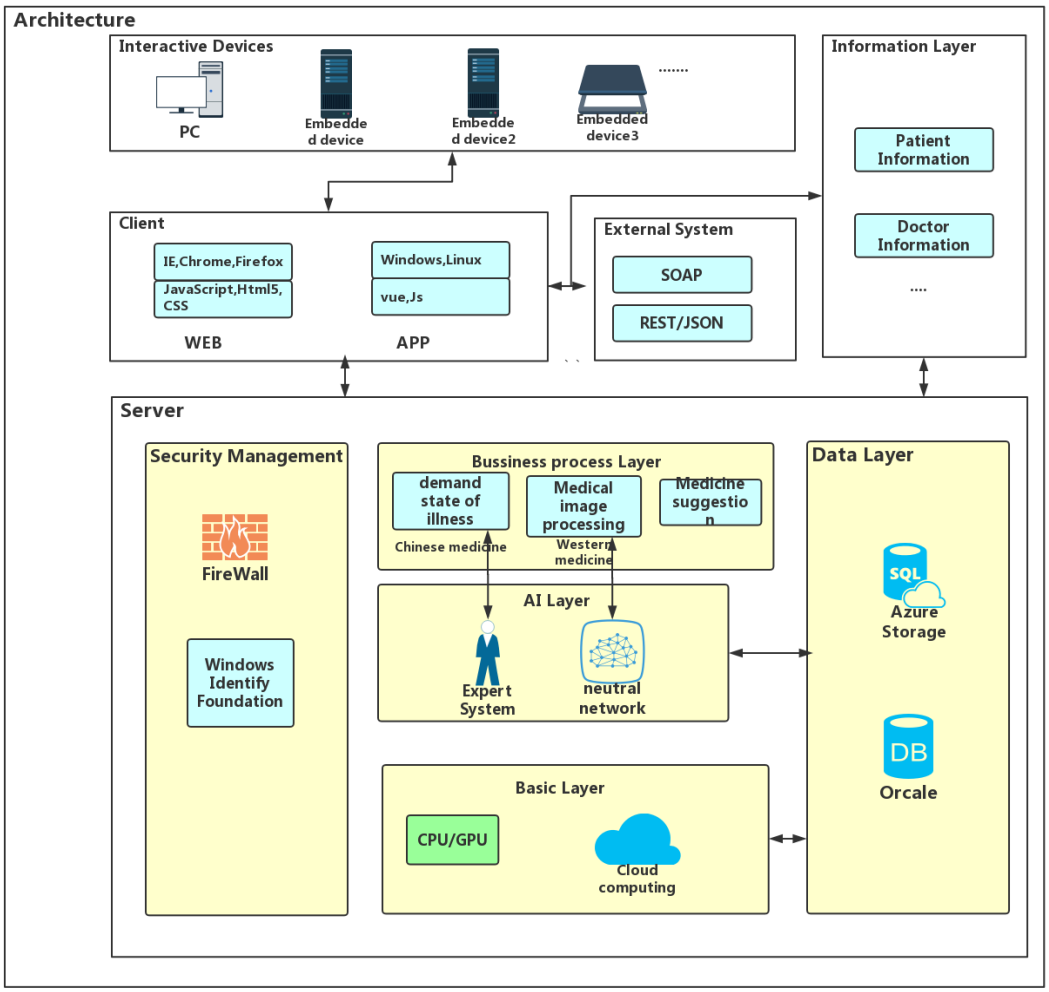

Figure 4.2 Hierarchical System Architecture

Interface and interaction:

4.3.1 Information layer

There are three sources of patient data and information:

1. Server

After the patient logs into the system, the diagnostic system will request the patient's past medical record from the cloud database as a medical history reference;

2. Client

The patient actively enters information on the client user interface to describe his or her clinical symptoms.

3.External system

The PC end or medical device in the external system sends the patient test result report to the system server through the network rest, such as the pulse signal obtained by the TCM pulse tester, the blood test result in the Western medical examination, the CT image test report, and the like.

The above three types of information form the information layer and interact with the Business process layer to provide input.

4.3.2 Business process layer

1. **Chinese medicine**

   After receiving the data of the Information Layer, the Chinese Medicine Diagnostic System of Business Process Layer transmits the data to the expert system of the AI Layer. The inference engine matches the data information with the conditions of each rule in the knowledge base, and concludes the matched rules. Store in a comprehensive database. Finally, the expert system will draw the final conclusion, which is parsed by the interpreter and transmitted to the client for presentation in the user interface. At the same time, the patient's diagnosis and related information sends a request to the cloud to update the medical record database and patient information database in the Data Layer.

2. **Western medicine**

   initial diagnosis: The Western medical diagnosis system first obtains the user description and medical history information in the Information Layer, and calls the AI Layer neural network to diagnose the target data and obtain the result. The result is transmitted to the client as a suspected disease name.

   Recommended inspection: According to the preliminary diagnosis result, the system calls the relevant recommendation algorithm, queries the knowledge base index, obtains the recommended list of the check items, and sends it to the client.

   Comprehensive diagnosis: After the patient's related examination, the information of the Information Layer is updated, and the new disease information is diagnosed by the neural network provided by the AI Layer, and the final diagnosis result is obtained. The system sends the diagnostic results to the client and the Data Layer separately.

4.3.3 AI layer

It mainly consists of two kinds of computing processing mechanisms: expert system and neural network, which provide services for Business Process Layer.

4.3.4 Data layer

Our data layer is implemented by cloud storage. The following figure is the architecture of our cloud storage platform:

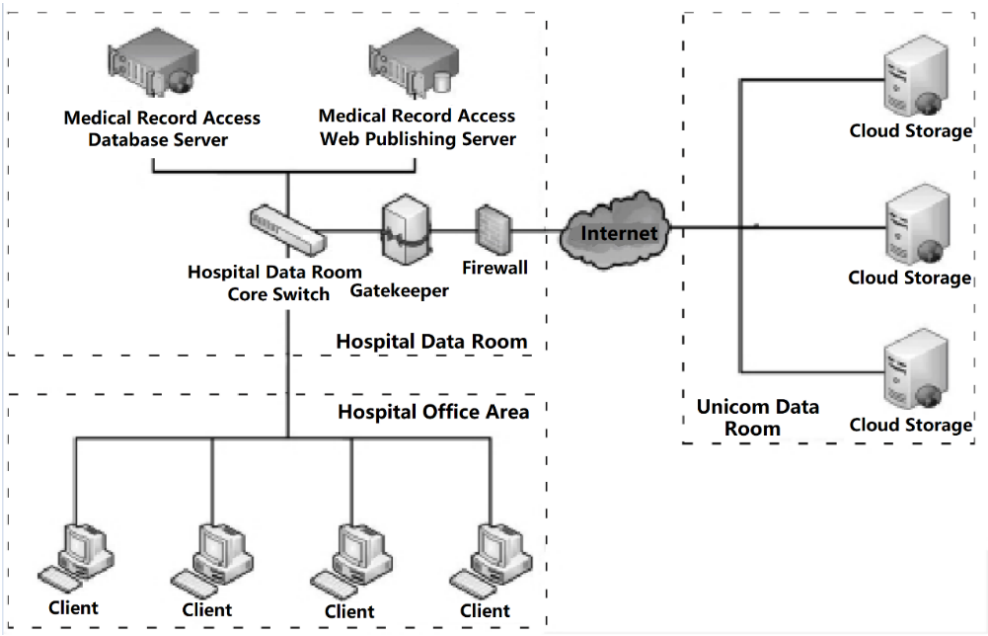

Figure 4.3 Cloud Storage Architecture

We chose to use Microsoft's Azure cloud storage technology. Because it is rated as the leading cloud computing solution in terms of the comprehensive features and strategies of application development and delivery.

4.4 Technical architecture

4.4.1 Western medicine diagnostic subsystem

Each site of interest corresponds to a neural network, the input is a description of the condition, and the required check items are output. The following is an example of diabetic retinopathy.

When the user's examination item includes a color fundus image, ffa, oct, etc., the image data is transmitted from the hospital's information management system to the corresponding diabetic retinopathy neural network (Note: different images have corresponding neural networks), The network has the ability to recognize the type of diabetic lesions and will output the corresponding test results. When the condition is mild, the medication recommendation will be given through the medication system. When the condition is too serious, only prescription drugs or other treatments will be given, and advice to go to the appropriate clinic will be given.

4.4.2 TCM diagnostic subsystem

Information collection module: collects the user's body information through existing sensor technology.

Analysis of information: the use of expert systems.

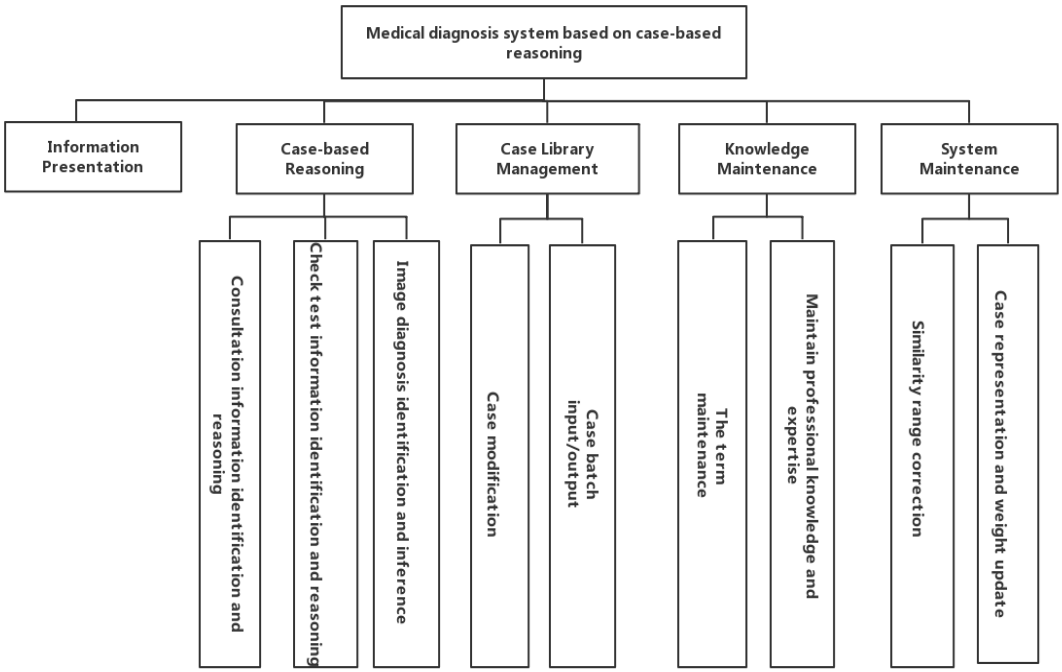

Figure 4.4 Case-based reasoning medical diagnostic system module structure

Information Representation Module: Human-computer interaction makes the basic conditions of the diagnosis system. The information representation module allows the machine to read the case library and also allows the user to understand the output information of the machine.

Case Reasoning Module: After decomposing the patient's symptoms, query the solution to the past case in the case library and match the case in the case library with the current problem. Calculate the similarity of the case and find the appropriate case according to the similarity; if you can't find the case with high similarity, you can generate the closest target solution through the inference engine according to the content of the expert database and the knowledge base according to the principle of target drive. ;

Knowledge maintenance module: used to add, delete, and modify the knowledge of the knowledge base;

System maintenance module: used to correct the value range of similarity and set the weight of related indicators.

4.5 Deployment architecture

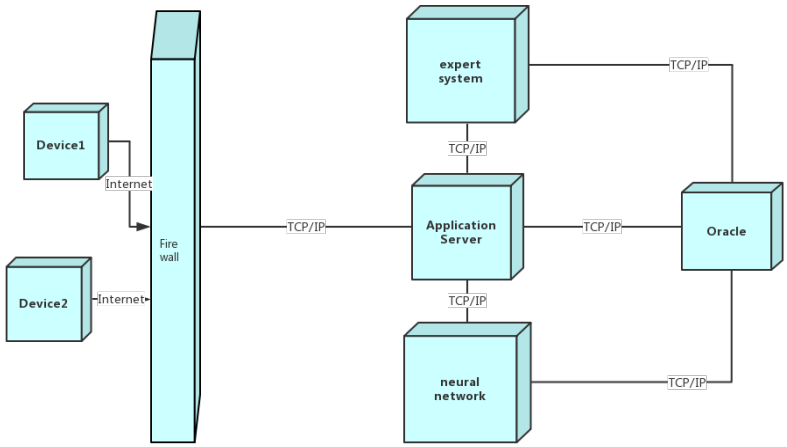

Figure 4.5 Deployment Architecture

As shown, the client communicates with the server over the Internet, during which information is filtered through the firewall. On the server side, application servers, expert system nodes, neural network nodes, and database servers are deployed respectively. The application server is a software framework that provides business logic processing for some basic requests. The expert system and the neural network are placed on two different nodes, and the application server passes the acquired data to the two nodes, and the two nodes return the running result to the application server. Deploying expert systems and neural networks on separate nodes ensures their efficiency. The database server is used to store a database application that provides database services for our system.

5 Future prospects

The intelligent diagnosis system has realized the remote medical diagnosis function, but the diagnosis speed and accuracy have not fully achieved the effect of the famous doctor. In future research, intelligent diagnostic systems need to be upgraded in the following ways:

1. The medical diagnosis system obtains the patient's human body information through the patient description, so the acquired human body information is not instant and comprehensive. In the future, under the 5G network, we can obtain more perfect human body information by means of computer graphics, sensors and other technologies.

2. The training time of the neural network is too long, and the diagnosis speed is also slow. It is improved to some extent by the genetic algorithm[6].

Diagnostic speed, in the future can be improved by genetic algorithm or neural network algorithm to further improve the speed of diagnosis and treatment.

3. Develop an inspection system suitable for the diagnosis of Western medicine, so that the diagnosis of Western medicine can get rid of a wide variety of examinations, thus making wisdom Can diagnose the system to the family, to achieve a good prospect of "good doctors".

4. Design an excellent treatment system for the diagnosis system to achieve integration of diagnosis and treatment.

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