Design and Implementation of Personal Medical Assistant System Based on Edge Computing

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Abstract. In recent years, people pay more and more attention to health. In order to correctly respond to state of illness and reduce unnecessary medical expenses, in this paper, a personal medical assistant system based on edge computing is proposed. The overall structure and each functional module of the system are designed, and the tasks of each layer in the structure and implementation methods of each function are analyzed in detail. This personal medical assistant system can provide state analysis of illness, diagnosis and treatment advice, remote medical treatment and map navigation services, which can give a great help when people encounter diseases.

1. Introduction

Recent years, people pay more and more attention to their health. However, when encountering diseases, many people don't know how to deal with it except to go to a hospital, or just know to go to a hospital, but do not know which hospital to go to or in which department to register. As a result, many minor diseases that do not need to go to hospital occupy a large amount of medical resources, while people with severe diseases can not go to hospital or be quickly treated due to the occupation of medical resources. Then it is not only wasting personal time and money, but also occupying valuable medical resources. Therefore, there is an urgent need for a smart medical assistant that can help people deal with diseases correctly, saving personal time, money costs and public medical resources.

With the development of Internet and the progress of medical technology, remote smart medical treatment has been widely concerned and studied by all walks of life. In China, remote smart medical treatment has not been broken through until the end of the 20th century. In 2003, Shenyang Central Hospital performed electrocardiogram and various routine examinations on remote patients through Internet, and completed interactive surgery [1]. In recent years, with the rapid development of cloud computing and Internet of Things, people begin to study the establishment of smart remote medical treatment system by combining Internet of Things technology, which even more enables smart remote medical treatment to enter the fast track of development. Wang Nengcai et al. [2] established remote medical treatment information service platform based on Internet of Things. This system can be used for remote video conference to facilitate remote clinical reception or consultation, and can dynamically present medical data. Jin Wei et al. [3] designed a set of remote smart medical system based on Internet of Things technology, mainly aimed at diseases prevention and chronic diseases, and adopted bluetooth transmission technology to design information gathering module. These systems are partial to specialized medical systems.
2. Edge Computing
With the deep development and wide application of big data, and Internet of Things technology, the number of user devices accessing the network has soared, and traditional cloud computing is difficult to meet service requirements of low latency, densification and privacy protection. In order to make up for the lack of cloud computing, edge computing came into being. There is a consensus on the core concept: edge computing is a new computing model that performs computation at the edge of network. Network edge refers to any resource from data source to cloud computing center[4].

3. System Architecture
The overall structure of this system is divided into three layers, as shown in Figure 1. End user layer and edge computing layer are connected through the access of network, and edge computing layer and cloud computing layer are connected through core network.

![Figure 1. Overall Architecture of Personal Health Helper System](image)

3.1. End user layer
End user layer is mainly composed of users' mobile phones, tablet PC, computers, cameras, sensors and other end devices. These computers or sensors at end user level gather information and make task requests based on user's illness state and needs. These requests may be processed through the edge or probably sent to cloud computing center. The results of task processing are also fed back to the user through terminal devices of end user layer, such as displaying processing methods, communicating with doctors through telephone, displaying the location around hospitals, the stream of people, etc.

3.2. Edge computing layer
Edge computing layer is mainly composed of nodes at the edge of network. These edge nodes are widely distributed and interconnected. They each have a division of work, some of them provide storage, computing and network resources, some are responsible for processing tasks submitted by the terminal, and some are responsible for task allocation and scheduling resources. Main tasks are as follows:

1) Storage of medical information, such as some typical and mild case symptoms, treatment methods or corresponding drugs, corresponding departments of general diseases, etc.
2) Receive task request and necessary data information transmitted from end user layer, including geographic location, people flow information, text, voice, image, etc.
3) According to the distribution of network resources and the resources needed to be consumed by tasks, determine whether edge layer or cloud computing layer should handle the processing, schedule resources for tasks and balance the load.
4) Provide services for some tasks requiring less computing and storage resources, such as answering typical and task requests for mild case, calling edge sensors to feedback the stream of people, and reminding of serious diseases. These service results are directly returned to user end layer.
5) Send tasks requiring more resources to cloud computing layer for further processing. These tasks include: people stream information of edge nodes, analysis and prediction of flow, etc.
6) Receive and transmit the information transferred from cloud computing layer to user terminal layer.

3.3. Cloud computing layer
Cloud computing layer is mainly composed of cloud servers, data center, computing center, etc. They provide powerful storage and computing services to the whole system. Main tasks are as follows:
1) Receive data information transmitted by edge computing layer, including the latest working office hours of each expert, the stream of people in the corresponding departments of each hospital and other relevant information.
2) Backup all kinds of data reported by edge computing layer and some necessary data information, including the location and grade of all hospitals in the country, the information of diseases which each department of a hospital is good at, and even relevant information of famous doctors, etc.
3) Handle tasks beyond the computing and storage capacity of edge computing layer, such as big data analysis of difficult and complicated diseases, nationwide recommendation of hospitals and doctors for serious diseases, analysis and prediction of the stream of people, etc.
4) Send the results, commands, images, videos and other data obtained by this layer to the lower nodes in different regions.

4. System Architecture
Personal medical assistant system can be divided into five functional modules, as shown in Figure 2.

4.1. Function module of Disease Analysis
This function is mainly to gather the description of illness state provided by the user, find illness state database according to the classification of illness state, get corresponding disease by fuzzy matching, corresponding treatment methods, available drugs and other information, and transfer it to the diagnosis and treatment advice module. If several possible diseases are found, the user will be further asked to clarify relevant symptoms. If the disease is still not confirmed, submit it to the cloud computing layer for big data analysis, several possible diseases and treatment schemes can be obtained.

4.2. Function module of Diagnosis and Treatment Opinion
This function displays the results of disease analysis to the user. If it is a mild case, only need to give information about how to treat it, available drugs and so on; in the case of serious disease, system will alarm and warn the user to go to the hospital, and transfer to medical resources module; if it is not sure what the disease is, corresponding treatment plan for these diseases can be given, and prompt the user to transfer to the remote doctor or medical resources module. Of which, there is a charge for using
remote doctor function, and the charge price is displayed, which should be much cheaper than going to the hospital.

4.3. Function module of Medical Resources
The user can choose to enter this function module based on diagnosis and treatment opinion function. It provides different information depending on the severity of disease. If it is mild case, mapping software will be called to locate it, and the name of hospital in surrounding area will be returned. Search hospital information stored, determine hospital grade and the department that should be registered in, display current stream of the department. Big data analysis is performed based on previous data of people stream of the department in cloud computing layer, and recommended time for seeing a doctor can be proposed if user need. In the case of serious disease, in addition to above functions, the results of big data analysis can also show some hospitals, departments and experts that are good at treating the disease in this province and the whole country. Click the hospital to see the address of hospital and registration matters that should be paid attention; click the department to see which doctor is in the department and brief introduction of each doctor’s specialties; click the expert to see the expert's relevant brief introduction and work schedule, which will be convenient for the user to know when, where to go, and get the biggest help by looking for whom to give medical treatment.

4.4. Function module of Remote Doctor
The user can choose to enter this function module based on diagnosis and treatment opinion function module. It can be divided into two parts: one is to remotely connect online doctors of corresponding departments, so that users and doctors can communicate face to face through the network. The other is charging module. After a doctor is connected, the user will be charged a prescribed price for medical treatment, and corresponding fees will be transferred to corresponding hospital or themselves.

4.5. Function module of Map Navigation
This function can be chosen by the user whether to apply it, which mainly helps users in other places to quickly seek medical treatment. The module can call general map software, locate the position of user, search and display hospitals and pharmacies in surrounding area, show hospital level, advice for what department should be registered in, and current stream of people in the department. If there are multiple hospitals or pharmacies around, the information can help users decide which hospital or pharmacy to go to. After the user has decided where to go, the best route can be displayed according to the user's choice combined with map software.

5. Conclusion
This paper has analyzed and designed personal medical assistant system based on edge computing. Personalized medical advice and resource information can be provided to users according to disease classification, and remote doctors can be seen through this system, which greatly helps people to cope with the situation of being at a loss when encountering diseases.

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