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Application of Cloud Message Management System in Medical Cloud Robot

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Abstract: China's economy is in the transition from high-speed development to high-quality development, and the traditional manufacturing technology is also undergoing technical changes. There are problems such as low production efficiency and slow development and innovation. The development and innovation of medical cloud robot technology in intelligent manufacturing has brought new development opportunities to the traditional manufacturing industry. As the combination of cloud computing technology and robot technology, medical cloud robot has the advantages of reducing energy consumption, improving production efficiency and so on. This paper discusses and studies the application of cloud message management system based on cloud computing technology and system software in medical cloud robots, and makes prospects for the development trend of medical cloud robots in the future.

Keywords: Cloud robot technology; Intelligent manufacturing; Cloud computing; Robotics; Medical care

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1. Introduction

1.1 Background of the study

With the development of intelligent industry in China, intelligent robots have been widely used and popularized in the medical field. In combination with the current population situation in China, the aging is getting worse and the number of children is getting smaller; With the development of economy and the reduction of Engel's coefficient, people have invested more time and money in their own health, and they have higher requirements for medical treatment. The Chinese medical robot market has risen rapidly. The mainstream applications of surgical robots are divided into three categories: da Vinci robots, radiation robots, and assisted surgery systems. Leonardo da Vinci robot can perform many complicated minimally invasive operations. Under the correct control of doctors, it can perform more delicate surgical operations and results, which greatly improves the success rate of surgery Radiation robot is a series of surgical operations completed by doctors through computer remote operation machine, which improves the accuracy of surgery and reduces adverse results caused by human factors during surgery [1].

1.2 Problem Statement

There are some deficiencies in the operation and maintenance process, deployment capability, and unified monitoring and scheduling:

（1）There are intensive computing tasks (visual recognition, SLAM map construction, etc.) in the operation and maintenance process, which will increase the robot's local computing cost;

（2）Poor rapid deployment capability for medical or new robots;

（3）It is unable to effectively monitor and schedule multiple robots in the area, and the management efficiency is not high. It is a trend to combine robots with cloud to establish cloud robot architecture and carry out operation and maintenance tasks based on

cloud architecture.

The concept of GUIZZO E. et al. [2] was first proposed by Professor James Kuffner in 2010. It refers to the combination of cloud computing [3] and robots, unloading complex computing such as data processing and decision-making to the cloud, while only basic mobility and operations with high real-time requirements are completed on the robot side. With the help of cloud computing, the computing power of robot system is expanded, thus reducing the computing cost of robot body; Deploying relevant services of robots in the cloud has innovated the development process of robots, facilitating the rapid deployment of robots. Singapore ASORo Laboratory proposed the Davinci framework based on Hadoop and ROS ,By running Fast SLAM algorithm in Map/Reduce, the efficiency of robot map construction is improved, and the demand for sensor performance is reduced. Doriya proposed the cloud robot system Robot cloud, which provides services for low-cost robots, but cannot meet the concurrent access of robots to cloud applications. Mohanarajah proposed the cloud robot system Rapyuta based on the RoboEarth project, which enables robots to use the interface provided by RoboEarth to access the shared knowledge base for work learning. Chen Xian and others in China also proposed a ROS based cloud robot service framework to provide face recognition services for robots. Most of the above cloud robot platform architectures are generic service-oriented architectures that meet most application scenarios. They use the Internet to provide services for robots. When communicating between the cloud and the robot, RosBridge is required to convert message formats, which will reduce communication efficiency. Therefore, the above cloud robot architecture has the characteristics of universality and strong service, it is not applicable to certain specific application scenarios. Based on the characteristics of hospital working environment and operation and maintenance tasks, this paper proposes a ROS based medical station cloud robot architecture, and provides a solution for large-scale application and unified management of medical robots based on the application of cloud message management system in medical cloud robots.

2. Research methods

2.1 Overall structure of the system

In view of the large number of hospital message categories and the involvement of many personal privacy, the system needs to ensure the privacy and security of messages in the process of implementing message exchange and sharing.

The system is composed of the basic layer, the management layer and the service layer, the basic layer through the server cluster and storage devices arranged to build a virtual database, process medical message storage, and provide network services to process the message transmission between the layers of the system, the management layer receives the business requests sent by the service layer, and retrieves the messages in the basic layer database， And through the relevant algorithm processing business processing, the processing results are transmitted back to the service layer management as the core layer of the system, which is composed of multiple modules, of which the logic module is an important module in the layer, which realizes the integration, storage, interoperability and sharing of medical messages and conversion and interoperability.This layer includes integrated security gateway, cloud storage and application server, message integration and interoperability sharing module, according to service requirements, messages that need to be shared or convertible are processed through the security gateway to process message communication; At the same time, the module can process the storage of data messages related to patients' medical images, and allow access to all mobile terminals, and can realize operations within the corresponding authority after processing identity authentication, and realize the conversion and sharing of medical data messages. Virtualized communication is the main part of hardware used to ensure the security of message communication, which can be used for authentication, secure channels, and ensure the integrity of message transmission. The secure channel is a domain based on the virtual network to achieve its inclusion of public and private, which is the collective name of all network terminals in the system that need to be securely managed. In order to ensure the security of the service, the network terminal needs to handle the access through the secure access method and connect to the basic security management domain. It is mainly composed of virtual hosts and virtual storage devices, which handle the execution of different types of business and provide related application services. Virtual Access Users need to access the relevant applications in the system through the virtual intranet.

2.2 System software

2.2.1 Securely share messages based on hierarchical keys

In the process of sharing medical messages, its privacy and security are particularly important, and message application visitors need to send mutual sharing requests, and must go through the identity authentication and permission of all the message parties, and obtain private messages and encryption keys before they can process the message sharing within their authority. Use customer groups denoted by V. $V=\{V_1,V_2,\ldots,V_n\}$； Access groups are denoted by V_i. It consists of one or more users who have access rights. Indirect keys for groups V_i to V_j:

$$k_{i,j}=\begin{cases}(k_{j,j}-w_{i,1})w_{i,2}^{-1}\ (v_j \le v_i) \\ 0\ (\text{other})\end{cases} \quad (1)$$

In this formula：$k_{i,j}$ and $k_{i,j}$ all represent symmetric encryption keys, Correspond respectively V_i and V_j； Private messages Indicated by $w_{i,1}$、$w_{i,2}$,It is processed by a random function F and belongs only to V_i. The build rules are described below:

(1) X_i and A_i both represent vectors, the former is private, the latter is public, and the symmetric encryption key of V_i is the inner product of the two, which is:

$k_{i,j}=X\times A_{i1}$

(2) To obtain the intermediate key of V_i in V_i, V_j, $V_I Anc(V_{i,G})$, for:

$k_{ij}=X_i\times AT_i$

(3) If V_i、V_j,$Anc(V_{j,G})$,so:

$X_i\times AT_i=0$

(4) The detailed steps for the algorithm are described below(1) Private messages are randomly selected from vectors. $Y_i=(y_{i,1},y_{i,2})$ and Z $i=(z_{i,1},z_{i,2})$, and neither is 0 and belongs to V_i. (2) F is used to implement mapping processing for Y_i to form a new vector W_i, which is processed by two steps: the first step: determine the exposed parameter r, and it is randomly selected calculation $w_{i,1}=Fy_{i,1}(r)$ and $w_{i,2}=Fy_{i,2}(r)$,i=1,2,...,n. Step 2: If $w_{i,2}=0$, you need to redefine r and start again from the first step. The transformation process is implemented on Z_i to become a vector X_i with dimension n when i=1,2 and i=3,4,...,n In both cases, there are $x_{i,1}=z_{i,1}$,$x_{i,2}=z_{i,2}$,$x_{i,3}=x_{i,4}$、... , x_i, n=0 and $x_{i,1}=z_{i,1}$, $x_{i,2}=z_{i,2}$ Two results, And when j≠1 $x_{i,j}=0$, then the vector X can be described by formula (2):

$$X=\begin{pmatrix}X_1\\X_2\\\vdots\\X_n\end{pmatrix}=\begin{pmatrix}x_{1.1} & x_{1.2} & 0 & \cdots & 0\\ x_{2.1} & x_{2.2} & 0 & \cdots & 0\\ x_{1.1} & x_{1.2} & 0 & \cdots & 0\\ x_{1.1} & x_{1.2} & 0 & \cdots & 0\end{pmatrix} \quad (2)$$

（3）Overdetection determines that X_1, X_2,...,X_n has wireless independence, if not, it will go to the next step, instead, return (1). (4) Obtain the symmetric encryption key and solve the public matrix A, and it is a full group. It mainly has 3 steps. Step 1: In the non-infinite domain, obtain the k i,i of each Vi, and it is randomly determined and belongs to G; Use equation (1) to solve ki,j. Step 2: The system of linear equations of A is obtained by equation (1) if $K_j=(k_{j,1},k_{j,2},...,k_{j,n})$, $K=[K_1K_2,...,K_n]T$, then X×A = K. Step 3: Solve the system of equations in step 2, then A = (X-1)K. (5) Send $((Y_i, Z_i), K_{i,j})$ to V_i and process it over a secure channel, while the service provider accepts F, r and A; Handle secure and shared messages.

2.2.2 Message transformation

Message conversion is an important part of the medical message management process, and message exchange allows doctors to understand the patient's history and medical history in detail. Information conversion is handled by the conversion bus. After the message exchange request is sent, the content conversion bus according to the request is distributed according to the current request with different request identifiers, corresponding to the corresponding service gateway, and the gateway processes the conversion request through a dedicated transfer interface and passes the transformation data result to the request sender.

2.3 System performance testing and analysis

2.3.1 Experimental test content and methods

(1)Message communication, sharing, communication connection and security testing under the conditions of different number of medical service institutions in different places. The test content takes the number of remote medical institutions as a variable, and increases the number of medical institutions connected by the platform to test the current information exchange and sharing communication status and access security of each medical institution.

(2) Conditional message sharing rate test with different medical message volumes. When you add data with different message volumes to the platform using the medical message volume as a variable, the platform message exchange and sharing rate is tested.

2.3.2 Medical message management

A tertiary hospital in a certain region was selected as the research object, and the system designed in this paper was applied to its message management to test the management results of the text system. The test content includes functional testing, performance testing, and application testing of the system. Drug inventory message management is an important part of the medical message management function, so take the management function as an example to carry out the relevant test, test that the output of drug

storage, outbound, return message modification, inventory message review and other outputs can fully meet the expected value, indicating that the system can achieve various functional operations and execution, and the implementation results meet the expected standards, indicating that the system in this article can effectively handle medical message management. In the process of medical message management, the intercommunication and sharing of messages has the use of customer concurrency, and the test text system achieves the overhead required to achieve 3GB message intercommunication and sharing in the case of concurrent use of customers, so as to measure the management performance of the system.

3. Benefits of a cloud messaging system

3.1 MR display of medical equipment and information

Combined with the practical, considering the practical functions, in the design, the system with the help of MR technology interaction mode, it breaks the limitations of the traditional working state, so that doctors can use holograms to check medical equipment, anytime and anywhere to understand the comprehensive situation of patients, effectively improve work efficiency.

3.2 Adjustable real-time data hanging window

The system's real-time instrument data display interface, control panel and real-time patient status data display interface are all free from the shackles of traditional dashboard display. With HoloLens' interface, it appears as a floating window in front of the user, and since the system is individually designed with a non-integrated window mode, each data window can be fixed or moved relative to the user's view, so the user can choose to see the control panel and data pool they want.

3.3 Use of Virtual Keys

The system combines the actual situation, designs a very complete virtual button and panel, greatly solves the problem of over-reliance on the actual equipment of the user, changes the original rocker arm or near control button control mode, moves the robotic arm and electron gun, realizes the remote operation of the doctor, expands the working space of the robotic arm, protects the safety of the user, and reduces the cost of purchasing a large console and dashboard.

4. Data analysis and findings

Hospital information technology platform integrates cloud computing management mode, which can not only facilitate data maintenance, but also improve the detailed operation and analysis of data terminals. Combined with the scientific and fast characteristics of cloud computing theory, the accurate allocation of medical service data resources is carried out, so that modern medical services can achieve precise regulation and control between various units in the operation of digital universe.

5. Conclusion

With the development of medical cloud robotics, more and more medical data application platforms have emerged, gradually expanded the cloud messaging management system. Many hospital enterprises have realized real-time sharing of cloud information, greatly improved the work efficiency of hospital enterprises. However, at the same time of its integrated development, it also contains many security risks. Such phenomena as information leakage and data loss have seriously damaged the interests and reputation of hospital enterprises or individuals. In the field of medical cloud robotics, ensuring cyber security is a key link. The realization of network environment security needs to optimize the technical path as the guarantee. Therefore, the continuous exploration and development of cloud message data security technology is also one of the key work at this stage. Lay a good foundation for the integration of the three. Technical personnel can maintain network security by building cloud computing data centers, strengthening network security technology, enhancing policy protection, and implementing secure access control policies. As people become more and more dependent on the Internet, the application range of medical cloud robots in medical network security storage is increasingly wide. Promote medical treatment, improve the application ability of cloud computing technology, the effectiveness of network security storage, can protect people's cloud message data security. Improving the effectiveness of people's use of cloud information can not only protect personal interests, but also help maintain normal medical order and economic development, and promote the healthy development of the country.

References:

[1]Yan Yongzhi. Distribution Station Monitoring System Based on Deep Learning and Knowledge Base [D] Jinan: Shandong University, 2021.

[2]GUIZZO E. Robots with their heads in the clouds[J]. IEEESpectrum, 2011, 48(3) : 16－18.

[3]ARMBRUST M.FOX A.GRIFFITH R. etal. Above the Clouds: A berkeley view of cloud computing[R]. Technical Report UCB/EECS－2009－28, EECS Department, University of California, Berkeley, 2009.