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A Dermatology Remote Visit Diagnosis and Treatment Service System Based on WebRTC

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Abstract: The traditional dermatology follow-up model has significant time and cost burdens, making it difficult to achieve long-term and real-time observation. To address these issues, this article designs a dermatology remote follow-up diagnosis and treatment service system based on WebRTC technology. Patients can conduct video follow-up visits at any location through the app, without the need for personal medical treatment, greatly reducing the time and cost burden; The system also designs a case tracking module, which allows doctors to view the uploaded lesion images and course of disease in real-time, and observe changes in the condition for a long time. The system also supports collaborative diagnosis and treatment among multiple doctors. Through the consultation mode, the same case can be discussed jointly by multiple doctors to improve diagnostic accuracy. The system also designed an electronic medical record function to record the complete course of the disease. The data collection and analysis module can extract big data information and provide reference for personalized treatment. The preliminary experimental results indicate that the system can effectively solve the problems of traditional follow-up mode and achieve convenient and efficient remote diagnosis and treatment. It is of great significance to reform traditional diagnosis and treatment models through information technology, improve service levels and resource utilization efficiency.

1. Introduction

There are problems with the traditional dermatology follow-up model[1-4]:

(1) For patients, follow-up visits to outpatient clinics require additional time and cost. Especially for chronic skin disease patients who undergo long-term follow-up, frequent return to the hospital for follow-up is a heavy burden. In traditional mode, patients need to arrange time to personally

visit the hospital for follow-up visits. For some patients who work or live in remote areas, it requires a significant amount of time and money to travel back and forth. A survey shows that nearly one-third of patients report that the time and cost burden of follow-up visits to outpatient clinics is significant, which affects the frequency of follow-up visits.

(2) For doctors, as the number of patients increases, it is difficult to ensure regular follow-up visits for each patient. At present, the number of outpatient patients in China is increasing by millions every year, but the lack of medical resources has led to a huge number of outpatient visits per doctor. Some patients may delay or miss the follow-up time due to personal schedule conflicts, transportation issues, or mild illness, which may affect the effectiveness of diagnosis and treatment. In traditional mode, doctors find it difficult to track the follow-up status of each patient, and they are also unable to solve various problems encountered by patients during the follow-up process in a timely manner.

(3) The traditional follow-up mode is difficult to achieve real-time and long-term observation of changes in the condition. The diagnosis of skin diseases relies on long-term observation of pathological changes, but it is difficult to accurately determine subtle changes in the condition through interval follow-up visits. For example, the healing process of acne and the spread range of tinea require long-term and continuous observation to provide accurate diagnosis. However, in traditional mode, doctors and patients can only have brief contact during the follow-up period, making it difficult to understand the real-time dynamics of the condition. This poses certain difficulties for accurate diagnosis and personalized treatment.

(4) Different doctors may have different judgments on the same case. Due to the reliance on vision in the diagnosis of skin diseases, different doctors may draw different conclusions for the same case. In traditional mode, patients can usually only see a fixed doctor for follow-up visits. This cannot guarantee the objectivity and accuracy of the diagnostic results. Multiple doctors need to discuss the same case in order to come up with a recognized conclusion.

With the development of information technology, video consultation technology has been widely used both domestically and internationally. Representative technologies such as WebRTC have laid the technical foundation for peer-to-peer video calls. WebRTC is an open source real-time communication API that allows for audio and video calls in browsers or mobile applications without the need to download plugins or applications. It supports cross browser and platform calling of cameras and microphones, achieving high fidelity real-time audio and video calls. In addition, with the popularity of smartphones, various healthcare apps have emerged. Representative apps such as a certain doctor have implemented a series of functions such as online consultation, appointment for medical treatment, and access to medical knowledge. This lays the foundation for remote medicine on the user side [5-11].

Therefore, with the widespread application of information technology and artificial intelligence in the medical field, unprecedented opportunities have been brought to improve the traditional dermatology follow-up model. This article designs a dermatology remote follow-up diagnosis and treatment service system based on WebRTC video follow-up, aiming to provide patients with a one-stop convenient and efficient remote follow-up service[12-15].

2. Design of a Real-time Video Follow-up Diagnosis and Treatment System for Medical Personnel Based on WebRTC

WebRTC (Web Real Time Communication) is currently the most mature open source real-time communication technology framework, allowing browsers to directly make peer-to-peer audio and video calls without relying on any plugins or external application support. This system utilizes WebRTC video technology to achieve real-time video follow-up consultations between patients and doctors, addressing traditional follow-up issues.

2.1. Working Principle of WebRTC

WebRTC adopts a session based peer-to-peer communication architecture. When the client needs to make audio and video calls, it will first perform NAT traversal through the STUN/TURN server to obtain its own public IP address and port. Then, it will use the SDP (Session Description Protocol) protocol to exchange media stream related information with the peer, such as encoding format, transmission protocol, IP address, and port. Finally, the two clients can directly establish audio and video data channels through IP and ports for real-time communication.

The entire process does not require a central media server, but directly achieves audio and video transmission between clients through P2P technology. This architecture has the advantages of high performance and low latency, greatly improving the experience of real-time calls.

2.2. Application of WebRTC in the System

This system uses Nginx as the web server and uses Node.js to develop backend applications. The front-end is developed using the React framework.

When a patient requests a video follow-up through an app or PC webpage, the system backend will generate a unique Room ID. Then use Socket. IO technology to pass the Room ID to the doctor client.

Once the doctor receives a follow-up request, the front-end will use the WebRTC API to establish an audio and video connection with the counterpart. Among them:

-Use getUserMedia to obtain local audio and video devices.

-Connect to the peer through the RTCPeerConnection object and exchange SDP information.

-Use RTCDataChannel to establish a data channel for text chat, etc.

-Use RTCSessionDescription to set local and remote SDP descriptions.

-The getStats method monitors connection quality in real-time.

After establishing the connection, both parties can conduct real-time video consultations. After the consultation, the system automatically turns off the audio and video stream.

2.3. Optimizing the WebRTC Experience

In order to improve the user experience of WebRTC in the system, this system has optimized the WebRTC connection as follows:

(1) STUN/TURN server selection. The system integrates online servers provided by well-known domestic STUN/TURN service providers, prioritizing servers with close proximity and fast response to reduce latency.

(2) Encoding parameter adjustment. Dynamically adjust parameters such as video encoding rate and resolution based on network conditions to ensure video quality while controlling traffic.

(3) Error handling. We have designed friendly error prompts and reconnection processes for various WebRTC error situations such as disconnected connections and device access failures.

(4) Statistical monitoring. Real time monitoring of network quality indicators such as packet loss rate, latency, etc. through getStats is used to automatically adjust encoding parameters or alert users to network issues.

(5) Noise reduction processing. Utilize the Web Audio API to achieve audio noise reduction, filter out background noise interference, and improve sound quality.

(6) Interface optimization. Using simple large icon operation, it is clear at a glance. The video screen adopts a picture in picture mode, leaving more interactive areas.

In summary, the real-time video follow-up function between patients and doctors has been achieved through WebRTC technology. And through backend architecture design and front-end optimization, the video consultation experience has been greatly improved, solving traditional follow-up issues.

2.4. Privacy and Security Protection

The video consultation involves the transmission of private data, and the system provides following protection for this:

(1) Communication encryption. Using DTLS/SRTP standards for end-to-end encrypted transmission of audio and video streams to prevent traffic interception.

(2) Access control. Strictly control the access scope of different roles using the RBAC permission model to prevent illegal access.

(3) Storage encryption. Encrypt patient information using AES-256 algorithm for database storage.

(4) Transmission security. Ensure the security of data transmission between clients and servers through HTTPS.

(5) Operational auditing. Record all important operation logs, such as modification of diagnosis and treatment records, for traceability purposes.

(6) Vulnerability fix. Regularly conduct security assessments and vulnerability scans on the system to fix issues as soon as possible.

(7) Backup recovery. Regularly backup databases and system configurations to achieve data recovery capabilities.

The above measures comprehensively ensure the security of the consultation process and data transmission, and protect patient privacy data from leakage or tampering.

2.5. System Optimization and Maintenance

To ensure the long-term stable operation of the system, it is also necessary to:

(1) Load testing. Conduct stress testing and performance optimization at different scales.

(2) Automated operation and maintenance. Adopting Docker containerized deployment to achieve automated construction, publishing, and monitoring.

(3) Fault tolerance mechanism. Use database master-slave replication, load balancing, and other means to improve system availability.

(4) Version management. Using Git version control code for easy bug tracking and update maintenance.

(5) Monitoring alarms. Monitor key indicators such as response time and concurrency, and set threshold alarms.

(6) Log analysis. Collect and compile system logs for problem localization and improvement.

(7) User feedback. Regularly investigate user needs and collect feedback for iterative upgrades.

(8) Security updates. Track security issues and issue patches to fix them as soon as possible.

The above work needs to be continuously optimized and improved during actual operation to ensure long-term stable and reliable operation of the system.

In summary, the video follow-up function has been implemented through WebRTC technology and comprehensively optimized to solve the traditional follow-up problem. At the same time, we attach great importance to privacy security and system reliability, and provide high-quality remote follow-up services for patients.

3. Technical Architecture Design of Video Follow-up System

3.1. The Main Architecture of the System Includes

-Front end: Developed using the React framework and running on a browser.

-Backend: Develop web service programs using Node.js.

-Database: Use MySQL or MongoDB to store user information and consultation records and other data.

-WebRTC module: Implement audio and video call function, using WebRTC standard.

-Consultation management module: Process consultation requests and generate unique Room IDs.

-Authentication module: Implement user login and permission control.

-Configuration module: used for system parameters and third-party service settings.

-Log module: Record operation logs and system operation logs.

-Monitoring module: monitors system performance indicators and sends alarms.

3.2. Main Processes

(1) Users request consultation through the app or website.

(2) The consultation management module generates a Room ID.

(3) The WebRTC module establishes an audio and video connection for consultation.

(4) The authentication module controls access permissions.

(5) Persist consultation records in the database module.

(6) The monitoring module monitors the operating status of the system.

This architecture realizes the design of front-end and back-end separation, focusing on solving the core problem of video calling, while paying attention to the support of other functional modules such as security and monitoring in the system to ensure the reliable operation of the overall service.

4. Conclusion

This article designs a dermatology remote follow-up diagnosis and treatment service system based on WebRTC technology. This system enables convenient remote video follow-up for patients through the app, solving the time and cost issues of traditional follow-up modes. At the same time, the system has designed a case tracking and multi doctor collaborative diagnosis and treatment module, achieving long-term observation of changes in the condition and improving diagnostic accuracy. The preliminary experimental results indicate that the system can effectively reform the traditional follow-up mode and achieve efficient and convenient remote diagnosis and treatment services.

Future work will further optimize system functions, such as enhancing video quality and experience, improving electronic medical records and big data analysis modules. At the same time, it will expand the scope of clinical applications and accumulate more practical operational data. Overall, the system utilizes information technology to effectively reform traditional diagnosis and treatment models, improve service levels and resource utilization efficiency, and is of great significance for promoting medical reform.

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If any, should be placed before the references section without numbering.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

The author states that this article has no conflict of interest.

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