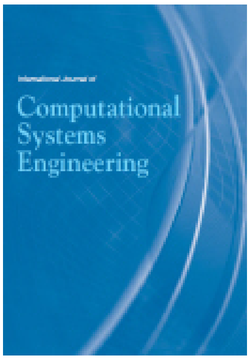

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Designing remote sharing system of network education resources for software engineering specialty based on web technology

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Abstract: With the rise of online education, the traditional offline education model has been greatly challenged, and people gradually tend to choose online education which is more convenient for acquiring knowledge. The study first proposed a method design for the remote sharing system of educational resources based on webRTC technology. Based on this, a load balancing method design based on an improved consistency hashing algorithm was proposed considering the problem of overloaded servers, and finally the constructed remote sharing system was tested with the improved algorithm. The experimental results show that the functions of all the modules of the network education resources remote sharing system constructed in this research can be used normally; by comparing the traditional hashing algorithm and the improved hashing algorithm proposed in the research, it is found that the average delay time of the improved hashing algorithm is shorter.

Keywords: network education; Hash algorithm; remote sharing system; web.

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Biographical notes: Qin Yang is a teacher of Jinling Institute of Technology. Her research direction is the technology and development of ideological and political education. She has been engaged in ideological and political education for more than ten years in the front line of teaching. She wrote and published the monograph "Research on Ideological and Political Education in Colleges and Universities in a U-learning Environment". She has published many research papers and has won many awards in educational technology competitions for teaching courseware and teaching research papers. Presided over and completed one project of the Ministry of Education and several provincial and municipal projects.

1 Introduction

The rapid rise of online education makes books no longer the only carrier of knowledge. More and more people acquire knowledge through online learning. Compared with traditional offline education, online education is widely respected by more and more people because of its convenience and knowledge range. In order to enable more people to use online education resources for independent learning, this research attempts to design a web-based remote sharing system of online education resources for students majoring in transfer engineering. In the current online education model, the sharing technology of online education resources is not mature enough, and there is still some room for improvement. For example, traditional online education often requires users' browsers to load plug-ins, which not only affects the user experience, but also has high requirements for devices. On the contrary, the webRTC technology proposed in this study has the advantage of no plug-ins and cross platform use. According to relevant reports, by the end of 2021, the number of internet users in China has reached nearly one billion, and the proportion of internet users who access the internet through mobile devices is as high as 98%. In addition, online education users are increasing year by year. These data show that China's online education has good prospects for development, and is also constantly facing various challenges. In order to further improve the current situation of network education resource sharing technology in China, make the remote sharing technology of education resources possible, thereby improving students' learning efficiency and improving students' learning mode, this research designed a network education resource remote sharing system for software engineering specialty based on web technology, and finally tested the remote sharing system constructed and the improved algorithm used. Through this research, we hope to provide more ideas for the remote sharing technology of online education resources, further develop online education in China, and use online education resources to innovate and reform our teaching model.

2 Related works

The internal structure of network technology is always changing with the development of the internet. How to combine the latest network technology with education research is the focus of current online education. At present, most online education research focuses on the acquisition, dissemination and storage of resources, and the research on the design of remote sharing systems for educational resources is relatively small. Qi et al. (2021) designed a teaching aid system using web technology. The system uses a multi-layer design structure to make data reading and transmission more convenient. The experimental results show that the system has faster data processing speed and lower energy consumption compared with traditional systems. The recall rate of course scheduling data and course selection data is higher than 96%. In order to improve the performance of web page segmentation, Jiang et al. (2019) proposed a two-stage segmentation method. This method can combine various features of web page content to segment complex dynamic web page content. Through a series of comparative experiments, it proved that this method has better performance, higher accuracy, and better recall and precision than traditional web page segmentation technology. Sahu et al. (2019) studied and developed a web-based intrusion detection model that distinguishes network attack types. By combining relevant algorithms, they can identify and group normal and malicious intrusion networks, and compare the accuracy of different algorithms combined with the web. The experimental results show that support vector machine algorithm combined with web services can randomly classify three instances of each cluster, and mark them according to the majority voting method. Compared with earlier methods, the performance of this method is better. Griffiths et al. (2019) proposed an intelligent agent based on web services. Through this web agent, two-way communication between the infusion pump and the electronic health record can be realised. At the same time, adding web services is conducive to eliminating errors generated when manually entering information. Salonen and Karjaluoto (2019) and other man-made spatiotemporal dynamic user preferences develop motivation-based complementary frameworks. At the same time, they aim to consider the benefits of user motivation when solving time dynamic problems, and create a complementary framework and proposition for motivation-based time dynamics. The experimental results show that the complementary framework constructed in this paper can promote web personalisation, and provide a new direction for web personalisation innovation.

With the development of the internet, online learning has gradually become the mainstream, and more and more educational resources have been spread and used in the form of network resources. The development of distance education not only promotes the informatisation process of education, but also promotes the development of online education in China (Hsu and Memon, 2021). The current distance education still has some shortcomings, such as slow transmission speed, low audio and video quality, and small capacity of knowledge dissemination. How to setup a network teaching resource sharing system that can give consideration to both teaching quality and communication efficiency becomes crucial. Xu (2022) studied and designed a new online teaching mode to solve the problem of different online education quality and one-way flow in the teaching process. Through this mode, the course objectives were reconstructed, the teaching content was reorganised, and the implementation process was redesigned to finally ensure the quality of online courses. Wu (2022) taking college English courses as an example, discusses the relationship between mixed teaching and ideological and political course teaching through the analysis of mixed teaching mode, and reforms the evaluation system according to the relationship between mixed teaching and ideological and political teaching to improve the quality of online and offline mixed teaching through reform. Chopra et al. (2019) studied a method to evaluate the effectiveness of e-learning experience by using students' perception. This method collected the data of students learning on the website with structured questionnaires, and analysed the data with different scales. The final results show that the proposed method can effectively explain the impact of e-learning system on e-learning effect.

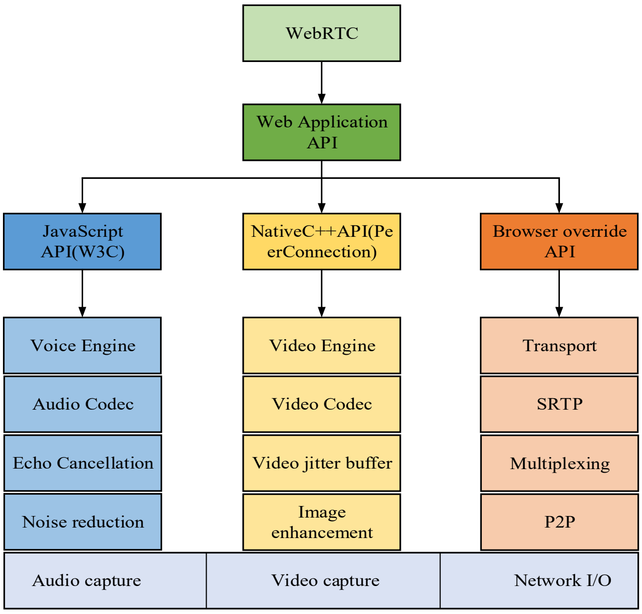
The research first proposed the method design of education resource remote sharing system based on webRTC technology. Because webRTC allows sites to establish connections between browsers without using intermediate media transcoding, it can achieve fast transmission of video stream, audio stream or other arbitrary data. Secondly, the five functional modules of the remote sharing system are described. On this basis, considering the problem of server overload, a load balancing method design based on the improved consistent hash algorithm is proposed. Finally, the remote sharing system and the improved algorithm are tested. Compared with the traditional resource sharing system, the distance sharing system of online education resources designed by the Institute has improved its propagation speed and quality.

3 Method design of educational resource sharing system for transfer engineering specialty based on web technology

3.1 Method design of remote sharing system of network educational resources based on webRTC technology

WebRTC, as a real-time communication technology, is different from the playback technology that requires the installation of traditional flash plug-ins. It allows sites to establish a connection between browsers without the aid of intermediate media transcoding to achieve the transmission of video streams, audio streams or other arbitrary data. With the rapid development of webRTC, more and more developers apply it to real-time communication applications. This research will design a set of network education resource remote sharing system for software engineering specialty based on webRTC technology, and apply webRTC technology to the online teaching module and video answering module in the network education resource remote sharing system. In order to meet the load balance, the research selects consistent hash algorithm as the basic strategy, optimises it with genetic algorithm, and finally tests the system performance. The general architecture of webRTC is shown in Figure 1.

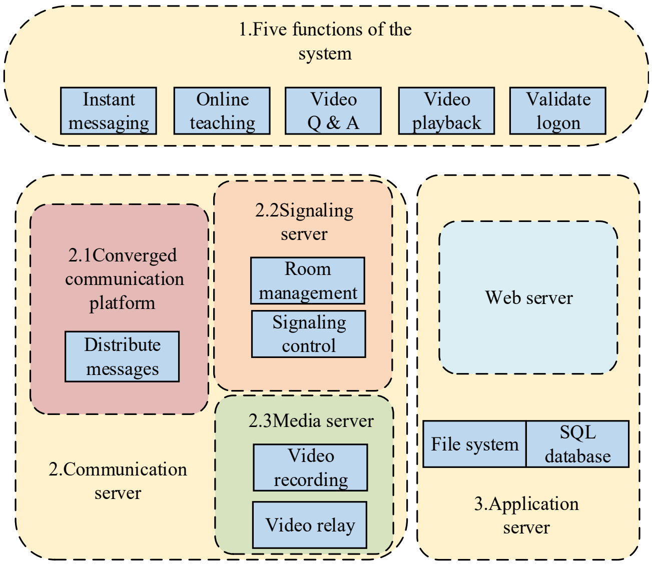
Figure 1 Basic architecture diagram of webRTC (see online version for colours)



There are generally three types of application programming interfaces (APIs) provided by this architecture, namely the JavaScript API specified by W3C, the NativeC++ API provided by the webRTC, and the API contained in each browser. The above API is mainly used to capture the real-time audio and video stream of the client, and realise functions such as audio and video input and output. According to the needs of the real-time communication – related part of the remote sharing system of educational resources for software engineering majors, the remote sharing system of educational resources based on webRTC technology mainly has five functions, namely web page login, chat communication, online video teaching, and after-class Q&A. As well as the video playback function, the overall architecture of the system is shown in Figure 2.

As shown in Figure 2, the system is divided into three parts, which are the business function part at the top, the communication function part and the application function part at the bottom. The business function part is mainly for the business functions that the system needs to implement, including web page login, chat communication, online video teaching, after-class Q&A and video playback functions. The communication function mainly deals with operations related to chat communication, such as text and pictures, audio and video. At the same time, this function also needs to integrate the communication platform and receive various instructions from the server. Application functions are mainly to provide corresponding services on web pages and clients, such as recording teaching videos and saving them in the background of the system, so that the video playback function can be used normally. Next, an appropriate webRTC network structure will be designed according to each module, and then the entire sharing system will be built on this basis. The common webRTC network structure is shown in Figure 3.

Figure 2 The overall structure of the remote sharing system of educational resources (see online version for colours)



It can be seen from Figure 3 that there are three common webRTC network structures. Combined with the remote sharing system of network educational resources proposed by the research, different webRTC network structures are selected according to the main functions of each module. For the remote sharing mode of online educational resources, the teacher usually sends one media stream, and the student receives one media stream. Therefore, for the online teaching module, it is more appropriate to use the SFU structure. For the Q&A module, SFU structure or MCU structure can be used, and the specific situation is determined according to the number of online Q&A users. If the number of online answering users is large, the latter is used, which can reduce the consumption of upstream and downstream bandwidth of the client. If the number of online answering users is small, the SFU structure is suitable, which can reduce resource consumption. For the mesh architecture, when the number of users is large, its performance is poor. Considering the large number of students in online teaching, this architecture is not used in this study. For the login module, two login methods are mainly designed, namely, user password login and scan code login. The specific process of login is shown in Figure 4.

Figure 3 WebRTC network structure diagram (see online version for colours)

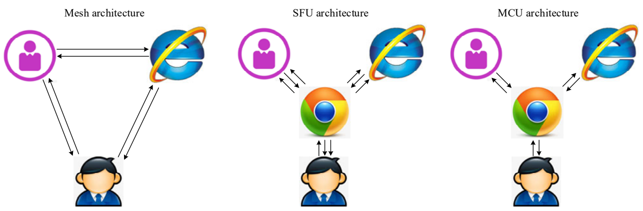
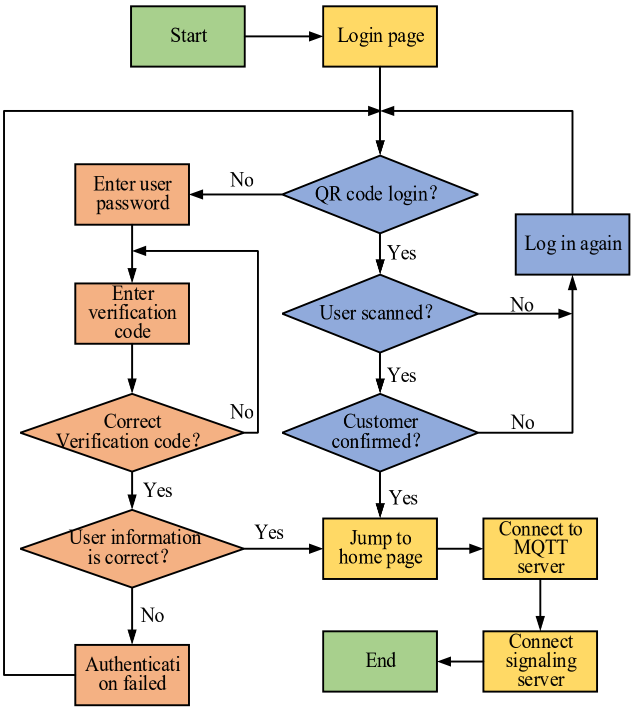


Figure 4 Login module flowchart (see online version for colours)



It can be seen from Figure 4 that there are two login methods: password login and scanning login. If the user correctly scans and confirms, he can successfully jump to the home page to connect to the server; at the same time, if the user's account and password are entered correctly, the correct user information can be obtained and the home page can be successfully skipped, then the server can also be connected. If the above two login methods fail, you need to re enter the login page to scan the code or enter the user name and password until the login is successful. For the design of the real-time communication module, the MQTT protocol is mainly used to realise its communication function. First, the client subscribes to relevant topics. If the topic message is updated, the instant messaging module will also be updated. The flowchart of the client subscription and publishing messages is shown in Figure 5.

The online teaching module mainly imitates the traditional offline teaching mode and realises online teaching through webRTC technology. Its main components are publishers, media servers, signalling servers and subscribers. As a publisher, teachers will publish their teaching content through the network, and establish contact with subscribers through the media server and signalling server. Publish content, and subscribers will directly receive the media stream forwarded by the media server. The specific schematic diagram of the online teaching module is shown in Figure 6.

Figure 5 Flowchart of real-time communication module (see online version for colours)

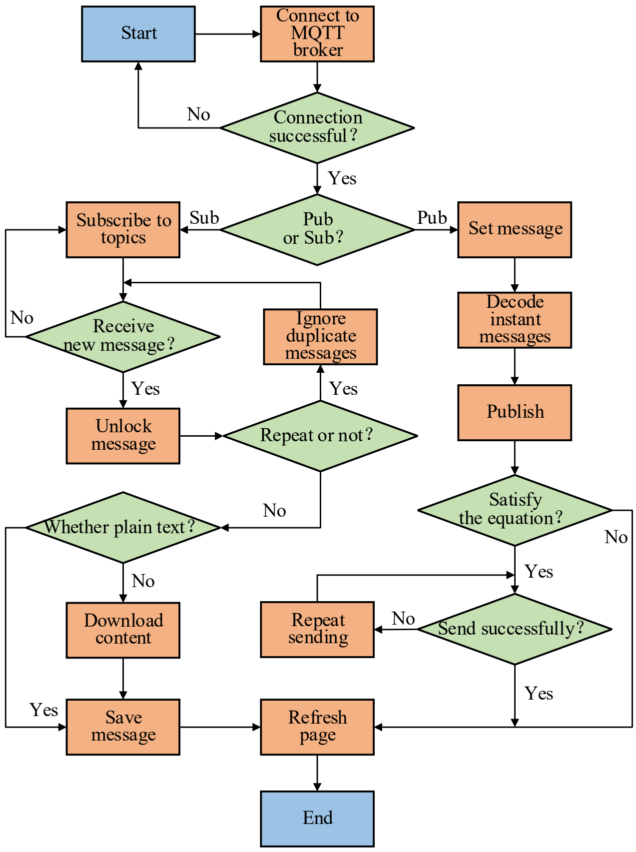
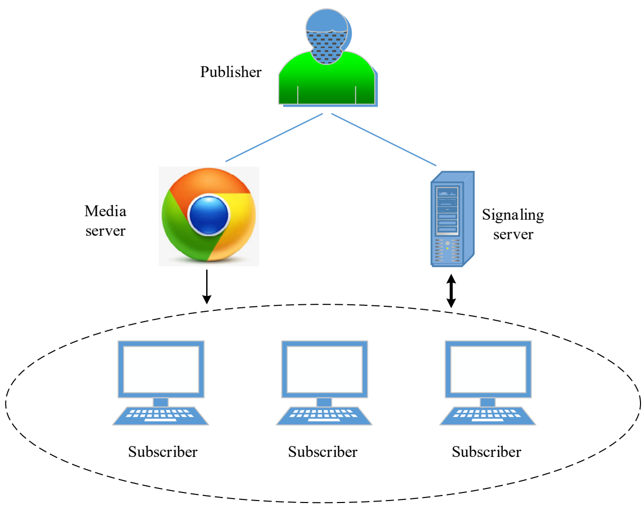
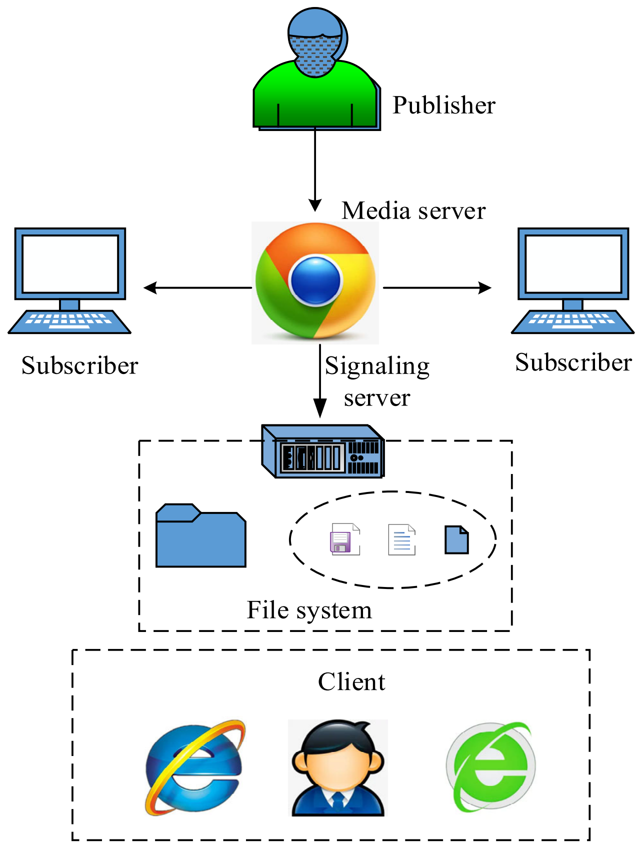


Figure 6 Schematic diagram of online teaching module (see online version for colours)



The Q&A module after class is similar to the online teaching module, both of which need to use webRTC technology, the only difference is that the latter has more subscribers and recipients than the former, and its subscribers publish more media streams. The last module is the playback module, which mainly provides playback functions for students, that is, the content of online teaching will be stored and recorded, and students can selectively playback through the playback function in the background. In order to ensure that students can quickly and accurately search for what they want video, the playback module will provide a keyword retrieval function, which is not precise to the specific name, and is mainly implemented through fuzzy query. The schematic diagram of the playback module is shown in Figure 7.

Figure 7 Schematic diagram of playback module (see online version for colours)

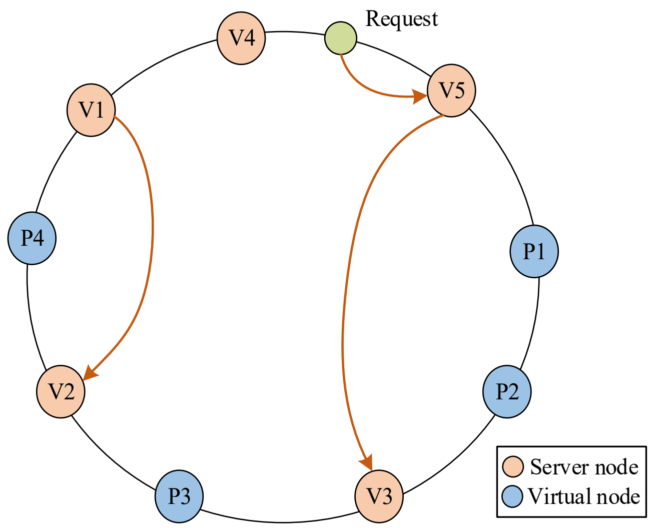


3.2 *Design of load balancing method based on improved consistent hash algorithm*

Since the number of participants in online education is high, the number of requests from the clients of this system will also increase, so there will be a situation that the server may not be able to load. Therefore, how to reasonably allocate the number of clients is a prerequisite for balancing the server load level. In order to meet the educational resources remote sharing system proposed in this study, and considering the consistency requirement that the system has to forward the transmission requests to the same media server for processing by the same group of clients for real-time media streaming, the study chooses the consistency hashing algorithm improved by genetic algorithm to do the evaluation of its load balancing.

The consistent hash algorithm needs to map the transmission request of the media server node and the real-time media stream to the ring with a value range of $[0, 2^{32-1}]$, and then find the node to process the request, and the clockwise rotation is satisfied during the search process, and find the closest one. When the number of servers is too small, the situation of request offset is prone to occur, that is, the number of server nodes is too small, so that the timely processing of a large number of requests cannot be satisfied, resulting in an avalanche effect. The above problems can be effectively solved by using virtual nodes. The schematic diagram of consistent hashing with virtual nodes is shown in Figure 8.

Figure 8 Schematic diagram of consistent hashing with virtual nodes (see online version for colours)



In Figure 8, V represents the virtual node and P represents the physical node. In this algorithm, the performance difference between servers is mainly represented by the difference in the number of virtual nodes allocated. The initial number of virtual nodes is usually a fixed value. In order to ensure the adaptability of the algorithm, it needs to be adjusted according to the real-time load state to reduce overload. Increase the number of media server virtual nodes with heavy load, and increase the number of media server virtual nodes with insufficient load.

$$LR_i = \alpha C_i + \beta M_i + \gamma B_i + \delta L_i \quad (1)$$

Formula (1) is the calculation formula of the load rate, which LR_i represents the load rate of the first i media server node, which C_i is the CPU utilisation rate, M_i the memory utilisation rate, B_i the bandwidth utilisation rate, and L_i the connection number ratio. The relationship is as follows [equation (2)]:

$$\alpha + \beta + \gamma + \delta = 1 \quad (2)$$

In formula (2), the sum of each load balancing index coefficient is 1, and the calculation formula of CPU utilisation is as follows [equation (3)]:

$$C_i = \frac{C_{ti}}{C_{all}} \quad (3)$$

Formula (3) is the calculation formula of the CPU utilisation, which C_{all} represents the total value of the rated CPU and the actual CPU value of C_{ti}, the first i media server node. The calculation formula of the memory utilisation is as follows [equation (4)]:

$$M_i = \frac{M_{ti}}{M_{all}} \tag{4}$$

Formula (4) is the calculation formula of memory utilisation, which M_{all} represents the total theoretical memory value and the actual memory utilisation value of M_{ti} the first i media server node. The calculation formula of bandwidth utilisation is as follows [equation (5)]:

$$B_i = \frac{B_{ti}}{B_{all}} \tag{5}$$

Formula (5) is the calculation formula of bandwidth utilisation, which B_{all} represents the total theoretical bandwidth and the actual bandwidth utilisation value of B_{ti} the i media server node. The calculation of the connection ratio is different from the calculation of the other three load balancing indicators above. When a user invites other users to conduct real-time communication, the other party may not necessarily respond, so it is necessary to introduce a constant in the calculation of the connection ratio k to represent the unresponsive part. The calculation formula of the connection number ratio is as follows [equation (6)]:

$$L_i = \frac{(L_{Ni} - L_{ti}) \times k + L_{ti}}{L_{all}} \tag{6}$$

Formula (6) is the calculation formula of the ratio of the number of connections, which k represents the number of connections that will accept the invitation among the number of unresponsive connections. When i the load rate $LR_i > LR_{\max}$ of the first media server node, the number of virtual nodes corresponding to each server needs to be recalculated.

$$P_i = \frac{1 - LR_i}{\sum (1 - LR_i)} \tag{7}$$

Equation (7) is the number of virtual nodes corresponding to each server that needs to be recalculated, and by summarising it, the total number of virtual nodes that need to be recalculated can be obtained.

$$V_i = [P_i \times V_{all}] \tag{8}$$

Equation (8) is the total number of virtual nodes that need to be recalculated. After calculating the number of virtual nodes, remapping needs to be performed, and the mapping calculation formula is such as equation (9).

$$h = hash(S)\%2^{32} \tag{9}$$

In formula (9), h represents the corresponding server number obtained after the hash operation, 2 32 is the size of the hash ring, and S is a characteristic string. If t, a request is received at the moment, the load balancer will calculate the total number of requests at the current moment, whose expression is equation (10).

$$LR_{sun} = \sum_{i=1}^{n} L_{i(t)} + L_{new} \tag{10}$$

In equation (10), LR_{sun} indicates the total load of the current system. n indicates the size of the service list. $L_{i(t)}$ indicates the number of load requests for the i^{th} media server node at time t. L_{new} indicates a new request. At this point the node load bound is set to the average of the individual node loads.

$$\overline{LR} = \frac{LR_{sun}}{x} \tag{11}$$

In formula (11), $\overline{LR}$ represents the average load of x all nodes, and represents the total number of all nodes.

$$M_i = \overline{L} * (1 + \varepsilon) \tag{12}$$

In formula (12), M_i represents the upper limit of the load of the node and ε represents the equilibrium constant. In view of the above-mentioned parameters are all fixed values set artificially, in order to reduce the error, the weights are now adjusted by genetic algorithm to obtain the optimal weights.

$$\overline{LR} = \frac{\sum LR_i}{x} \tag{13}$$

Equation (13) is a further optimization of Equation (11). $\sum LR_i$ denotes the summation over all nodes.

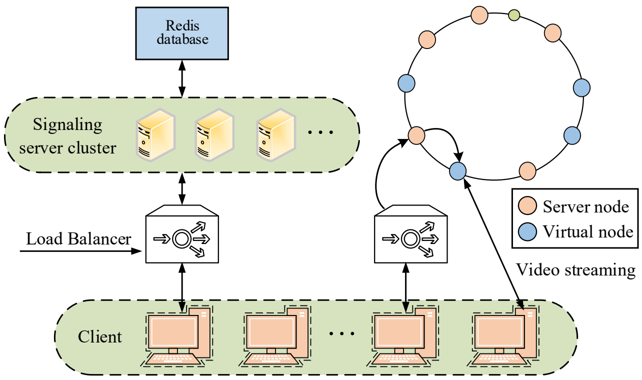
$$S^2 = \frac{\sum \left(LR_i - \overline{LR}\right)^2}{N} \tag{14}$$

In formula (14), according to the roulette algorithm, one chromosome needs to be marked first, and then the one with high fitness is selected from the remaining chromosomes for marking, and the positions of the two chromosomes are exchanged through random cross-selection, and then through mutation operation The stability of the cluster is guaranteed without changing its genetic algorithm weights. Its fitness function calculation formula is shown in equation (15), f the larger the value is, the higher its fitness is.

$$f = \frac{1}{S} \tag{15}$$

The hash algorithm optimised by the genetic algorithm is used to solve the problem of excessive server cluster load, and the algorithm is applied to the server cluster load problem of the system constructed in this research. The final architecture diagram of the media server cluster is shown in Figure 9.

Figure 9 Server cluster architecture diagram (see online version for colours)



4 System performance test and experimental results analysis

4.1 Server cluster load performance test based on improved hash algorithm

In order to verify the advantages of the improved hash algorithm proposed by the research (later referred to as Model 1) in server cluster load, the modified benchmarking analysis tool is used to test the server cluster load under the improved hash algorithm proposed by the research, and at the same time, it is compared with the traditional hash algorithm (later referred to as Model 2). The video stream encoding is set to H.264, the resolution is 800 × 600, the frame rate is 25 fps, and the audio stream is encoded by WAV. The computer configuration used in the experiment is 8-core CPU, 8 GB memory, 1 G bandwidth, and 500 GB hard disk. The comparison results are shown in Figure 10.

From Figure 10(a) that when the number of server clusters is less than 500, the average delay of the two algorithms fluctuates between 200 and 350 ms, and the difference is almost small. When the number of server clusters exceeds 500, the difference in average delay between the two tends to increase, and the overall average delay of Model 1 is smaller. In order to make the analysis results more accurate, the cluster load variance under the two algorithms is also calculated. It can be seen from Figure 10(b) that the variance value of Model 1 is generally lower than that of Model 2, and the fluctuation is smaller. As the number of clusters increases, its variance value hovers between 15 and 35. To sum up, it shows that the improved hash algorithm proposed by the research can solve the problem of overloading the server during use, and effectively balance the cluster load.

In order to explore the performance of different servers under this algorithm, and because the client is disconnected and reconnected after connecting to the media server, we further explored the number of servers connected to five media servers with different performance under the background of Model 1. It can be seen from Figure 11 that with the increase in the number of cluster connections, the number of server connections under the five servers also increases steadily. Among them, the growth rate of server 1 and server 2 is the fastest, the growth rate of server 3 and server 4 is moderate, and the growth rate of server 5 is the slowest. Among them, the number of connections of server 1 is at most 148, and the number of connections of server 5 is at least 47. It explains that performance 0differences between servers can cause them to allocate different numbers of server connections.

Figure 10 Comparison of average delay and variance under the two algorithms, (a) comparison diagram of average delay of two algorithms (b) comparison diagram of cluster load variance of two algorithms (see online version for colours)

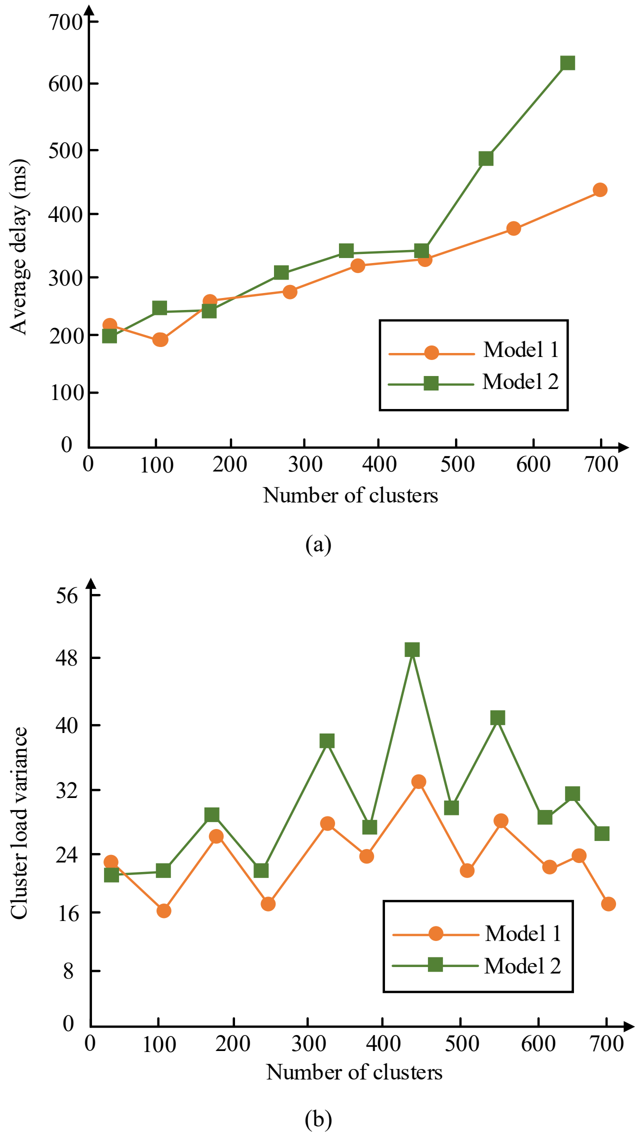


Figure 12 shows the load balancing under five media servers with different performance. Among them, the load rate of server 5 can reach up to 79.8%. It shows that the overall load performance of the server under the algorithm in this paper is better, and the load rate of servers with different performances is not much different.

Figure 11 Comparison of the number of server connections under this algorithm (see online version for colours)

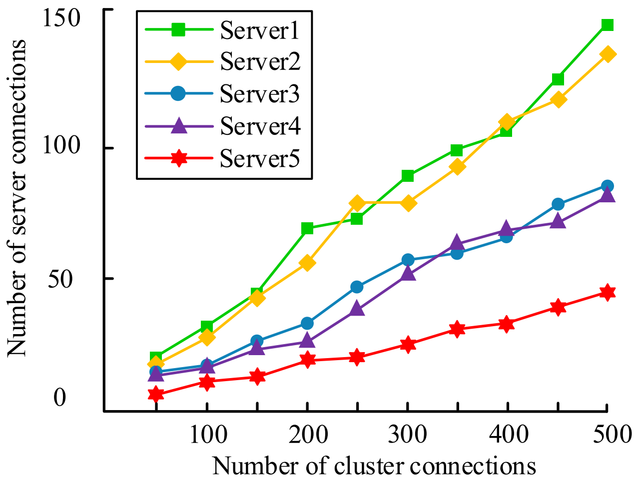
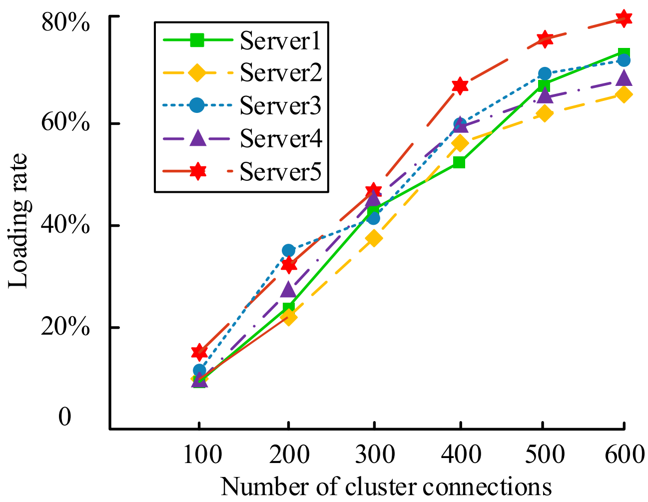


Figure 12 Comparison of load rates of five server clusters under this algorithm (see online version for colours)



4.2 *Analysis of test results of education resource remote sharing systems*

This section will test the educational resource remote sharing system built above to verify whether the functions of its various modules can be implemented normally and meet the needs of users. The test environment architecture of the educational resource remote sharing system is shown in Figure 13.

Test each module according to the test environment architecture diagram shown in Figure 13. In order to test the test results of the system, the research carried out comparative experiments on the computer client and mobile phone respectively. The experimental objects were students majoring in software engineering. The students 'online learning data was used as the basic sample, and the basic sample was divided into two groups of experimental data. For the remote sharing system, compare the running stability of the system on the computer client and the mobile phone, and the smoothness of audio and video under each set of data.

Figure 13 Architecture diagram of remote shared system test environment (see online version for colours)

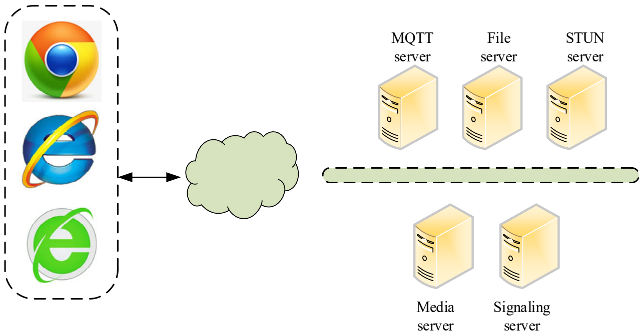


Figure 14 Comparison of system operation stability under two sets of data, (a) operation stability of the first data centralised system (b) operation stability of the second data centralised system (see online version for colours)

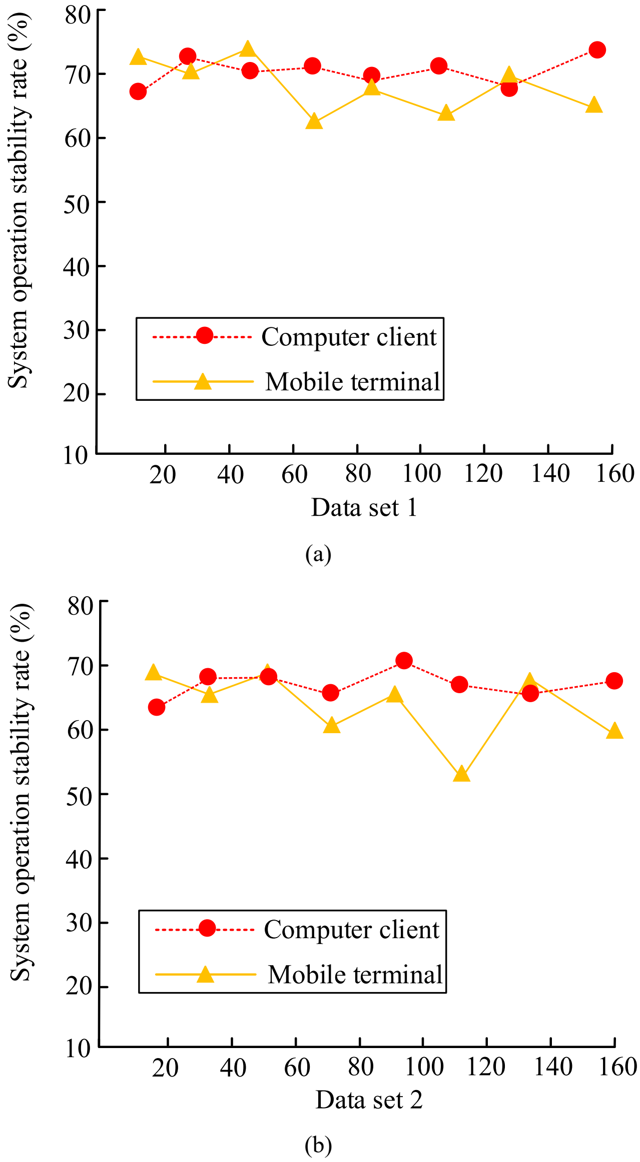
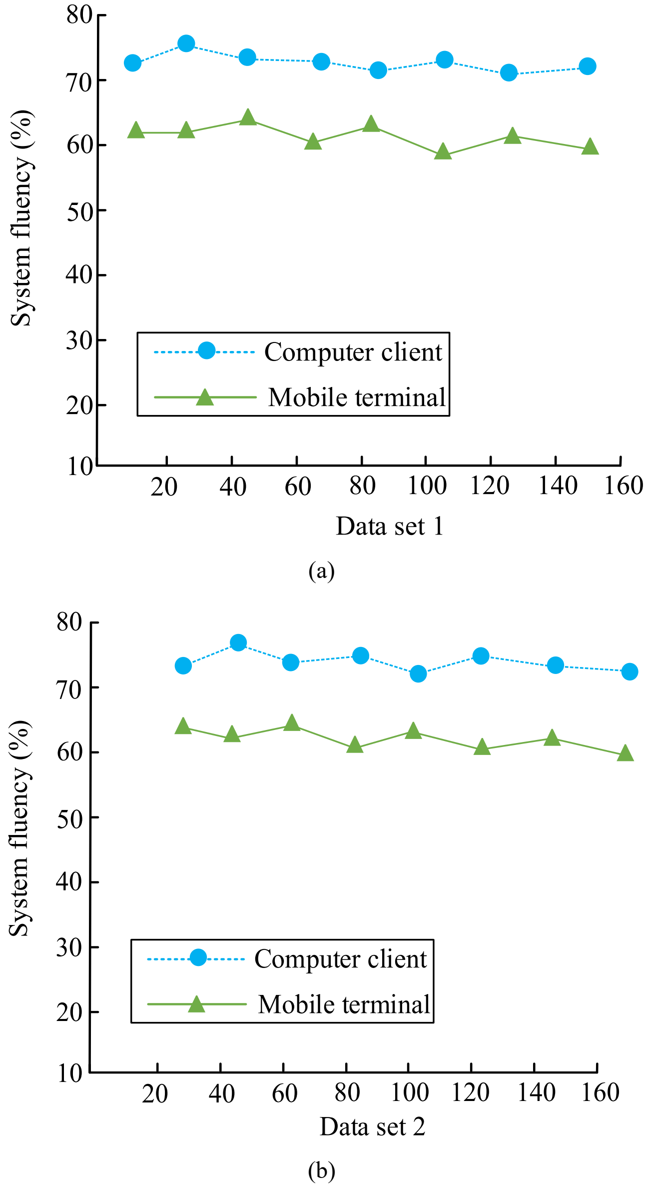


Figure 15 Comparison of system audio and video fluency under two sets of data, (a) audio and video fluency of the first data centralised system (b) audio and video fluency of the second data centralised system (see online version for colours)



It can be seen from the line graph in Figure 14 that under the two sets of experimental data, the stability of the remote sharing system of educational resources on the computer side is generally better than that on the mobile phone side. In Figure 14(a), with the increase of the number of users, the stability of the remote sharing system of educational resources on the computer side fluctuates between 68% and 77%, while the operating stability on the mobile phone side fluctuates greatly. 61%, the highest is 73%; in Figure 14(b), with the increase of the number of users, the stability of the remote sharing system of educational resources on the computer fluctuates between 62% and 73%, while on the mobile phone, the stability of the terminal operation is 51% at the lowest and 69% at the highest. To sum up, the stability of the educational resource remote sharing system on the computer side is better than that on the mobile phone side.

It can be seen from the line chart in Figure 15 that under the two sets of experimental data, the audio and video fluency of the educational resource remote sharing system on the computer side is generally better than that on the mobile phone side. In Figure 15(a), with the increase in the number of users, the fluency of audio and video on the computer side has been floating around 73%, the lowest is 71%, and the highest is 76%, while the fluency of audio and video on the mobile phone It is not as good as the computer side, which is 57% at the lowest and 63% at the highest. In Figure 15(b), the smoothness of audio and video in the computer side of the educational resource remote sharing system remains above and below 74% as the number of users increases. On the contrary, the overall audio and video fluency of the mobile phone is lower than that of the computer, and the fluency is 64% at the highest. To sum up, it can be seen that the audio and video fluency of the remote sharing system of educational resources on the computer is better than that on the mobile phone, so it is recommended that students use the remote sharing system on the computer to complete online learning.

5 Conclusions

With the development of online education, more people start to choose the convenient and efficient online education mode, and it becomes especially important to establish a remote sharing system of online education resources according to the different needs of students of different majors. The study proposes a method design for the remote sharing system of educational resources based on webRTC technology. The five major functional modules in the system are firstly modelled, based on which a load balancing method design based on an improved consistent hashing algorithm is proposed, and finally the constructed remote sharing system and the improved hashing algorithm are tested. The results show that comparing the traditional hash algorithm and the improved hash algorithm proposed in the study, it is found that the average delay time of both increases with the increase of the number of server clusters. When the number of server clusters is within 500, the average delay time of both algorithms fluctuates between 200~350 ms, and the average delay time gap between the two is not large, and with the increase of the number of server clusters, the average delay time gap between the two. The difference in latency gets larger and larger as the number of server clusters increases. Comparing the magnitude of the variance values between the two, it was found that the latter had a smaller overall variance value. The load balancing situation and the number of server connections under the five servers with different performance were also compared, and it was found that the load ratio under the five servers showed a steadily increasing trend, and the difference in the size of the load ratio between the servers was not significant, indicating that the overall load performance of the servers under the algorithm of this paper was better. Finally, the stability and fluency of audio and video when running the system under the mobile phone terminal and the computer terminal were compared respectively, and it was found that the stability and fluency of the computer terminal were better than that of the mobile phone terminal, with the best stability at 77% and the highest fluency at 76%. As only the stability and audio and video fluency of the constructed online education resource sharing system were compared between the mobile phone and computer side, the performance of the system could not be fully demonstrated. To further obtain a better performing resource sharing system, parameters such as the propagation speed and response time of the system should be studied subsequently.

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References

Chopra, G., Madan, P., Jaisingh, P. et al. (2019) 'Effectiveness of e-learning portal from students' perspective: a structural equation model (SEM) approach', *Interactive Technology and Smart Education*, Vol. 16, No. 2, pp.94–116.

Chowdhury, T.I., Hoque, M.R., Wanke, P. et al. (2022) 'Antecedents of perceived service quality of online education during a pandemic: configuration analysis based on fuzzy-set qualitative comparative analysis: evaluation review', Vol. 46, No. 3, pp.235–265.

Griffiths, S.M., Sapirstein, A., Guzman, J.C. et al. (2019) 'Automated, web-based solution for bidirectional EHR-infusion pump communication', *Biomedical Instrumentation & Technology*, Vol. 53, No. 1, pp.30–37.

Hsu, H. and Memon, N. (2021) 'Crossing the bridge to STEM: retaining women students in an online CS conversion program', *ACM Transactions on Computing Education*, Vol. 21, No. 2, pp.1–16.

Jiang, Z., Yin, H., Wu, Y. et al. (2019) 'Constructing novel block layouts for webpage analysis', *ACM Transactions on Internet Technology*, Vol. 19, No. 3, pp.1–18.

Qi, S., Li, S. and Zhang, J. (2021) 'Designing a teaching assistant system for physical education using web technology', *Mobile Information Systems*, No. 6, pp.1–11.

Sahu, S.K., Katiyar, A., Kumari, K.M. et al. (2019) 'An SVM-based ensemble approach for intrusion detection', *International Journal of Information Technology & Web Engineering*, Vol. 14, No. 1, pp.66–84.

Salonen, V. and Karjaluoto, H. (2019) 'About time a motivation-based complementary framework for temporal dynamics in web personalization', *Journal of Systems and Information Technology*, Vol. 21, No. 2, pp.236–254.

Wu, X. (2022) 'Research on the reform of ideological and political teaching evaluation method of college English course based on "online and offline" teaching', *Journal of Higher Education Research*, Vol. 3, No. 1, pp.87–90.

Xu, J. (2022) 'Research of online courses construction based on the theory of interaction', *Journal of Higher Education Research*, Vol. 3, No. 1, pp.26–28.