Construction of Interactive Teaching Platform for University Clarinet Performance Based on Streaming Media Technology

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Abstract

Aiming at the single teaching method in the existing clarinet teaching, this system will use streaming media FFmpeg tool and JAVAweb technology to construct a clarinet teaching platform based on streaming media. This system can help teachers and students to carry out teaching activities of synchronous clarinet performance through the mode of live classroom, and use the barrage function to complete the interaction between teachers and students. With the help of streaming media technology, this system can make clarinet teaching more intuitive, interesting and vivid than traditional teaching methods. Because it is not limited by time and space, students can participate in it more flexibly, so as to realize the interactive teaching between teachers and students. The development of streaming media clarinet interactive teaching system will contribute to inheriting and developing the operation skills of clarinet instruments, enriching China's artistic and cultural forms, and continuously developing clarinet music.

Keywords: *Streaming media technology; Clarinet performance; Interactive teaching; Teaching platform construction*

1 INTRODUCTION

Since the clarinet was introduced into China at the end of the 19th century, it has achieved fruitful results in more than one hundred years of development, and China has gradually become an influential clarinet art country in the world. The higher education campus is the highest institution of clarinet performance teaching in China, and it should focus on cultivating high, fine and sharp clarinet theoretical research and performance talents. First of all, when observing the actual situation of most colleges and universities, the main teaching mode of piano teaching in colleges and universities is still the traditional teaching mode, that is, the teacher is the center, playing the main role, and the students play the object role. In the teaching process, the teacher puts too much energy on the students' mastery of clarinet knowledge, which severely constrains the students' thinking ability. Secondly, in the class of clarinet teaching, students lack enough opportunities to practice freely, and some students have limited self-control ability, so it is difficult to have a continuous process of practice, which leads to the difficulty of improving students' clarinet playing level substantially. In the long run, it is extremely unfavorable to the improvement of college students' clarinet playing level [7]. In addition, due to the influence of some conditions, it is difficult for some colleges and universities to provide students with a real music concert for them to enjoy, and it is difficult for students to feel the real atmosphere at the concert site personally in the process of learning music theory knowledge, and it is difficult for them to resonate with clarinet music.

The best way to effectively solve the above problems is interactive teaching. "Interactive" teaching mode, guided by modern teaching theory, comprehensively uses various teaching resources and means to stimulate teaching potential, deepen teaching theory, expand teaching ability and improve teaching quality through interactive ways such as teaching subject and teaching conditions, curriculum theory and practical application [3]. Therefore, we need to seek an effective integration way to realize the interactive teaching of clarinet. With the advent of the information age, computers are getting deeper and deeper into people's daily lives. More and more information is transmitted in the network, which gradually develops from the original plain text to the type information of music and video streaming media. With the continuous improvement of computer network

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bandwidth, network streaming media technology has also made great progress [6]. With the support of streaming media technology, online video playing and live broadcast technology has been well promoted, which has brought great changes to people's life and education. With the progress of science and technology, online education has begun to develop and has initially formed a certain scale, and the music discipline has introduced streaming media technology into music teaching without exception. The successful application of streaming media can make music teaching more intuitive, interesting and vivid than traditional teaching methods. It can be said that students can participate in it more flexibly because they are not limited by time and space, so as to realize the interactive teaching between teachers and students.

According to the characteristics of streaming media, this paper will develop the function of streaming media technology under FFmpeg tool and use JAVAweb technology to present the web page effect to construct and design an ideal interactive clarinet teaching platform in colleges and universities. This system develops three main functional modules: performance appreciation, live class and video report to help solve the problems in clarinet music teaching, such as limited time and space, poor teaching resources and poor self-control of students after class. First of all, the system sets up a cross-space live interactive network clarinet teaching platform for teachers and students. By watching the live broadcast, students can simultaneously train the repertoire in the teacher's performance teaching process, put forward the problems existing in their own performance in the course in time and provide their own opinions and ideas at any time under the barrage function, so as to realize the interactive teaching between teachers and students. Secondly, this system also provides a channel to supervise clarinet practice and test students' learning achievements, which enriches students' materials for enjoying clarinet music after class, reduces students' learning cost and enriches the teaching methods of music teachers. The teaching platform established by integrating streaming media technology can effectively promote the development of clarinet teaching in colleges and universities in China, and inject new impetus into the reform of clarinet teaching mode in China.

2 KEY TECHNOLOGY

2.1 Streaming media technology

Streaming media technology refers to a technology that compresses a series of multimedia data, sends the data through the Internet in segments, and transmits audio and video instantly on the Internet for users to watch. Before the advent of streaming media technology, people had to download multimedia content to their local computers first, and wait for the complete downloading of multimedia content before they could enjoy multimedia content. With the emergence of streaming media technology, people can enjoy the media content only after a few seconds or more than ten seconds of startup delay, instead of waiting for the media content to be completely downloaded. Including streaming media, audio stream, video stream, text stream, image stream, animation stream, etc., and continuous media data in time. Streaming media has strong real-time and interactivity. By using streaming media technology, the media startup time on the user side is greatly shortened, and users don't have to "wait until all the media contents are downloaded before browsing" as in the past, but can enjoy the media contents immediately after a startup delay. Compared with the traditional media transmission mode, streaming media technology greatly reduces the cache capacity requirement of the client (user computer) [2].

2.1.1 Composition of streaming media system

Generally speaking, streaming media system includes the following parts:

Scripter: A compilation tool that can integrate multimedia. The job of the encoder is to convert the input signal or data, and ensure that the converted data exists in the form of signals that can be transmitted and stored, and is presented in the form of mutual assistance. Encoder: The main function of the transcoding tool is to compress and transcode. As there are large streaming media files, it is inconvenient to save and transmit them, so the application of transcoding tools solves this problem well. After the encoder compiles multimedia files, the role of transcoding tools is to further optimize the content converted by the encoder and ensure the convenience of file transmission and storage. Server: Responsible for managing a large amount of multimedia content and delivering it to the corresponding client according to the user's requirements. After the multimedia files are compiled and transcoded, the server stores these files in a known directory in order, and responds to the user's needs in real time, and sends the files required by the user to the designated client according to the instructions issued by the user. Player: After the client device receives the streaming media content from the server, the player is responsible for presenting the streaming data content. The choice of player is also very important. A high-performance player can be used to play more format files. Besides, there are many tools (Content Creation Tool) for making multimedia. When an online video website wants to realize the on-demand function, it is necessary to use an Encoder to compress the uploaded multimedia files and convert them into files suitable for streaming transmission, and then send the successfully converted files to the server, which will send them out. The architecture of streaming media system is shown in Figure 1.

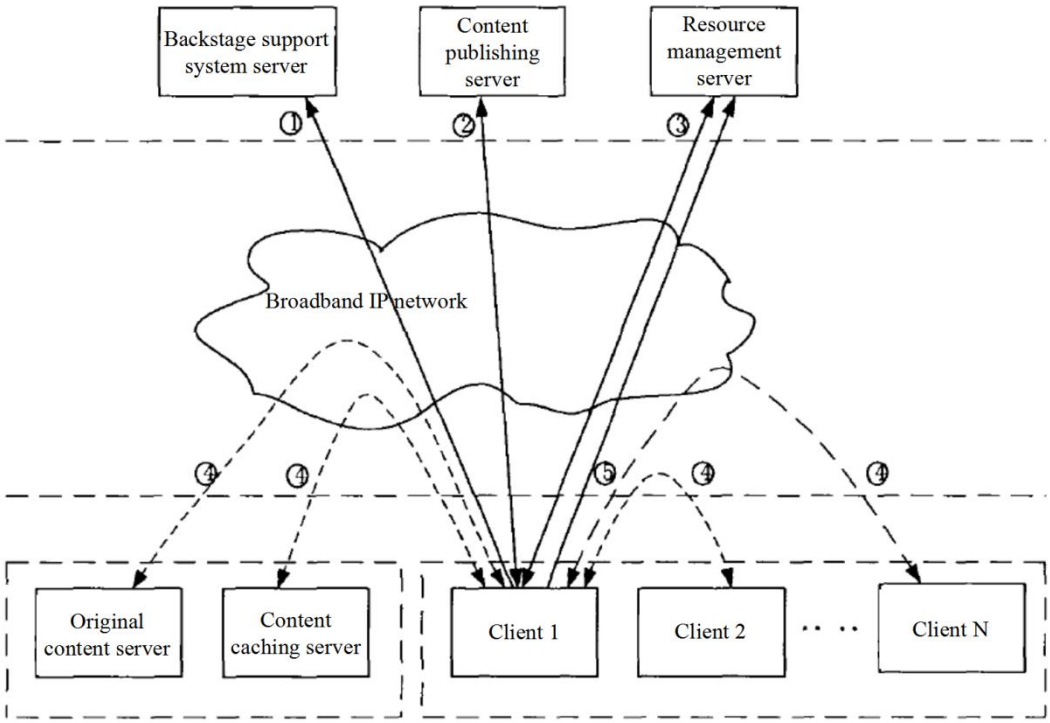

Figure 1: Streaming media system architecture diagram

2.1.2 Development agreement

Current mainstream streaming media transmission protocols include RTCP, RSVP, RTSP, RTP, RTMP, HLS and so on. This paper briefly introduces RTMP and HLS which are mainly used in this system. RTMP (Real Time Messaging Protocol) is an open protocol developed by Adobe Systems for audio, video and data transmission between Flash player and server. RTMP (Real Time Messaging Protocol) is used by Flash for the transmission of objects, videos and audio. This protocol is based on TCP protocol or polling HTTP protocol. RTMP protocol is like a container for data packets, which can be either AMF format data or FLV audio/video data. A single connection can transmit multiple network streams through different channels. Packets in these channels are all transmitted according to fixed-size packets. HTTP Streaming (HLS) is an HTTP-based streaming media transmission protocol implemented by Apple Inc, which can realize live streaming and on-demand streaming. It is mainly used in iOS system, providing live audio and video streaming and on-demand solutions for iOS devices (such as iPhone and iPad). HLS VOD is basically a common segmented HTTP VOD. The difference is that its segments are very small. Compared with common streaming media live broadcast protocols, the biggest difference of HLS live broadcast is that what the live broadcast client gets is not a complete data stream. HLS protocol stores the live data stream as continuous and short-duration media files (MPEG-TS format) on the server side, while the client side downloads and plays these small files continuously, because the server side always generates new small files from the latest live data, so that the client side can realize live broadcast as long as it keeps playing the files acquired from the server in sequence. Therefore, basically, it can be considered that HLS is the technical way of on-demand to realize live broadcast. Because the data is transmitted through HTTP protocol, there is no need to consider firewall or proxy at all, and the length of segmented files is very short, so the client can quickly select and switch the bit rate to adapt to different bandwidth conditions. However, this technical characteristic of HLS determines that its delay is always higher than that of ordinary live streaming media protocols [9].

2.2 FFMPEG

FFmpeg is not only an audio and video coding and decoding tool, but also a set of audio and video decoding development kits. As a codec development kit, it provides developers with rich call interfaces for audio and video processing. The main workflow of MPEG needs to go through six steps: first reading the input source for audio and video decapsulation (calling interface in libavformat), then decoding each frame of audio and video data (calling interface in libavcodec), then converting parameters to encode each frame of audio and video data (calling interface in libavcodec), and finally repackaging audio and video (calling interface in libavformat to output to the target). The main functional components used in this process are shown in Table 1 [8].

Table 1: Main functional components of the FFmpeg

Name	Function
libav format	Used for the generation and analysis of various audio and video packaging formats, mainly including video format parser DeMuxers and generator muxer.
libavcodec	Used for various types of audio and video coding and decoding.
libavutil	Contains the public utility functions required by FFmpeg library, such as Base64 codec, DES encryptor and decryptor.
libswscale	Used for video scene scaling and color mapping conversion, such as RGB to YUV.

2.3 Development environment

This system is built in Linux CentOS 8.2 environment. The functional development framework of streaming media adopts FFmpeg. In this paper, Nginx 1.21.5 server is deployed on the server equipment, so that it can support the reception and distribution of functional data of the whole system. In this paper, Nginx+RTMP server is selected as the streaming media server of clarinet interactive teaching system, and RTMP module is deployed on Nginx to realize the forwarding of streaming media data. The main steps to build the Nginx+RTMP server are to download and install the Nginx compressed package and the RTMP compressed package first, then configure the installation options of Nginx and compile Nginx. On the basis of the default configuration of Nginx, add the RTMP third-party module with the add-module command and finally use it. /Nginx command to start nginx. The code implementation is shown in Figure 2.

```
[root@localhost nginx]# cd /usr/local/nginx/conf
[root@localhost conf]# vim nginx.conf
rtmp  {
    server  {
        listen 1915;
        timeout 20s;
        application live  {
            live on;
            record off;
        }
        application anyrtc  {
            live on;
            hls  on;
            hls_path temp/zyh;
            hls_playlist_length 5s;
            hls_fragment 1s;
        }
        application vod  {
            play /var/flvs;
        }
        application vod_http  {
            play http://IP/vod;
        }
        application hls  {
            live on;
            hls on;
            record off;
            hls_path /tmp/hls;
            hls_playlist_length 5s;
            hls_fragment 1s;
        }
```

Figure 2: Nginx + RTMP server deployment code

The user's personal learning function of this system is developed in JAVA language based on JDK1.8 environment, and Struct2 development framework is deployed in IDEA 2021.1.3 (Ultimate Edition). Tomcat9.0 is used for the deployment of Web server, and MySQL 8.0.28 is used for the database. In this system, the common libraries of FFmpeg4.2.1 are packaged by using JavaCPP1.4.3, which turns Native API into Java API, and uses JAVA CV1.5.4 to package tools. Deploy JAVA CV on IDEA, and create a sub-project named ffmpeg-basic under the javacv-tutorials project to use FFmpeg to realize various functions related to streaming media. Through the introduction of the above technologies and environment configuration, the technical feasibility of constructing clarinet interactive teaching platform based on streaming media technology is determined.

3 REQUIREMENT ANALYSIS

3.1 Functional requirement

Based on streaming media technology, the system of clarinet interactive teaching platform in colleges and universities is analyzed from the perspective of teachers and students. From the teacher's point of view, it needs to have the function of collecting real-time teacher's video and audio for teaching through remote broadcast. The system can also make use of multimedia materials played by famous artists, so that students can experience their good playing skills and artistic appeal, and improve their love for clarinet music. From the students' point of view, students can accompany the teacher's performance teaching in the process of watching the live broadcast, carry out synchronous performance training on the repertoire, put forward the problems existing in their own performance in the course in time and provide their own opinions and ideas at any time. Secondly, students can watch abundant clarinet teaching and learning resources anytime and anywhere. In addition, the system needs to provide a function that can report and summarize the recently learned content remotely, so as to check the shortcomings of students' own recent studies and constantly optimize their practical clarinet playing level [1].

3.2 Overall design

The interactive teaching platform based on streaming media clarinet adopts B/S architecture for overall design, and the system architecture diagram is shown in Figure 3. The front-end view layer is developed and written in HTML+CSS+JavaScript language. Nginx is used as a proxy server between the view layer and the business layer to support the reception and distribution of various system function data in TOMCAT, the web server of the business layer, and Nginx+RTMP, the streaming media server. The business layer uses Struct2 framework to develop the functional services related to the web pages that users of this system learn personally. The live broadcast function architecture of the service layer mainly includes the push end, the streaming media server and the receive end. The push end uses FFmpeg to collect screen and microphone data, and encodes, compresses, encapsulates and pushes the collected data to the server. In this system, RTMP module is deployed on Nginx to realize the forwarding of streaming media data, and RTMP protocol is used to transmit data between client and server for streaming. The data includes H.264 encoded video data and AAC encoded audio data encapsulated in FLV format. After receiving the data sent by the streaming terminal, the server forwards the streaming media data to the streaming terminal. The streaming client player adopts Flash player, and HLS protocol realizes the streaming operation of the player to the streaming media server. After the video and audio are unpacked and decoded respectively, the audio and video content can be played after synchronous operation. The data processed by the business layer is saved and called by MySQL data in the data layer [5].

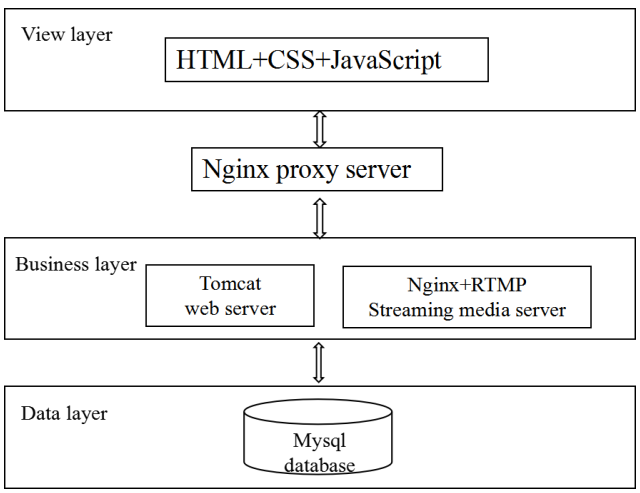

Figure 3: Overall architecture diagram of the system

4 FUNCTION IMPLEMENTATION

According to the main participants in the teaching process, the interactive teaching platform of clarinet in colleges and universities based on streaming media has two types of clients: teacher side and student side.

4.1 Student side

Students log in to the system through their student ID and password, and they can see four functional modules of the system, including performance appreciation, live class, video report and management panel, as shown in Figure 4. Click to enter the performance appreciation

module, and students can see the performance videos of famous clarinet performers to improve their musical literacy, such as the video of the solo performance album "Famous Clarinet Songs" by Yuan Yuan, a famous domestic clarinet player, and the video of the clarinet duet "Krama" performed by Liu Jun, Yin Bo, the solo performance by Yehuda Gilad, a famous foreign musician, and the concert works by Nicolai Preffer. Click to enter the live classroom function module, and students can enter the live classroom to watch clarinet teachers on time at the specified time. During the teacher's performance teaching process, they can also perform training on the repertoire. Secondly, students can also ask questions in time about the unclear questions such as mouth shape, tongue play, fingering and timbre in the teaching course by clicking the barrage release button at the bottom of the live screen. Teachers can answer students' questions in the live broadcast course, grasp the students' real-time learning situation through the barrage of students, and repeatedly demonstrate and emphasize key issues on the spot. Click on the video report module, and students can regularly shoot clarinet practice tasks assigned by teachers, and report by uploading video. They can also view the improvement opinions left by the teachers of the previously uploaded video report assignments, and improve their improper performance according to their opinions. By clicking on the management panel module, students can view the live records of historical viewing and the collected playing video resources, and play back in the process to learn the wonderful content repeatedly. In the management panel module, students can also modify their personal information [10].

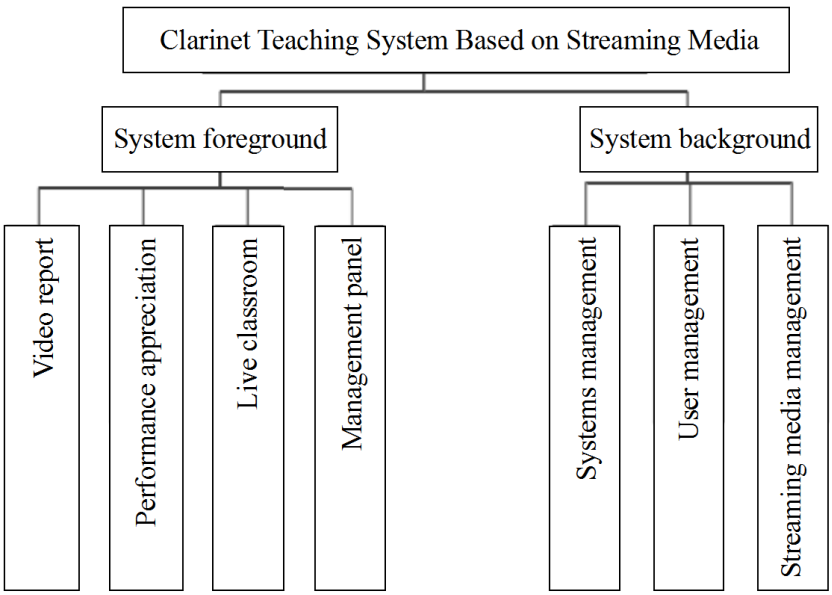

Figure 4: Architecture diagram of clarinet teaching system based on streaming media

4.2 Teacher side

Teachers can log in to the system through the account and see the same functional modules as the student side, but the specific functional details of performance appreciation, live class and video report are different. In the performance appreciation module, teachers have the function of uploading videos. Teachers can upload files of the videos of famous performances screened from the Internet, and delete and modify the uploaded video resources. In the live classroom module, the teacher's client can initiate a live broadcast, and the teaching courses can be recorded live through the camera and microphone. In the video report module, the teacher can view the video report assignments uploaded by all the students, and enter the improvement opinions on the student's performance video in the blank text box below the video and submit them [4].

5 CONCLUSIONS

To sum up, after the clarinet art was introduced into China, it has made remarkable achievements in creation, performance and teaching in the course of a hundred years' development. This is clearly reflected in all kinds of research. At present, the research on clarinet should be further deepened, which will witness the development of Chinese clarinet art and play an important theoretical guiding role in the future development, reflecting the important and special contribution made by contemporary people to the development of this art.

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