The Design and Application of Online Interactive Teaching System of Chinese Painting in Colleges and Universities Based on FFMPEG Technology

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Abstract. According to the current requirements of online interactive teaching of Chinese painting in colleges and universities, this paper deeply studies the technology of live course based on FFMpeg. After the second development and compilation of FFmpeg software, with the online interactive teaching system as the background platform, the functions of FFmpeg's protocol resolution, decapsulation, decoding and data storage are implanted into the system to realize the audio and video playing function of live classroom. This system uses the combination of H.264 video coding technology and AAC audio coding technology to establish a data compression environment. Can effectively reduce the amount of transmitted data. In this foundation, HTML5+CSS3+javascript language is adopted in the front-end design, and the back-end uses JAVA development language and SSH framework to complete the system implementation.

Keywords: Streaming media; FFmpeg; H.264; Design of teaching system; Live broadcast technology.

1 Introduction

The traditional Chinese painting is a traditional painting form in China, which contains profound aesthetic and philosophical views in Chinese culture. But the existing traditional Chinese painting teaching methods in China are mostly based on book-based teaching outlines, lecture notes and classic works. The systematic teaching of inspiration and cultural connotation. The Students can only train the basic skills of painting through the short-term classroom demonstration teaching by teachers, which makes the learning environment and time for students after class limited, and it is difficult to rapidly increase their traditional Chinese painting skills. And the network live broadcast platform just inherits the traditional teaching methods, and it can save the teaching contents and integrate multi-angle and multi-level teaching interaction into it through information teaching methods, and meet the different learning needs of each student through barrage communication, forming a new form of interactive learning with scenes. But the current public commercial live broadcast platform has too many external interference factors, which can't be well applied to interactive teaching of Chinese painting in colleges and universities. At present, the most widely used video and audio processing software of live streaming media technology is FFmpeg. So the author thinks

that the online interactive teaching system of Chinese painting in colleges and universities should be designed and applied. [1]

2 Key Technologies

2.1 The introduction of ffmpeg audio and video processing technology

The FFmpeg is an open source application program which is specially designed to convert digital multimedia audio and video files into data streams recognizable by the server. It can not only encode and decode audio and video files, but also be a suite for developing audio and video decoding. The FFmpeg provides a large number of audio and video calling interfaces for streaming media developers. [2]The main workflow of FFmpeg can be roughly divided into four steps. The first step is to read the information of the input source and parse the audio and video encapsulation formats by calling libavformat interface. The second step is to decode each frame of audio and video files, which is provided by libavcodec. The third step is to convert the parameter coding of audio and video data of each frame. The fourth step is to repackage the audio and video data files and then output them to the target. [3]

2.2 H.264

H.264 is a video coding standard proposed by JVT, which is the tenth part of MPEG-4 standard. H.264 is a measurement standard based on compression rate, image quality and network dependence. H.264 is the standard of encoder. The function of encoder is to convert the audio and video recorded in hardware devices into data forms that can be recognized by the system. The working principle of H.264 is shown in Figure 1. The encoder and decoder of H.264 use a hybrid coding scheme that combines conversion and prediction. In the stage of encoding, the input frame is encoded and decoded by using intra-frame and inter-frame modes according to the macro-block unit specification. The intra mode uses the macroblock encoded in the current frame for prediction. While the inter-frame mode predicts the motion of n(n>1) previous frames. The difference between the predicted value and the original value is calculated for subsequent transformation, quantization, reordering. After that, the quantization system is used for inverse quantization and inverse transformation, and added to the prediction system. And the uF* can be obtained without a filter. The uF* frame is inter-block filtered to obtain the currently reconstructed frame uF*. At last, the original picture is obtained after the filter processing. Filter, that is, ffmpeg's filter, is used to process audio and video with special effects. The scaling, flipping and superimposing of audio and video all need Filter. [4].
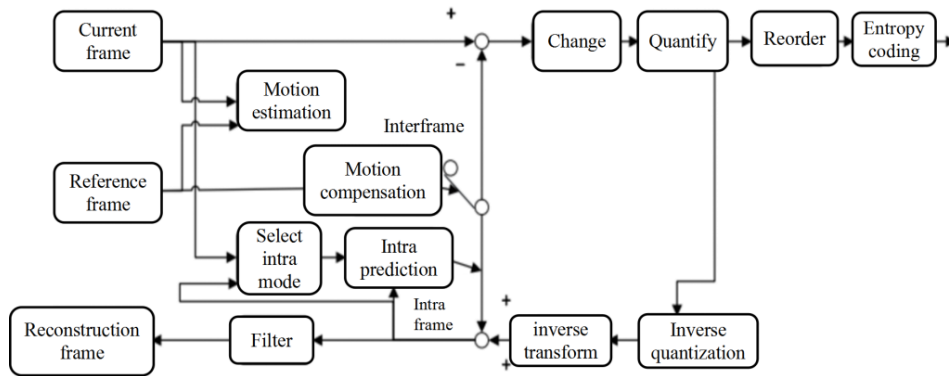
Fig. 1. Functional Composition of H.264 Encoder

2.3 RTMP

The RTMP is a protocol developed by adobe and used in the application layer. In the process of streaming media data transmission, the RTMP protocol can be used to deal with multiplexing and subcontracting problems. Because RTMP is in the important application layer, it uses the safe and reliable TCP as the transport layer protocol to transfer data. The RTMP will establish a transmission channel for sending control messages between the server and the client through the handshake link of the RTMP Connection after the three-way handshake using TCP protocol is established. The format of control message includes CreateStream and SetACKWindowsSize. The RTMP carries out data transmission in the link in order to improve the fairness of data information processing in subcontracting operation and multiplexing operation, and some special treatments will be carried out. The RTMP needs to split the Message into a new form -Chunk at the sender. However, due to the different size specifications of message, it may happen that chunk is a complete message form. Although the data information contained in the chunk has different id and size specifications, the receiver can still reassemble these scattered parts into a complete Message. [5]

2.4 Development environment

Based on FFMPEG technology, the development environment of online interactive teaching system of Chinese painting in colleges and universities is divided into streaming media environment and web programming environment. This system uses streaming media technology to realize the live video function in the training platform. The operating system of this system is Linux cent os7 version. The streaming media server is developed with the framework of Nginx+RTMP, and the development software is FFmpeg4.0.2. [6].

3 Overall design

In this paper, the overall structure of the online interactive teaching system of Chinese painting in colleges and universities is divided into three parts, namely, the pushing end, the server and the receiving end. Among them, the push end needs to collect the screen data of PC system controlled by teachers, microphone data connected with computers and camera data.

At the push end, ffmpeg is needed to integrate, encode, package and push the collected audio and video data. Then, the server connects the data transmission among the three ports by deploying the third-party RTMP protocol module. During this period, RTMP can receive the streaming media data from the streaming end and distribute it to the streaming end. The data includes both H.264 video coding and audio coding format AAC. On the server side, samba server and nginx download service are added. By these two service functions, students and teachers can share teaching documents. In this system, the receiving end uses the receiving end of Windows PC, and the received RTMP protocol stream data from the server is decapsulated, decoded and played.

4 Function realization

The main functional modules of the system include four key modules: online live teaching, extracurricular supplement, homework and teacher-student communication. The core function is live teaching. And the technical emphasis of realizing the function of live broadcast teaching lies in realizing audio-video synchronization. The system realizes the accuracy of audio and video synchronization by designing buffer. When the system carries out the variable operation of streaming media transmission, the mutual exclusion lock is realized by using POSIX algorithm mechanism through the buffer, so that the transmission data accessed by multiple threads can be controlled and accessed, and the efficiency of audio and video synchronous integration processing can be improved. [7]

In the aspect of testing whether the audio-video synchronization function of the system is perfect, this paper chooses SPD formula to test, and SPD is the synchronous phase distortion algorithm test. The mathematical expression of synchronization phase deviation is shown in formula 1. [8]

$$Q_{av} = \left(X_a(i) - X_v(j) \right) - \left(Y_a(i) - Y_a(j) \right) \tag{1}$$

In the formula, Q_{av} is an SPD parameter. When the video stream and the audio stream have very high correlation at two time points in a certain period, the SPD of two adjacent frames I and J is represented by Q_{av}. The playing time and generating time of the corresponding data unit are $X_a(i)$ and $Y_a(i)$ in the formula. Similarly, the corresponding index of the j frame is represented by $X_v(j)$ and $Y_a(j)$. In a certain period of time, the synchronization of audio data and video data is reflected by the value of APD. In this research, two groups of experiments are designed for comparison. After the system uploads and sets the resolution of an example video, the FFmpeg function component is used to specify the coding rate of H.264 in the same control group. And the rate encoder of audio sampling adopts AAC. The experimental data of two groups of audio and video synchronization designed in this paper are shown in Table 1.[9]

Table 1. Two groups of test parameters

Number	Video bit rate(kb/s)	Video resolution	Video frame rate	Audio frame rate	Audio bit rate	Audio resolution
1	500	320×240	25	100	16	8
2	400	640×480	30	100	16	8

In order to verify the synchronous control effect of audio and video playback in this system, a second set of experimental data is mainly used. The second group using the improved synchronization control method studied here for the SPD testing situation is shown in Figure 2. The SPD numerical map of the processed second set of experimental data can see that the basic amplitude fluctuations are no more than 40 SPD / ms, which is very stable in terms of desynchrony. The calculated mean value difference is 41.62ms between the SPD of the initial simple playback synchronization control method and the improved synchronization control method SPD studied here. The experiment shows that the system studied in this paper can realize the audio and video synchronization effect in live class. [10]
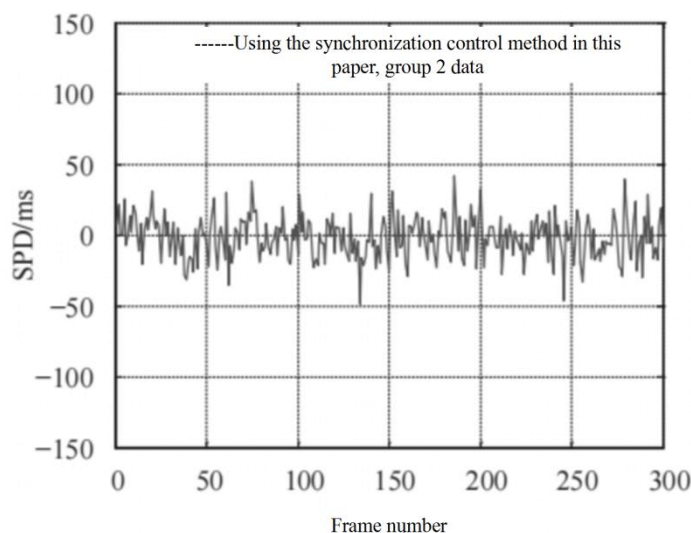
Fig. 2. Test of the second group of processed experimental data

5 Conclusion

The online interactive teaching system of college Chinese painting studied in this paper can enable teachers and students to have a better user experience in the use process, because the system is designed in java language and can be used across platforms. However, due to the limited time and energy of the author, there are still many areas to improve the system. This paper only studies the implementation of the PC terminal, considering that mobile phones have a wider user group. It is hoped that some experts and scholars can optimize and improve this system to the teaching system suitable for Android intelligent terminal and PC end.

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