Construction of Distance Live Teaching System for Packaging Design Major in Colleges and Universities Based on FFmpeg

Meng Liu

22206479@qq.com

Hulunbeier University Hulunbeier, Inner Mongolia, China

Abstract—In order to actively respond to the call of the state and cultivate innovative technical talents, this paper has reformed the traditional teaching mode of packaging design course. Using FFmpeg decoding tools, this paper combines streaming media technology, Web technology and computer application technology, and constructs a FFmpeg-based remote live broadcast teaching system for packaging design major in colleges and universities. The overall development of the system is based on Linux operating system, and the development framework of Java Web application is used to complete the development of Web Server, and the integration and encapsulation of various functional interfaces are improved. The overall design of the system will be based on B/S architecture, and then deployed in layers according to MVC mode to maintain the smooth operation of the live broadcast teaching system, so as to improve the basic problem of outdated teaching mode and lack of teaching resources and further promote the comprehensive development of college students.

Keywords-distance education system; computer application technology; FFmpeg; packaging design; live streaming media

1 INTRODUCTION

With the development of science and technology, the changes of the times. With the increasingly fierce competition of commodities in the market, operators gradually realize that beautiful and novel packaging can attract consumers' attention and arouse consumers' desire to buy. Therefore, in order to seize the market opportunities and make use of market resources, the demand of packaging design talents in various enterprises has expanded, and the requirements are also stricter. Under the background of new engineering, the high-quality development and technological innovation of packaging industry put forward higher requirements for packaging design education in colleges and universities. Packaging design course is a basic course in the curriculum system of packaging engineering major, with a wide range of teaching contents and strong comprehensiveness. In this course, students not only need to master professional design knowledge, but also have flexible and innovative thinking and sensitivity to fashion trends, and understand consumers' preferences, so as to complete the product packaging design perfectly. However, there are still some problems in the current training and teaching of packaging design in colleges and universities. First of all, the teaching mode in colleges and universities is outdated. Packaging design course is a practical course that focuses on cultivating students'

hands-on ability and innovative thinking. Single classroom teaching has restricted students' thinking activities to some extent, which is not conducive to students' comprehensive development. Secondly, the teaching resources of packaging design course are scarce. Nowadays, with the rapid development of science and technology in the Internet age, the update speed of book knowledge is slow, so it is difficult to update social hotspots and enrich learning resources in real time, which can't meet the learning needs of students. Finally, the teaching effectiveness of packaging design course is poor. After-class practice activities of packaging design courses are seldom carried out in colleges and universities, which leads to students' lack of practical ability, solidification of thinking mode and difficulty in generating new design ideas. In view of this, the current situation of packaging design education in colleges and universities is in urgent need of reform and transformation, and a brand-new and modern education model is on the horizon.

In the face of all kinds of disadvantages caused by the traditional teaching mode in packaging design education in colleges and universities, teachers should constantly adjust the course structure and teaching content to meet the current teaching needs and improve the teaching work. As for the change of teaching mode, we should pay attention to the great influence of current information technology on modern education, make full use of the advantages of a series of high-tech technologies in the current network information age, and build an interactive teaching of packaging design in colleges and universities with diversified teaching tools and equipment, high-frequency communication resources and convenient and free interaction, so as to promote the thinking exchange between teachers and students. Therefore, this paper believes that based on FFmpeg, the combination of streaming media technology and Web application development will complete the construction of the FFmpeg-based remote live broadcast teaching system for packaging design major in colleges and universities. Through online live interactive teaching platform, we can strengthen mutual learning and resource sharing among teachers, students and classmates. At the same time, the innovative live teaching method can stimulate students' interest in learning, and students can learn more intuitively about the teaching content through live online learning, so as to exercise their own design literacy and aesthetic ability, and improve the teaching effectiveness of packaging design course.

2 KEY TECHNOLOGIES

2.1 Web technology

Web is a network service based on the Internet, which provides users with the required operation interface. The core component of Web is webpage, which can be divided into static and dynamic. Static webpages are presented in the form of text, pictures, videos and audio, while dynamic webpages can automatically generate new pages, which is convenient for users to call other Web applications through webpages. As far as current practical applications are concerned, most of them are web pages that combine dynamic and static.

Web development depends on the corresponding technical support. On the whole, Web application is divided into three parts: client browser, server-side business logic processing Web server and subsequent data storage database server. The corresponding Web technologies are also divided into client-side development technology, server-side programming technology and database development technology. Among them, the client development technology needs

to use HTML, CSS, JavaScript three development languages, and cooperate with the corresponding framework to complete the design and development of web pages. [1] In server-side technology, relying on the combination of powerful object-oriented programming languages such as Java, PHP and C# and various development frameworks (J2EE and ThinkPHP), the development process of server-side can be greatly simplified. However, the data development technology needs the cooperation of database servers. The common data servers are MySQL, Oracle and SQLServer. The specific structure is shown in Figure 1
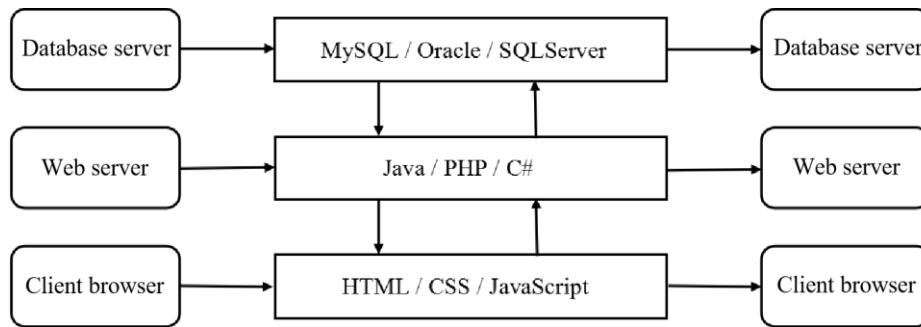

Figure 1. Web Development technology structure diagram (original)

2.2 Streaming media technology

Streaming media technology is a multimedia network transmission technology, which can realize the real-time transmission of audio and video files. Its technical core lies in converting video, audio and other files into a continuous transmission medium-data stream, that is, using a specific algorithm to compress multimedia files into tiny compressed data packets, which are transmitted continuously and in real time by a streaming media server through a specific network protocol. After the client receives these compressed data packets, it is decompressed and played by a specific decoding software. In this paper, the online live broadcast function of interactive teaching platform mainly uses video streaming and audio streaming. The transmission process is shown in Figure 2. First, the audio and video content is collected, and after encoding and compression, the streaming media files are uploaded to the streaming media server through the streaming media transmission protocol. This process is also called push streaming. Then, the client also obtains the resources of the streaming media server through the streaming media transmission protocol, and finishes decoding and playing. This process is called pull streaming.
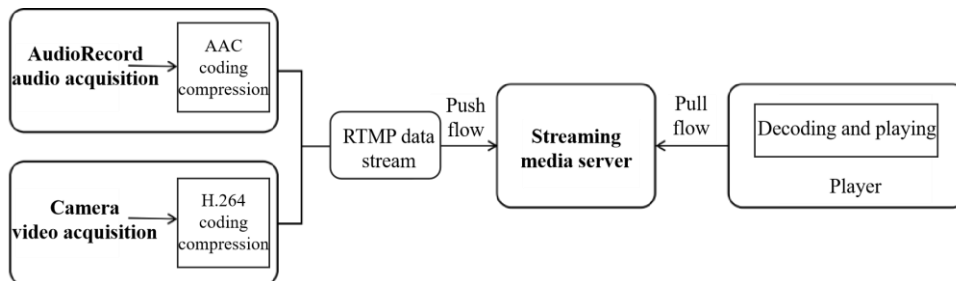

Figure 2. Streaming media technology operation framework diagram (original)

At present, three main protocols commonly used in streaming media technology are RTMP, HTTP-FLV and HLS. RTMP, the real-time message transfer protocol, is the most widely used protocol in live broadcast. It has the advantages of good real-time, strong compatibility, good data confidentiality, high stability, etc. It is the best choice to realize the online live broadcast function in this system. The HTTP-FLV protocol can transform general media data into FLV format, and then transmit it to the client by HTTP protocol. Although it has the characteristics of flexible scheduling and anti-shielding, this protocol only supports playing on mobile phones. [2] HLS protocol is developed by Apple, which is more suitable for Apple products, that is, IOS system. It has high performance, but the delay of data transmission is usually 10s-30s, which affects the viewing experience of system users.

2.3 Java

Java is an object-oriented interpretive programming language. Because of its powerful functions, stable performance, cross-platform, dynamic loading and high security, Java has become one of the most widely used languages. The biggest function of Java is to make web pages lively. It is simplified from C language, which not only inherits many advantages of C language, but also circumvents many complicated functions. Java has a wide range of Applications, including Android mobile app, large websites and PC software. In JAVA, JDK is the development kit of Java and the core of the whole Java, including JRE, jar and so on.

2.4 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 implementation in libavformat), then decoding each frame of audio and video data (calling interface implementation in libavcodec), then converting parameters to encode each frame of audio and video data (calling interface implementation in libavcodec) and finally repackaging audio and video.

2.5 MVC

MVC is one of the programming modes in ASP.NET, and it is a special mode for creating Web applications. MVC layering helps to manage complicated program applications, and programmers can pay attention to one aspect for a long time. Besides, MVC layering can also focus on view design without relying on logical business, making it easier to test program applications. MVC can divide system components into three layers in detail, namely view, model and controller. The view layer is mainly responsible for page display and user data interaction. There are many technologies to realize page view, including HTML, CSS, JS and other front-end technologies. The model layer is mainly responsible for the realization of system function modules, the modules that carry data and calculate the requests submitted by users. Most of the models are implemented with JavaBean. JavaBean is a reusable component, which can be used in any structure only after being written once. The controller layer is responsible for summarizing the work of the first two layers, that is, corresponding the view to the model. The construction of this platform takes MVC pattern as the whole frame structure, and the development and creation are based on the component-based layered development

technology. Distributed multi-tier technology is an important development technology to create this platform. Using this technology can effectively realize the functions of the traditional pattern, and it has certain advantages in scalability and maintainability of the platform. The running diagram of MVC is shown in Figure 3.
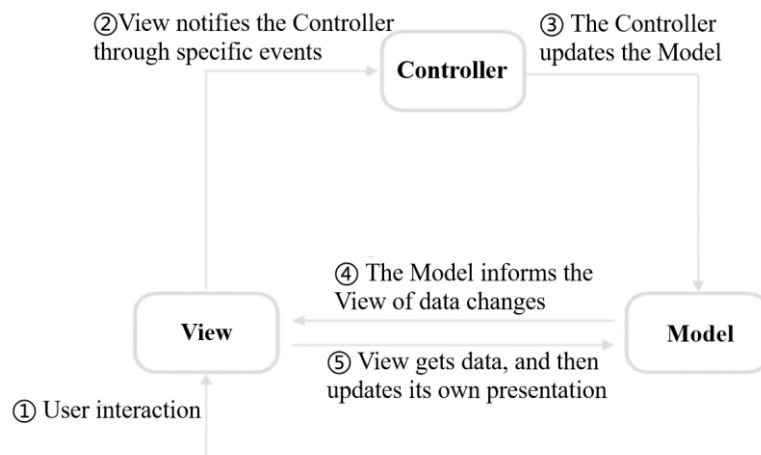

Figure 3. MCV mode operation diagram (original)

2.6 Development process

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 4.

```
[root@localhost nginx]# cd /usr/local/nginx/conf
[root@localhost conf]# vim nginx.conf
rtmp {
    Server {
        listen 1915;
        timeout 20s;
        application 1ive {
            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 4. Nginx+RTMP server deployment code (original)

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. [3] Through the introduction of the above technologies and the configuration of the environment, the technical feasibility of constructing the remote live broadcast teaching system for packaging design major in colleges and universities based on FFmpeg is determined.

3 FUNCTION REALIZATION

3.1 Student side

3.1.1 Live course learning module: When users access this system for the first time, they need to complete user registration according to the page instructions. This system divides

users into two categories: teacher users and student users, and provides different services for different users, so as to ensure that the system can accurately meet the needs of users. Because the course of packaging design is the basic course in the curriculum system of packaging engineering major, the teaching content covers a wide range. Therefore, there are many subjects in this module, and students can choose according to their learning interests. Different from the traditional linear learning, students don't need to study step by step by unit, which further cultivates students' learning planning ability. On the main page, the system will recommend courses according to the user's past usage records. Click the corresponding live studio, and students can enter the live course study. For example, when students click "Visual Image Design of Packaging" in Chapter 6, they can make full use of the detailed functions of interactive communication, courseware downloading, live video recording and after-class drills at the bottom of the live broadcast room when watching the live broadcast course. When the picture is not good, they can also click the right button to adjust the clarity. During the learning process, students can send real-time barrage to interact with teachers, and questions and difficulties can also be released directly through barrage. Teachers will give targeted explanations to barrage questions so that students can understand them. On-line live course system can enable teachers to incorporate knowledge into practical operation, so that students can no longer understand the skills of packaging design software only by imagination as in classroom teaching, and provide students with a better space for their creative thinking. The online code is shown in Figure 5.

```java
import java.net.Socket;
import java.net.UnknownHostException;
public class ChatClient extends Frame{
private TextField tfText;
private TextArea taContent;
//private Button btnSend;
private Socket socket;
private DataOutputStream dos;
public void launchFrame(){
add WindowListener(new WindowAdapter(){
public void windowClosing(WindowEvent e){
disconnect();
System.exit(0);
tfText = new TextField();
taContent = new TextArea();
//btnSend = new Button("Send");
//btnSend.addActionListener(new ActionListener() {
```

Figure 5.　Online communication code (original)

3.1.2 Online learning module: Under this function module, the system supports students' video review of live courses, and the live courses will be backed up to the system database in the form of video content, which is convenient for students to watch and watch repeatedly in the future. At the same time, online learning also supports the viewing and downloading of learning materials such as courseware, graphic materials and after-class exercises in classroom

teaching, so that students can make use of their own fragmented time and fully rely on the convenience of network resources for continuous learning and consolidation. The data download code is shown in Figure 6.

```
@RequestMapping(value = "/downLoadFile")
public HttpServletResponse downLoadFile(String file_id,HttpServletResponse response )throws Exception {
    System.out.println(file_id);
    FileBean downloadFile = fileService.getFileById( file_id);
    String filename = downloadFile.getFile_name();
    String fileRelativePath = downloadFile.getFile_relativePath();
    StringfileAbsolutePath= System.getProperty("user.dir")+tomcatPath+fileRelativePath.replaceFirst(".","");

    InputStream fis = new BufferedInputStream(new FileInputStream(fileAbsolutePath));
    byte[] downloadFileBuffer = new byte[fis.available()];
    fis.read(downloadFileBuffer);
    fis.close();
```

Figure 6. Data download implementation code (original)

3.1.3 After-class extension module: Packaging design is a practical course with strong comprehensiveness and wide cross-discipline. After class, students need to take part in practical activities issued by teachers, such as analyzing a brand of classic packaging, conducting a public opinion survey on the applicability of different materials packaging, and practicing visual image classification design. After students finish their practice, they need to publish their learning results to the individual center for teachers to review. The upload code is shown in Figure 7. This module not only pays attention to practical teaching, but also pays attention to the development of thinking. Students can use the thinking extension module to watch art exhibitions and browse works of art, so as to learn art knowledge and enrich their innovative thinking. With the richness and diversity of network resources, it broadens students' horizons, stimulates students' interest in learning, encourages students to think independently and actively, and cultivates students' spirit of inquiry.

```
/ / Verify the current, normal form or file upload
        if(item.isFormField())      //The proof is a normal form field
            //Gets the form element content (value value)
            String name=item.getFieldName();
            //The name attribute of the form instead of the value value
            if(name.equals("username"))
                out.print(item.getString("utf-8"));
        }else{//File upload
            String filename=item.getName();
            //Throw it under the server directory
            String path="/WEB-INF/folder";// relative path
            String paths=this.getServletContext().getRealPath(path);
            out.print(paths);
            File file=new File(filename);
            File uploadFile=new File(paths,file.getName());
            item.write(uploadFile);
            out.print("Upload success");
```

Figure 7. Learning result upload code (original)

3.2 Teacher side

3.2.1 Resource management module: The function of the teacher side is more inclined to the organization, supervision and guidance of practical activities. Teachers can use the real-time innovative resources provided by the platform to make courseware and enrich the teaching content. They can also take advantage of the network's high-quality resource sharing, appropriately recommend art lectures of famous schools to students, and cultivate students' aesthetic taste. Teachers need to manage each class, and then divide the users of the class into groups to ensure the follow-up practice courses. Teachers can use the platform's data uploading function to upload online live course materials to the library, so that students can download and review them themselves.

3.2.2 Comprehensive evaluation module: Because the packaging design course is a practical course in general, and it has great variability in the implementation process, a single way can't comprehensively evaluate students' learning process and results. Therefore, this system changes the evaluation mode, combining the process evaluation with the summative evaluation to form a multidimensional evaluation mode, so as to meet the actual teaching needs and pay attention to the internalization of practice content and the extension of practice process. The process evaluation will be graded from the aspects of classroom activity, schoolwork completion and barrage communication frequency. The grading standard will be graded according to five grades: excellent, good, fair, poor and very poor, which correspond to five weights of 10, 8, 5, 3 and 1 respectively. The evaluation method will be carried out according to the comprehensive mode of students' mutual evaluation and teachers' comments. After the evaluation, the system will automatically construct the evaluation model matrix, combine the students' mutual evaluation with the teachers' evaluation, and introduce the confidence Z to finally complete the total score evaluation. Formula 1 is the evaluation matrix, where R represents students' mutual evaluation, and X represents the degree scores of different assessment points. In the evaluation matrix of formula 2, C represents the teacher's score, and Y represents the degree score of different assessment points. The final comprehensive score

calculation formula of students is shown in Formula 3, where P represents the final exam score and M is the final score. In order to ensure the teaching effectiveness of the live broadcast teaching system, this paper makes an actual investigation on the students after class, and draws Figure 8, which reflects the students' love for the live broadcast teaching system.

$$R=\begin{bmatrix} x_{11} & x_{12} & x_{13} \\ x_{21} & x_{22} & x_{23} \\ x_{31} & x_{32} & x_{33} \end{bmatrix} \quad (1)$$

$$C=\begin{bmatrix} y_{11} & y_{12} & y_{13} \\ y_{21} & y_{22} & y_{23} \\ y_{31} & y_{32} & y_{33} \end{bmatrix} \quad (2)$$

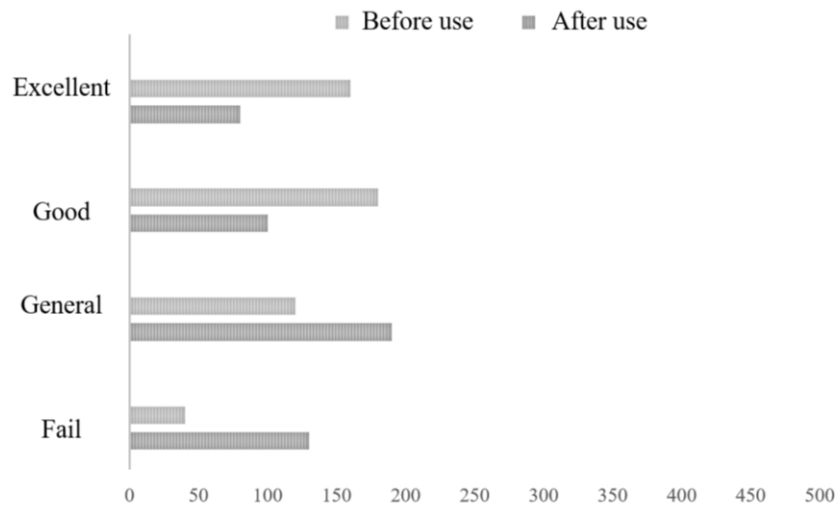$$p+\sum\left[(x\times r)+(y\times c)\right]=M \quad (3)$$

Figure 8. Survey form of live course teaching effectiveness (original)

4 CONCLUSION

Packaging design is a discipline closely related to the market, and the traditional teaching methods have been difficult to meet the market demand. Therefore, in the course of packaging design, we should focus on developing students' innovative thinking and cultivating their practical ability, guide students to skillfully combine art with packaging technology, improve their aesthetic level, give full play to their respective strengths, and design excellent packaging works with personal style to meet the changing needs of the times. [5] With the development of science and technology, the society has put forward more rigorous requirements for college graduates. Combined with the background that China's economic development has entered a new normal, this paper constructs a remote live broadcast teaching system for packaging design major in colleges and universities based on FFmpeg, which provides technical support for the innovation of packaging design teaching mode and the improvement of education system in

colleges and universities in China. In the follow-up research, we will further expand the extensibility and applicability of the system, and make the system function more perfect.

REFERENCES

[1] Wan Meifen. Research on Teaching Application and Importance of Streaming Media Technology in College Campus Network. Wireless Internet Technology.2019.05.

[2] Tao Kuiyin. Design and Implementation of Live Education System Based on FFmpeg. Dalian University of Technology.2021.06.

[3] Ge Meng et al. Java Web Application Based on Spring MVC Framework[J]. Computer and Modernization.2018.08.

[4] Zhou Wei, Zhou Yi. Teaching Reform and Innovative Practice of Packaging Design Course[J]. Packaging Engineering. 2021(S1).

[5] Zhou Wei, Zhou Yi, Chen Jing. Research on Innovation of Teaching System of Packaging Design Course in New Engineering Era[J]. Packaging Engineering. 2019(S1).