Design of Online Art Appreciation Course Teaching System Based on Interactive Scene

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Abstract. The teaching of art appreciation course is quite different from that of other professional courses, and there is a high demand for interaction between teachers and students. In order to solve the defects of the online art appreciation course teaching system and obtain better teaching effect, an online art appreciation course teaching system based on interactive scene is designed. The system hardware design unit includes teaching data processor selection unit, system operation controller selection unit and peripheral circuit design unit. The software module includes student state detection module, interactive scene setting module and database construction module. Through the design and development of the above hardware units and software modules, the operation and application of the online art appreciation course teaching system are realized. The experimental results show that compared with the comparison system without interactive scene, the system response time obtained by using interactive scene design system is shorter and the accuracy of student state recognition is higher, which fully proves that the design system has certain feasibility and effectiveness.

Keywords: Interactive scene · Online art appreciation course · Teaching system · Yolo algorithm · Data processor

1 Introduction

With the increasing attention of the state to school education and the improvement of campus network facilities, in order to better, more convenient and faster learn and understand knowledge, we should combine the current advantages and change the previous traditional teaching methods to the current intelligent teaching methods, so that the learning efficiency can be continuously improved. In addition, the design and implementation of an intelligent network teaching system for art majors is one of the feasible paths for intelligent teaching in today's society. Although the network technology has developed rapidly and the network teaching of art majors has also achieved certain results, there is still a big gap compared with the network teaching system of art majors in developed countries in Europe and America. In the more advanced teaching system, students in Europe and the United States have better learning ability, and more and more teachers use online teaching, and the method is more and more suitable for students, so a new feasible idea is proposed to improve the current teaching system.

W. Fu and G. Sun (Eds.): eLEOT 2022, LNICST 453, pp. 14–27, 2022.
https://doi.org/10.1007/978-3-031-21161-4_2

This topic aims at the network education of an art appreciation course, which has great particularity in the professionalism of the course, the focus of teaching and the cultivation of professional knowledge. In the past, the guidance method of an art appreciation course basically adopted one-to-one method, which not only limited the utilization rate of teachers' time, but also students had to spend a lot of time hiring teachers to provide guidance for themselves. In addition, it was difficult for teachers to pay attention to students' teaching in their spare time. Luo Lili [1] takes students as the main body, integrates the two modes of network teaching and traditional teaching, and combines the design of database to realize the function of online and offline hybrid intelligent auxiliary teaching system, which can meet the requirements of autonomous learning and improve students' learning enthusiasm. However, in practical application, the system response time is long, and the accuracy of student state recognition is low. Therefore, it is proposed to adopt a more intelligent way to replace the existing teaching methods. Under this condition, teachers can arrange their own teaching tasks according to everyone's common learning time, and timely count the students' understanding of a module, so as to increase the corresponding teaching proportion to the module. In addition, according to the comprehension level of most students listening to the class, the courses are divided into key points and difficult points, which can not only maximize the learning efficiency for students, but also allow students to obtain the greatest knowledge reserve effect within a limited learning time. Therefore, according to the actual situation of students, it is imperative to develop an intelligent online teaching system suitable for art appreciation courses.

Judging from the existing research results, the existing online art appreciation course teaching system has certain defects and cannot obtain better teaching effects. Therefore, an online art appreciation course teaching system design research based on interactive scenes is proposed. While completing the task of knowledge explanation, the online teaching teacher is allowed to conduct real-time teaching interaction with students in class, and give targeted feedback according to the real-time performance of the whole class and individual students, so that the teaching teacher can directly participate in the students' question answering and puzzle solving, and the tutor is only responsible for solving unexpected emergencies in class. Through such teaching methods, make full use of teaching teacher resources, let thousands of students receive equal education regardless of location, time and manpower, let students really participate in classroom learning, experience the attention of teachers, and stimulate students' learning interest and learning autonomy while enhancing their dependence on teachers. After all, interest is the best teacher. At the same time, it is hoped that the development of the system will truly popularize high-quality teaching resources all over the country, so that students can gain in class, so that teachers can better prepare lessons according to students' feedback in each class, solve the waste of time and resources caused by repeated teaching without gain, strengthen the sense of dependence and trust between teachers and students, and improve the teaching effect of art appreciation course.

2 Hardware Design of Online Art Appreciation Course Teaching System

Hardware design is the basis and premise of system operation. In order to improve the problems existing in the existing system and improve the teaching effect of art appreciation course, the hardware unit of the system is designed, mainly including the selection unit of teaching data processor, the selection unit of system operation controller and the design unit of peripheral circuit. The specific design process is as follows:

2.1 Selection Unit of Teaching Data Processor

Considering the function, real-time and flexibility required by the design system, this study has the following requirements for the selected teaching data processor:

(1) Can run embedded Linux system:

The operating systems that the selected design system runs are Linux system and real-time kernel. Therefore, when selecting a teaching data processor, it is required that the selected processor can run the embedded Linux system smoothly, so as to provide guarantee for the operation of the design system.

(2) With hardware floating-point arithmetic capability:

Because the advantage of the ARM processor lies in the aspects of transaction control and task scheduling, the data computing capability is not as good as that of the DSP processor. However, in order to reduce the structural complexity of the design system, this study did not introduce a DSP processor. At this time, it is necessary to select an ARM processor that supports hardware floating-point arithmetic.

(3) Development platform, customizability and portability:

Some ARM chip programming requires the chip provider to provide professional development software and programming tools, and its programming development relies on the compiler, debugger, etc. provided by the supplier, resulting in the developed software not having customizability and low portability. The portability of the design system software among the hardware platforms is a very important issue. The reasonable selection of the hardware platform with good compatibility is very helpful to improve the portability of the developed software and bring great convenience to the upgrading and maintenance of the hardware platform in the future [2].

Considering the above factors, the design system chooses to use the (ARM) BCM2835 chip produced by Broadcom as the teaching data processor. The selected BCM2835 chip belongs to the ARM11 architecture microprocessor and adopts the BGA package, and the hardware design technical requirements are very high [3]. The BCM2835 chip structure is shown in Fig. 1.

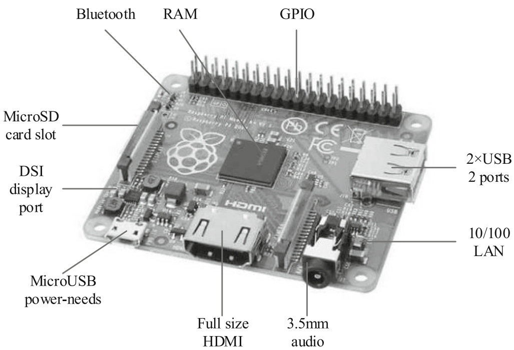

Fig. 1. BCM2835 chip structure diagram

As shown in Fig. 1, the BCM2835 chip has a relatively simple structure and rich internal resources, which can provide great convenience for the development of the design system.

2.2 System Operation Controller Selection Unit

According to the design system requirements, Samsung's S3C4510B is selected as the system operation controller, which has the advantages of low power consumption and high performance, and is most suitable for system applications that are sensitive to price and power consumption [4]. The S3C4510B controller features are described as follows:

One is the architecture. With integrated system, full 16/32 RISC architecture, support for big and little endian mode, debugging scheme based on JTAG interface, boundary scan interface, etc.;

The second is the system manager. External bus controller with bus request/response pins and support for EDO/conventional or SDRAM memory, while also being able to program access cycles;

The third is the integrated instruction/data Cache. Cache can be configured as internal SRAM and supports LRC replacement algorithm.

In addition, the S3C4510B controller has abundant pins to support it to complete a variety of functions. Pin related definitions are shown in Table 1.

Table 1. S3C4510B controller pin definition table

Pin	Signal	Describe
3	nUADTR1	UART1 data terminal ready
4	UATXD1	UART1 data transmission
5	NUADSR1	UART1 data device is ready

(*continued*)

Table 1. (*continued*)

Pin	Signal	Describe
17	nDTRB	HDLC Ch-B terminal ready
19	nRTSB	HDLC Ch-B transfer request
23	nCTSB	HDLC Ch-B transfer clear
30	RXD_10M	10M receive data
36	RX_ERR	Receive error
45	TX_ERR	Send error
55	FILTER	Ceramic capacitor
58	TCK4	Test clock
59	TMS	Test mode selection
60	TDI	Test data input
61	TDO	Test data output
62	nTRST	Reset signal

Different from other controllers, the connection method of the address bus of the S3C4510B application system is relatively simple. Since S3C4510B uses a 32-bit address bus, all addresses can be regarded as byte addresses. The address bus provides a 4GB linear addressing space. When a word access signal is issued, the storage system ignores the lower 2 bits A[1:0]. When signaling a halfword access, the memory system ignores the lower A[0] bits. Therefore, the S3C4510B generates components through an on-chip address bus to hide the process, and only needs to connect the address bus of the

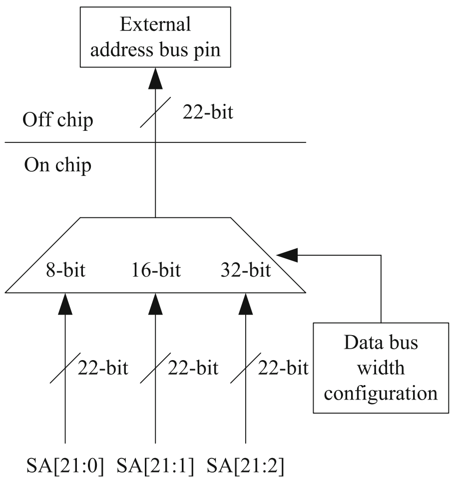

Fig. 2. Schematic diagram of S3C4510B address bus conversion

S3C4510B with the address bus of the memory one by one. The S3C4510B address bus conversion is shown in Fig. 2.

Through the above process, the selection and configuration of the system operation controller is completed, which provides effective help for the development and application of the design system.

2.3 Peripheral Circuit Design Unit

Peripheral circuit is one of the key components of designing system hardware and undertakes the important task of connecting hardware units. Due to space limitations, only the switching signal input and output circuits are shown [5]. The switch signal input and output circuit is shown in Fig. 3.

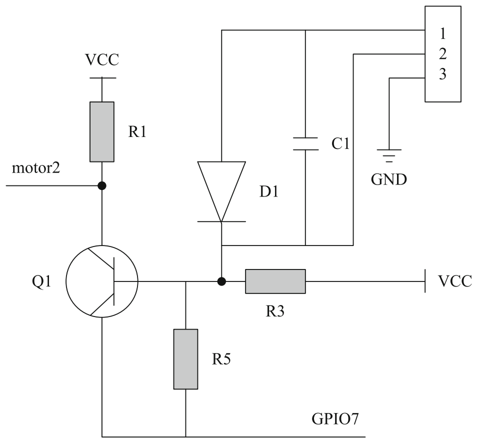

Fig. 3. Schematic diagram of switching signal input and output circuit

The above process completes the design and selection of the hardware unit of the design system, but still cannot realize the teaching of the online art appreciation course, so the system software module is designed and developed.

3 Software Design of Online Art Appreciation Course Teaching System

The design system software module includes student state detection module, interactive scene setting module and database construction module. The specific design process is as follows:

3.1 Student Status Detection Module

In class state detection such as students' concentration and hands raising is one of the preconditions for completing interactive scenes and improving the teaching effect of art appreciation course [6]. Aiming at the student state detection and classification, the design system uses the widely used Yolo algorithm to complete the student state detection. In class, the system camera recording will be turned on to record students' behavior in class. Firstly, the video in class will be processed in frames, and the output student picture set will be input into Yolo model for target state detection and positioning. The detection targets are divided into positive targets, negative targets and hand raising targets, in which positive targets represent students' focused state and negative targets represent students' non focused state. Finally, the location of the detection target is written into the database for system call.

Yolo algorithm steps are as follows:

Step 1: Input image. After image preprocessing, output 300 × An image of 300 pixels is used as the input of the algorithm;
Step 2: Feature extraction. The layers and sizes of feature maps selected by Yolo algorithm are shown in Table 2.

Table 2. Level and size of feature map

Layers of feature maps	Sizes of feature maps
Conv4_3	38 × 38
Conv7	19 × 19
Conv8_2	10 × 10
Conv9_2	5 × 5
Conv10_2	3 × 3
Convll_2	1 × 1

According to the different layers of the feature map in Table 2, a priori box with the same size is set on the same feature map, and the size of the priori box in each layer of the feature map increases layer by layer to match the real target. There are $n \times n$ center points in the feature map of each layer, and each center point will generate a default box of different size. For example, each center point of the Conv4_3 layer uses 4 default boxes, then the calculation method of the number of a priori boxes generated by this layer is 38 × 38 × 4, and the calculation result is 5776 a priori boxes. By analogy, a total of 8732 a priori boxes are generated in the six layers. Each a priori box corresponds to a set of bounding boxes, which are convolved through two different 3 × 3 convolution kernels to output a set of independent detection values, including the confidence of the category to which the detection target belongs and the position information of the bounding box;
Step 3: Loss calculation. It is calculated by weighting the category loss function and the position loss function;
Step 4: Model training [7]. In the training process, the ratio of the area of the intersection of the two boxes to the sum of the areas of the two boxes is denoted as IoU. For each real box in the picture, find the a priori box with the largest IoU to match, and ensure that at least one first the test box matches the ground-truth box. The bounding boxes

corresponding to such a priori boxes are used as positive samples for training, and the remaining unmatched a priori boxes are used to calculate the IoU value between them and each real box. Generally, the threshold of IoU is set to 0.5. If the IoU value is greater than the threshold, the a priori frame is matched with the corresponding real frame with the largest IoU value, and for the a priori frame whose IoU value and all real frames are less than the threshold, such a priori frame is used as a negative sample;
Step 5: Prediction process. Preprocess the picture to 300 × 300 pixels input Yolo algorithm to predict the category confidence and location information of each a priori box, filter out the a priori boxes whose prediction result is background or whose confidence is less than the threshold, and the remaining a priori boxes are arranged according to the confidence. Decode the first 400 a priori frames with the highest confidence to the position in the original image, and screen out the intersecting a priori frames with IoU greater than 0.5 through non maximum suppression processing to obtain the final classification target, including the category and position information of the detection target.

In the Yolo algorithm shown above, the core step is loss calculation. The calculation formula is:

$$L(x) = \frac{1}{N}(Lconf(x) + \alpha Lloc(x)) \tag{1}$$

In formula (1), $L(x)$ represents the loss value; N represents the number of a priori boxes; $Lconf(x)$ represents the classification loss function; α represents the default value of 1; $Lloc(x)$ represents the position loss function.

In formula (1), the calculation formula of the classification loss function $Lconf(x)$ is:

$$Lconf(x) = -\sum_{i=1}^{N} x_{ij}^{p} \log\left(c_i^p\right) - \sum \log\left(c_{ij}^{0}\right) \tag{2}$$

In formula (2), x_{ij}^{p} indicates that the i a priori box matches the real box of the j category p, and a value of 0 indicates that no a priori box matches the real box; p indicates the type of target; c_i^p represents the probability that the i prediction box is of type p.

In formula (1), the calculation formula of the position loss function $Lloc(x)$ is:

$$Lloc(x) = \sum_{i=1}^{N} \sum x_{ij}^{k} smoothL1\left(l_i^m - g_j^m\right) \tag{3}$$

In formula (3), k represents the type of object; $smoothL1(\cdot)$ represents the position determination function; l_i^m and g_j^m represent the width and height of the prior frame, respectively.

Through the above process, the detection of student status can be completed, which provides effective support for the realization of online art appreciation course teaching.

3.2 Interactive Scene Setting Module

The interactive scene setting module mainly sets the interactive process of online course teaching accordingly. During the teaching process, the lecturer interacts with students through interactive components. The types of interaction include order maintenance of the lecturer, question and answer interaction between teachers and students, question and answer interaction between students, volume feedback interaction, preferred screen projection interaction and group PK interaction [8].

Among them, the business process of order maintenance of the lecturer is as follows: The lecturer triggers the classroom order maintenance component according to the students' concentration before and during the class, and the system detects the students' concentration every 3 s through the camera in the classroom. The lecturer adjusts the strategy of class order maintenance according to the proportion of students whose concentration is not up to standard. If more than 30% of students are identified as not paying attention in class, the lecturer will maintain the overall order of the class, otherwise remind the students to take class seriously through the buzzer of the answering machine.

The business process of question and answer interaction is: For the question and answer interaction strategy, when the teacher calls the roll, in order to give all students a chance to answer questions, give priority to the students who have not answered the questions, and then choose the students who answer the questions less and raise their hands less. The system first detects whether someone raises his hand. If a student raises his hand, the teacher selects the student who raises his hand less often to answer. If no one raises his hand, the teacher randomly selects a student to answer. If the first student answers wrong, in order to test the overall effect of students' listening, the teacher asks another student to answer the question in the same way. If the second student still answers wrong, the teacher explains the knowledge point in detail, and then praises the students who answer correctly.

For the volume interaction strategy, the teacher asks questions to individuals or groups, and makes corresponding verbal feedback according to the volume of students. If the teacher asks questions to the whole class, the lecturer judges the volume of students' answers according to the system radio equipment in the classroom, divides the volume of students into low volume, medium volume and high volume, and starts different strategy branches according to the volume feedback, including praising students, encouraging students or explaining problem strategies. For the loud feedback, the system starts the praise script, and the speaker teacher praises the students, such as: "the students answer loudly, so keep it up". In response to the feedback of medium volume, the system activates the students' encouraging words, and the lecturer encourages the students, such as: "The students are not very loud, please read it again with the teacher", and the students follow the second reading. In response to the low volume feedback, the system judged that the students did not understand the content of the question, and the lecturer re-explained the relevant knowledge and asked the question again in the same way. If the lecturer asks a question to the individual, the system will record the sound through the clicker, and the teacher will give feedback according to the received volume. The general question and answer mode is generally used in the follow-up questioning of English teachers, and the individual question mode is generally used in personal reading in English class [9].

Due to space limitations, this study only shows the interactive process of optimal screen projection, as shown in Fig. 4.

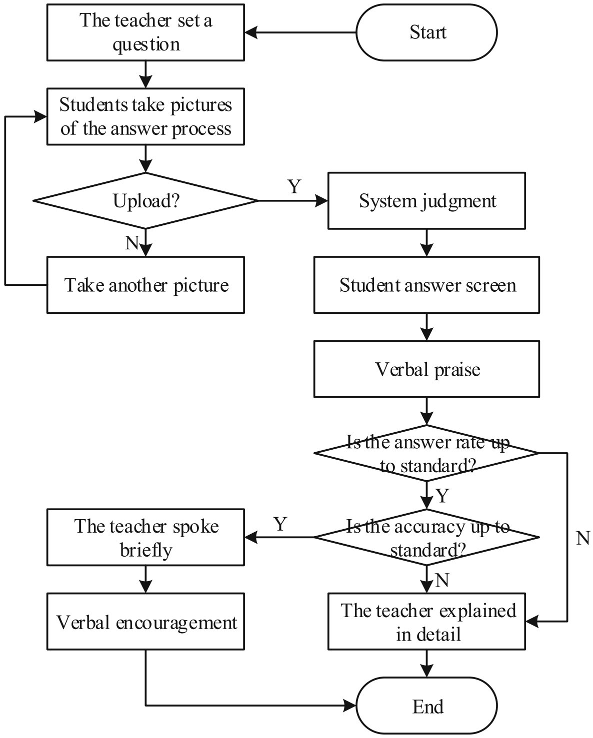

Fig. 4. Schematic diagram of the preferred screen projection interaction process

The above process completes the setting of the interactive scene and helps the design system to complete the teaching interactive task, so as to improve the students' interest in learning and enhance the teaching effect of the online art appreciation course.

3.3 Database Building Blocks

The database is mainly responsible for the recording and storage of teaching data and system operation data, and is the basis for the stable operation of the design system. The database is mainly constructed in the form of logical tables. Due to space limitations, only some of the logical tables are displayed, as shown in Table 3.

Through the design and development of the above hardware units and software modules, the operation and application of the online art appreciation course teaching system are realized, which provides help for the development of the online art appreciation course teaching.

4 Experiment and Result Analysis

In order to verify the application performance of the above design online art appreciation course teaching system, a simulation comparison experiment is designed. The specific experimental process is as follows:

Table 3. Part of the database display table

Field name	Field code	Type
U_Id	Number	Int
U_name	User name	char
U_ema	Mailbox	char
U_pw	Password	char
R_id	Role	Int
P_id	Pass or not	Int
S_sex	Gender number	char
S_add	Address	char
S_date	Time	Int
S_ph	Telephone	Int

4.1 Experimental Preparation Stage

The experimental preparation stage mainly undertakes the task of formulating the experimental data acquisition process. On this basis, it obtains accurate experimental data and prepares for the analysis of subsequent experimental results.

The experimental data is mainly the feedback results of course teaching. The feedback results of course teaching include the process after the teacher explains the teaching content. The core process includes the implementation of student course evaluation, student after-school test, in class report generated by the system according to students' performance, parents' message, parents' praise and other processes. After submitting the course evaluation, students need to take a classroom test to test the students' listening effect. Students shoot the problem-solving process through the question answering camera and upload it to the background of the system for problem judgment. The system will generate students' in class report according to the students' behavior records in class. After the tutor confirms that it is correct, upload the students' report. After parents log in to the system, they can download it on the parents' service page or view the in class report online. You can also leave messages, comments and likes in the parent comment area, and give feedback to teaching institutions while parents communicate with each other, so that institutions can understand the real needs of parents and improve teaching development strategies in time. The feedback logic of course teaching is shown in Fig. 5.

The above process completes the preparation of experimental data and provides support for the subsequent online art appreciation course teaching experiment.

4.2 Analysis of Experimental Results

In order to quantify the performance of the online art appreciation system and show the results as follows:

The system response time data obtained through experiments are shown in Table 4.

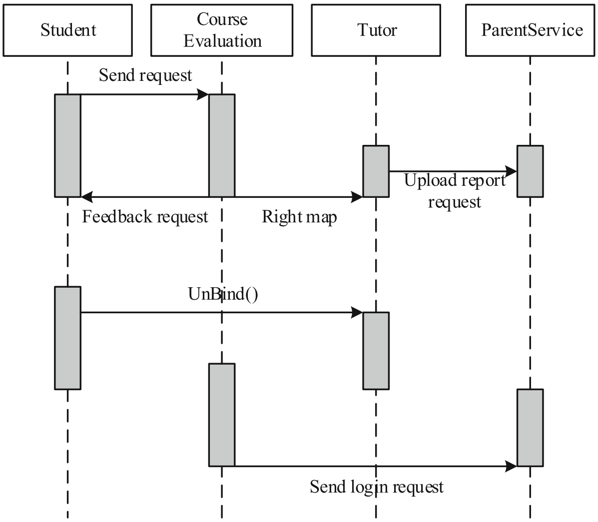

Fig. 5. Schematic diagram of curriculum teaching feedback logic

Table 4. Data sheet of system response time

Number of experiments	Application interactive scene design system	Interactive scene comparison system is not applied
1	3.56s	6.98s
2	4.02s	7.15s
3	2.19s	7.58s
4	3.57s	8.50s
5	3.20s	9.45s
6	3.66s	6.20s
7	4.59s	7.24s

As shown in Table 4, with the increase of test times, the system response time of the design system and the comparison system fluctuates. The response time of the design system is between 2.19s and 4.59s, the response time of the comparison system is between 6.20s and 9.45s, and the longest system response time difference is 4.86s. The response time of the application interactive scene design system is shorter than that of the non application interactive scene comparison system, indicating that the design system has stronger real-time performance. The accuracy of student state recognition is obtained through the experiment, as shown in Fig. 6.

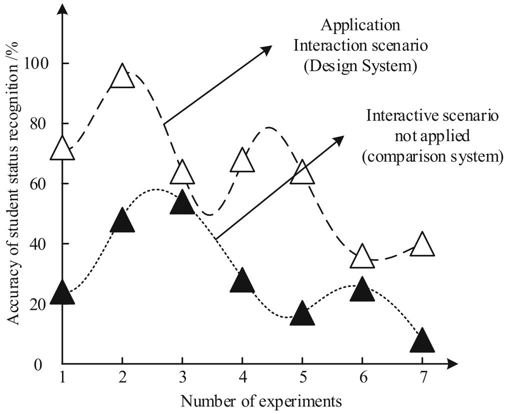

Fig. 6. Data chart of student state recognition accuracy

As shown in Fig. 6, the accuracy of the application of interactive scene design system is generally higher than that of the non application of interactive scene comparison system. When the number of tests reaches 10, the accuracy of the non application of interactive scene comparison system is 10%, and the accuracy of the application of interactive scene design system is 40%, with a difference of about 30%, compared with the non application of interactive scene comparison system, the student state recognition accuracy of the application of interactive scene design system is higher.

The above experimental data show that compared with the non application of interactive scene comparison system, the application of interactive scene design system obtains shorter system response time and higher accuracy of student state recognition, which fully proves that the application performance of the design system is better.

5 Conclusion

In order to solve the defects of the online art appreciation course teaching system and obtain better teaching results, an online art appreciation course teaching system based on interactive scenes is designed. Using Linux system, ARM processor, bcm2835 chip and Samsung S3C4510B as system operation controller can reduce power consumption and improve detection accuracy. Yolo algorithm is used to detect students' status and improve the effectiveness of online art appreciation course teaching. Set up the interactive scene module, increase the interaction between teachers and students, mobilize students' interest in learning, and improve learning efficiency. Build the database module, record and store the teaching data and system operation data, so that the design system is feasible. After experimental verification, the design system can greatly shorten the system response time, improve the accuracy of students' state recognition, provide a more effective system support for the development and implementation of online art appreciation teaching, and also provide a certain reference for the related research of the teaching system. However, due to the limited research time, the number of tests in this paper is less, which may produce a little error in practical application. It is necessary to increase the number of tests in the follow-up work practice, improve the system, and better serve users.

Fund Project. Nanning College's 2021 Professor Cultivation Project "Research on Cultural and Creative Design and Artistic Creation of Weizhou Island's Characteristic Landscape Resources", Project Number: 2021JSGC22.

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