Remote Vocal Singing Course Design Based on Embedded System and Internet of Things

1. Introduction

The swift growth of network expertise has made a wide range of applications in the realm of education. The changes in the way of educational information dissemination have led to large changes in the educational model, educational philosophy, and educational methods [1]. The use of network technology in education gives students not only a diverse range of learning possibilities but also a wealth of instructional tools. Our improvement has made learning activities more diverse and broken the boundaries of traditional teaching time and space. It also accelerates the pace of updating teaching content and systems [2]. Distance learning can be independent of time and space, and students can learn independently through the network in any place as long as they have network conditions.

In terms of distance learning characteristics, the number of nonreal-time interactions between teachers and students will be much greater than that of real-time interactions. The effectiveness of interaction will discover the learning effect of the course. Firstly, the remote vocal singing course can create a strong sense of display through real and vivid communication. This can attract the eyes and achieve the communication effect of a deep impression and a lasting memory. It can also combine the use of streaming video to carry out exploratory learning, collaborative learning, and so on. Secondly, distance learners assemble in the virtual space around the same topic or issue, realizing the interpersonal...
connection by relying on the social elements provided by the platform, such as the course discussion forum. Through this feedback information, teachers can adjust online teaching to meet the requirements of learners. In addition, the course learning records of students are available on the online platform in a timely manner, such as the number of visits to teaching materials, page entry time, page stay time, page leave time, login times, and basic user statistics. The summary of the study on the interaction activities is of practical significance for guiding how to carry out effective distance learning interactions and use the network teaching platform.

In the vocal singing teaching curriculum, we regard vocal singing teaching as a system, which includes a “teaching” system and a “learning” system. The synergy between the two subsystems of “teaching” and “learning” produces a synergistic effect, that is, to achieve scientific vocal singing teaching, “teaching” and “learning.” The synergistic operation of the two subsystems directly affects the effect of vocal singing teaching.

However, in practice, there are other factors that affect vocal music teaching: from the “teaching” system, teachers’ factors that affect the effect of vocal singing teaching are teachers’ own singing concept, singing method, singing level, teaching technology level, teachers’ educational values, teaching theory, cultural background, personality charm, and so on; from the “learning” system, the factors that affect the effect of vocal singing teaching from the students’ side are students’ physical quality, voice condition, basic musical quality and cultivation, students’ intellectual status, knowledge structure, artistic intuition differences, personality characteristics, emotional state, and emotional intelligence.

These factors cannot be fully demonstrated in the current distance education platform because the traditional teaching of vocal singing is a bilateral activity between teachers and students, the reliance on equipment and curriculum design is very strong, and the equipment has a direct impact on both teachers’ “teaching” and students’ “learning.” The equipment has a direct impact on both the teacher’s “teaching” and the students’ “learning,” and the professional music and recording equipment directly affects the effect of teaching.

Embedded systems and software application is a very popular research area at present. An embedded system is a class of specialized computer systems based on modern computer technology. They are both application-centered and application-oriented. They can be customized according to system or user requirements such as environment, volume, power consumption, cost, security, and reliability. The functionality and performance of the microcontroller can be achieved by flexibly cutting hardware and software modules and performing comprehensive optimization [3].

In this paper, a remote vocal singing course design based on an embedded system and IoT is proposed. The study meets the needs of basic vocal teaching in terms of not only hardware but also the software requirements. It improves the teachers’ understanding of students’ singing skills and personalized teaching strategies for different students with specified content. The key contributions of the paper are explained as follows:

(a) The current hardware equipment has been made more suitable for vocal singing instructions by updating it using embedded and IoT systems.
(b) We designed a special distance learning course for vocal singing and introduced one-to-one and one-to-many teaching methods into the course, making the course more suitable for distance learning.
(c) We introduced an objective teaching evaluation system and added a feedback and interaction method in the course design to facilitate students’ learning and communication. It will also help teachers to improve the course.

After the introduction, the literature review of the paper has been discussed. After that, the method of the implementation of the embedded system and IoT-based system has been discussed in which the structure and efficiency of distance learning have been explained deeply. Following that, the simulation experiments and optimization results have been discussed. Lastly, the research paper has been concluded.

2. Related Work

Embedded systems and the Internet of Things are a very extensive field in the research and development area at present. Previously, a number of researchers have expressed their piece of work on vocal music teaching and practices to make it feasible for the learners to take advantage of it. In this section, some of the related work has been highlighted in the following.

2.1. Current Status of Vocal Performance Teaching. First, the basic singing skills of students need to be further strengthened. At the present stage, when it comes to the singing skills of students of popular vocal music in colleges and universities, it becomes difficult to recognize them. A large proportion of students have weakened the practice of basic skills with the depth of vocal singing teaching content. This lack of attention directly affects the singing skills of students. The practice of fundamental skills is intended to accompany the whole professional learning process, which is an important component of popular vocal music teaching [4]. Second, the pop vocal singing performance fluency is poor. The rapid development of pop vocal singing styles causes an influx of new music types into the music field. Most of them are positive and sunny types, which makes teenagers more willing to use pop singing to express their inner thoughts and feelings. Many current pop vocal students do not sing with their natural voice, resulting in poor vocal performance fluency. This type of performance affects the aesthetic perception of the whole pop music work and does not fully reflect the characteristics of pop music. Thirdly, the high and low tone processing skills need to be improved. In the current performance of many students in the singing, the process did not master the correct way of high and low tone processing. In addition, the middle and low parts are also an important part of the entire pop vocal
singing. Students are often accustomed to the way of singing in the high register to deal with the middle and low parts, but a single reliance on natural tone and pitch is unable to achieve the desired singing effect, which makes the singer lose his voice and expression. This singer is required to integrate the bass and soprano singing skills and articulate them in the singing impression in order to achieve a complete expression of the pop music works.

2.1.2. Optimizing the Strategy of Pop Singing Vocal Teaching

(1) Breathing Training. Pop vocal singing is usually based on the combined thoracoabdominal breathing method. This breathing method requires the use of the singer’s mouth and nose at the same time. The intercostal muscles move up with the waist expansion around the rib cage, while the diaphragm contracts down. The chest cavity expands around so that the lungs can inhale a given volume of air into the deep lungs in the shortest possible time. During the performance, the singer’s breath control depends on the joint action of the abdominal and lumbar muscles.

(2) Language Training. Bite and the correct way of spitting out words largely affect the singing effect. There are two types of bite, a soft bite and a hard bite. The application of flexible penetration can naturally make the emotions penetrate into singing. The key to biting and spitting is pronunciation. Refining pronunciation requires analyzing the head, belly, and tail of each word and finding the connection between them. In terms of ensuring the consistency of lines and tones while singing, the pronunciation of each word should be up to the standard to achieve the right amount of front and back, looseness, and tightness [5].

(3) Vocal Exercises. Vocal exercises are diversified in ways and means, and there is no fixity. The way of vocal practice depends on some principle. Natural development protects the function and movement of vocal organs and determines the way of vocal practice based on the principle of teaching and differentiation. The progress of vocal exercises should be easy at first and subsequently hard, from shallow to deep, with steady strength in a continuous tone. There are many types of vocal exercises, such as skipping, legato, lengthening, and staccato. Teachers must make suitable deployment in the relevant training level and expand the training based on the original vocalization, regardless of how easy or difficult they are.

2.1.2. Optimizing the Strategy of Pop Singing Vocal Teaching

Optimizing the strategy of pop singing will help the students to learn and improve their singing technicalities. Some of the strategies are discussed as follows:

(a) Let students master the vocal principle.

High and low tones are important components of pop music works. Sublimating music itself means coloring music, but without proper handling of high and low tones, the whole music works will lose color.

(b) Improve the singing curriculum.

In order to let students experience a variety of styles of vocal works, teachers recommend a large number of textbooks or music resources in their daily courses. The perfection of curriculum settings largely affects the effect of vocal teaching. The perfection of the singing curriculum mainly has the following two points. One, based on a large number of teaching practice summaries, the value of students’ vocal learning materials and the role of teachers’ teaching reference materials are known to be determined by the professionalism and uniqueness of textbook selection, so selecting professional and unique textbooks is a basic requirement for perfecting the curriculum, which can effectively promote the healthy development of professional vocal education [7]. Secondly, under the influence of the long-term traditional music singing style, the setting of professional vocal music classes needs to match the teaching system with strong characteristics. Such classes are divided into simulated classes, mini-classes, and inverted classes, which have wide application at this stage and can greatly promote the realization of the professional development goals of colleges and universities.

(c) Improve students’ own cultural literacy.

Music teaching should not only provide students with continuous singing skills training but also improve students’ cultural literacy. The development of cultural literacy and musical aesthetic ability is a way to accomplish the goal of comprehensive literacy. According to the students’ existing knowledge
reserves, it needs to be based on the actual situation and targeted cultural literacy improvement. Although pop music singing has known popular characteristics, in addition to the performance format, the cultural meaning of the sung works and the singers themselves must be considered. This requires the performers to improve their cultural literacy in the first place so that they have comprehensive qualities, including singing skills, rich emotion, and cultural literacy at the same time [8]. Therefore, on one side, the teaching of popular vocal music in colleges and universities should focus on professional music knowledge and singing skills. On the other hand, it shall tell the students the cultural background and connotation hidden behind the professional knowledge. A deep and thorough understanding of the culture behind the musical works can make the song singing performance more accurate and promote the comprehensive quality of students. Students who have both cultural literacy and singing ability and skills perform better in the interpretation of works and subject assessment in colleges and universities at the present stage. The key to this is that students can accurately grasp the cultural background behind the music works. This will result in students having more outstanding effects in the expression of emotion and use of skills.

(d) Cultivate innovative musicality.

Students’ perception of music in daily song singing is a musical sense. This musical sense is frequently expressed in the performer’s self-signing style. The following aspects are required for the cultivation of innovative music sense. Firstly, cultivate the sense of pitch. By placing themselves in their singing, students may better understand their own feelings and perceptions of music melodies. It requires daily training, independent practice, and perception to gradually cultivate. Secondly, students need to develop the accuracy and stability of their “sense of beat” in order to be able to recognize new beats fast and precisely and recall the original beat with special accent changes. Thirdly, cultivate a sense of rhythm [9]. The cultivation of the sense of rhythm requires long-term training to improve, and the guidance of teachers is indispensable in this process. Fourth, cultivate a sense of force and speed. The performance of the sense of force and speed in singing is the transition, change, and turn of the music content. The sense of force and speed in the song singing can be controlled well to better express the lightness and urgency of the music works and the emotional ups and downs.

(e) Optimize the assessment mode of popular vocal music teaching.

In the past, the assessment mode of vocal music class was almost fixed. Students sang on the stage, and the assessment teacher observed and listened to them, mostly with piano accompaniment. This simple and stereotypical assessment mode frequently made students too nervous. This would lead to difficulty in sinking breath and very tight voice performance and, in serious cases, can make a singer out of tune. To make the assessment method achieve a more objective assessment effect, one can adjust the accompaniment method of vocal assessment. This method will allow students to choose their own accompaniment band, using a small band or self-playing guitar and so on to reduce students’ nervousness [10]. Secondly, students are allowed to choose their own performance form, clear singing, solo singing, combination performance, and so on. As far as the existing pop vocal assessment reform is concerned, diversified assessment forms are more popular among students. The greater the space for free play is, the more the students can fully display their personal characteristics and styles and better present their daily learning outcomes. In addition, pop vocal teaching should not take place in the piano room; in fact, it should gradually reduce students’ dependence on the piano room so that they will not get used to practicing singing in the piano room relaxed and freely. They will become nervous when they are not adapted to the stage environment, which will affect their voice state. The teachers are required to move the teaching classroom to the stage. This will result in students getting familiar with the environment in their daily practice and using the accompaniment to attain acceptable training results.

2.2. The Function of the IoT-Based Course Teaching System.

The IoT-based course teaching system adopts ARM11 [11] as the main control platform and develops a new management system for course teaching. The platform integrates brainwave control, remote network appliance management, network remote monitoring, network remote audio-visual
entertainment, intelligent security, and voice assistance, with the following main functions:

1. Remote users can access the WEB page through the public website and realize the interactive control of the server to achieve the intelligent management of the furniture and electrical appliances.

2. Remote users can also use handheld devices (iPad, cell phone, and laptop) of any platform to complete the corresponding control [12].

3. In addition to the handheld terminal platform, local users can also use voice control to manage their convenience. The voice module program of this system is set to control the command. The voice system needs to be activated in the form of a password before control.

4. In addition to course teaching management, this system also has audio and video entertainment functions. Through network technology, they can use online on-demand songs, videos, server downloads, and other common Internet functions.

This system is integrated to complete a course teaching information platform with embedded WEB server construction, IoT RFID, and other technologies. This platform can realize the function of remote cross-platform control of singing equipment through WEB page, voice, and handheld devices (iPad, cell phone, and PC) through the master control center. They can also be controlled with intelligent audio and video and other functions at the same time.

3. Method

This section discusses the methodology used in this study, which includes the methodical organization of several research phases, as well as the thorough design and implementation of the embedded system and IoT-based remote learning design. Furthermore, the components’ selection and integration to meet the design objectives are detailed.

3.1. System Hardware Structure's Design. The key to the remote learning system of vocal singing is to test the learning effect of students. It gives timely learning suggestions, thus recognizing the intelligence between learning and teaching [13]. As shown in Figure 1, the base of knowledge, learning module of students, teaching module of instructor, assessment module, human-machine interface, and the system’s hardware structure are the primary components of the system.

All of the elements are finished with the help of the base of knowledge. It is a unit that preserves the information and queries given to students and makes it easier for them to answer them properly [14].

3.1.1. Student Learning Module. The student learning module may correctly represent the learning ability and skill level of students and gives a customized teaching base to the system. This module is composed of teaching coordination agents and several other agents. Different teaching agents have the required knowledge for independent problem-solving and as independent AI individuals. They are mainly responsible for specific teaching material presentation,
problem-solving, and providing instructive advice to students [15–18]. Knowledge sharing is achieved through a collaborative mechanism. During this entire teaching process, the coordinating agent is able to adjust the entire learning syllabus based on the monitoring data and the teaching strategies sent by the instructional management [19]. The student learning module is shown in Figure 2.

3.1.2. Teacher Teaching Module. This module combines knowledge about the structure of the course. It provides answers to students’ selection questions and supervises students’ learning behavior. The model is a concrete measure to achieve learning in an individual-oriented interactive way [20]. This module provides students with acceptable teaching strategies mainly based on learning requirements. Throughout the teaching and learning process, the teacher can collect student feedback through the Internet as a way to improve the teaching strategy database. At the same time, the students can use their own reasoning mechanism to provide intelligent guidance on problems encountered during the teaching process [21]. For any system information, the instructor’s teaching process is documented in the teacher teaching model database. This is necessary in order to document the teaching style and offer the assessment module [22].

3.1.3. Assessment Module. The assessment rules are used to analyze student responses, determine the ideas that students have grasped, and pass them to the learning unit of students. It employs artificial intelligence reasoning to create a thorough assessment of students’ learning behavior, attitude, effectiveness, and ability. The reasoning is based on data supplied by the student learning module and the instructor teaching module, as well as its rule base.

3.1.4. Human-Computer Interface. The Human-Computer Interface serves as a medium of communication between the students and the instructor. The system and the knowledge it provides must be well known to the students. The student login interface is shown in Figure 3.

According to their learning aptitude and history, the system may pick educational items that pupils have not yet acquired. It can also present the most suitable learning solution to students based on their historical selection records.

3.1.5. Functional Design of the Distance Learning System. In the backend database server, the system employs SQL Server 2000 and Internet Information Server 5.1 as the...
information server and C# as the design language [23]. The system uses a browser mode that is not limited by hardware and may be used to create cross-platform apps. It provides a variety of online learning support services for students, which plays an important role in boosting students’ learning effectiveness. Figure 4 depicts the software’s functional design.

As shown in Figure 5, the specific process of implementing the software is part of the evaluation module design.

Assume that the gathered data from student learning and teaching module are $m$, the storage rate is $v$, and the learning rate of the students is $v_1', v_2', \ldots, v_n'$. Then, the resulting data properties are as follows:

$$m = \{v_1', v_2', \ldots, v_n'\}, \{v_2', v_3', \ldots, v_n'\}, \{v_n'\}.$$  \hspace{1cm} (1)

Online assessments for various students’ learning progress can only be done once the system has been recorded. The system memo saves and mines the aforementioned attribute data. The mined data is normalized, and then the initial value of the online assessment can be derived after analysis, thus completing the data online assessment.

Personalized teaching is completely realized in the network environment to assist students’ autonomous learning, which is designed to lead students and may properly alter the learning content with reasoning and diagnostic functions [24]. Different pupils can learn instructional tactics that are tailored to their own knowledge levels. As a result, fair assessments of teaching and learning are made in order to improve students’ ability to learn independently. Distance education can give a tailored interface, paired with network technology, to increase the stimulation of students’ sensory thinking of learning and promote student motivation. The modular structure is utilized to keep the system’s common databases in the system independent of one another, thus improving the maintainability of the system [14].

4. Simulation Experiments

Simulation experiments are conducted to analyze the rationality of the design of the distance learning system verified.

4.1. Experimental Parameters and Environment Settings.

The experimental parameters are set as shown in Table 1.

As shown in Figure 6, the experimental environment is set up according to the above parameters.

4.2. System Interface Display.

The part of the interface of the teaching software is shown in Figure 7.

4.3. Results and Analysis.

Big data was used to compare and assess the educational impacts of the traditional distance education with new methods. The results show that the new method significantly improves learning effectiveness and student satisfaction.
The experimental results were based on a score of 500 students. The results of the two types of distance learning were compared in Table 2.

Table 2 shows that when the number of students is 200, the maximum score acquired using the old approach is 325, and when the number of students is 1,000, the lowest score produced using the traditional system is 265. The greatest score acquired by using the IoT-based distance learning system when the number of students is 400 is 485, and the lowest score obtained by using the IoT-based distance learning system when the number of students is 200 is 465. When the number of students is 600 using the distance learning system, the highest score is 480, and when the
As shown in Figure 8, the teaching efficiency of a traditional system is 92%, and that of the artificial intelligence system is 61% when the time is 10 seconds. After 20 seconds, the efficiency of a traditional system lowers down to 61%, whereas that of the artificial intelligence system goes up to 91%. The teaching efficiency of the traditional system is 92%, and that of the artificial intelligence system is 61% when the time is 30 seconds. When the time limit is 40 seconds, the traditional system’s teaching efficiency is 93 percent, while the artificial intelligence system’s teaching effectiveness is 62 percent. Initially, both systems are affected by the delay, which results in a lower teaching efficiency, but then the AI-based system moves faster and swiftly returns to the normal mode. In summary, the design of the distance learning system based on AI networks is reasonable.

5. Conclusion

There is a vital need to adapt to the new distance learning model for teaching vocal singing. Though student’s learning feedback allows timely access to students’ course learning records and adjustment to teaching content to meet learners’ requirements, there is an urgent need to adapt to the new distance learning model for traditional courses that must be taught one on one such as teaching voice singing. During the teaching of vocal singing, there is often high demand for equipment in terms of sound, such as radio, encoding, and playback, and low demand for images. The present distance learning course platform cannot fulfill the fundamental content of vocal music education, much alone promoting material-based and individualized teaching. In this paper, we propose a remote vocal singing course design based on an embedded system and the Internet of Things, which meets the basic needs of vocal teaching in terms of hardware. Throughout the monitoring phase, data collection is required to automatically enhance the guidance programs. It also improves teachers’ understanding of students’ singing levels and personalized teaching strategies for different students’ specified contents. Two approaches were used to the comparability and assessed the effectiveness of teaching. The results of the two methods were compared with each other, that is, the traditional learning and the distance learning system. In the end, it is observed that the distance learning system is fast and efficient.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References


