





Computer-Aided Simulation and Simulation of Virtual Vocal Performance Teaching Platform

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Abstract. In the past few years, under the guidance of the rapid development of information technology and the concept of smart education, a new era of "information technology + education" has been opened, and a new chapter in the development of education informatization has been entered. As an important supporting technology for smart education, virtual reality technology is subverting the traditional classroom learning and teaching mode of vocal music performance. This article uses computer-aided technology to build a set of high-simulation, multi-perceptual dimension virtual reality system; creates a multi-modal scene model, establishes a complete data transmission mechanism, and performs necessary optimization processing for the scene model; uses lattice technology Accurately simulate facial expressions and bind virtual characters in real time with the help of screen projection and transmission interaction technology; coordinate with positioning tracking technology to refine the gestures of virtual characters, and save key data under the multi-view recording of the virtual camera. The simulation training platform is mainly to construct a virtual environment through a combination of software and hardware to train students in operation; the platform should be highly similar to the actual equipment and instruments, and strive to achieve the best visual and tactile experience. The simulation training platform can effectively improve the teaching effect and efficiency, and there are many benefits.

Keywords: Computer-aided; virtual vocal performance; simulation and simulation

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1 INTRODUCTION

At this stage, in various higher skill education and teaching, the combination of theory and skills is

often emphasized, and students are required to be able to operate while understanding theory. Employment pressure is high and market competition is fierce. Hu [1] consider the more proficient and profound the students acquire through learning, the more they can increase their chances of winning in the fierce competition in the future. Therefore, how to cultivate students' skill level and how to make students faster, better and more accurate Mastering operational skills is a question that every educator will think about. Simulation operation training is model-based operation training, which is a way to use model simulation to replace real equipment for operation, experiment, and research. Including appearance simulation, operation simulation, visual experience simulation and so on. At this stage, simulation operation training has penetrated into all walks of life and is developing very rapidly, especially in higher-skill teaching positions, where it is widely used and has significant effects.

Advanced skills teaching is generally a teaching method that teachers combine theory and practice to enable students to master the theoretical foundation and operational skills, so as to achieve the training goals set by the talent training program. The operation skill training part is very important for students to complete the actual installation training process from zero to proficiency. If the simulation training platform can be used for training first, and the actual installation training will be carried out after the students are proficient to a certain level, I believe they will reach the highest level. Good results. The simulation training platform generally includes two parts: the hardware part and the software part. The hardware part mainly completes the tactile simulation, and the software part mainly completes the visual simulation. The combination of the two can achieve the effect of fake and real. Applying the simulation training platform to teaching and turning a boring classroom into a lively operation site will greatly increase students' interest in learning, which is very helpful to improve teaching efficiency. The virtual vocal performance teaching platform is shown in Figure 1.



Figure 1: Virtual vocal performance teaching platform.

For vocal music, due to its strong teaching practice, the emotional experience and expression in the singing process are extremely rich, and it is rarely used in the current virtual reality education field. In some of the few virtual reality teaching applications, there are problems of poor authenticity, unsatisfactory interactive experience, relatively single visual content of teaching, and poor fluency. These problems are mainly summarized as follows: First, some researchers use the virtual panoramic video technology (ArcSoft Panorama Maker) to produce three-dimensional panoramic image data, so that the singer can follow the preset teaching main line in the panoramic range for audio-visual interaction, and obtain different styles Audio-visual experience effect. There is a lack of in-depth interactive information in the perceptual experience, a lack of vivid expression of singing emotions and expression language, and it is difficult to establish in-depth interactive functions. The second is

that some researchers use the next-generation engine technology (VRPlat form) to produce depth information of the three-dimensional scene, which can provide users with a more comprehensive selection of scenes in singing interaction, and can also achieve certain facial expression binding. There is poor realism in rendering and fluency, graphics algorithms are not optimized enough, and real-time screen calculations are prone to freezes.

However, looking at the development history and current situation of vocal music performance teaching in colleges and universities, vocal music performance teaching in colleges and universities has continued the traditional "one-to-one" teaching communication mode and the teaching method of "experienced demonstration and imitation" for many years, that is, the "three-one" teaching method. "The teaching mode of a piano, a student, and a mirror. Zhang [2] think although this teaching model has undergone many years of practical verification and has certain scientific merit and rationality, it has gradually revealed some drawbacks. In order to more accurately grasp the status quo and problems of today's vocal music teaching model, the author chose a college student majoring in music performance to conduct interviews. In order to ensure the coverage of the survey subjects, the author set the number of interviews to four grades from freshman to senior A total of 40 students majoring in vocal music have collected 40 interview records. Li and Shi [3] think the recovery record is 100%, of which 40 are valid records. Through interviews and analysis of the collected data, it can be seen that the existing vocal music teaching methods are single, simple in methods, and limited in space. Students are prone to nervousness when learning in such an environment, and their interest in vocal learning is gradually eroded. Teng and Cai [4] consider the initiative and creativity of learning thinking are limited. On the other hand, the traditional vocal performance curriculum system is centered on imparting vocal performance skills and knowledge, and lacks guidance on the creation of musical space imagination and performance psychological mechanism of musical works, which directly leads to the limitation of students' emotional expression of works and the comprehensive quality of vocal performances. Farha et al. [5] think the problem of weak application ability is highlighted. At the same time, the low frequency of vocal face-to-face teaching and low efficiency of students' self-study after class have severely reduced the efficiency of vocal music learning. Limited by venues, funding and other reasons, there are few opportunities for students to practice stage performances in vocal performance teaching. Due to the lack of practical performance experience, many students' lack of stage awareness, self-expression, and work interpretation ability directly affect the teaching results of vocal performance, and greatly restrict the training of Chinese vocal performance professionals in the long run [6-7].

With the further development of science and technology, it has become the consensus of current scholars and educators to try to apply cutting-edge technology to all aspects of academic research and teaching practice activities. "Therefore, the field of vocal music performance is also actively trying to combine emerging technology with teaching practice. As a product of the new stage of information technology development, virtual reality technology is based on computer technology and integrates 3D graphics technology, multimedia technology, simulation technology, and sensor technology. Technology and three-dimensional display technology are equal. Computers or other output devices are used to simulate a three-dimensional virtual world, and an immersive environment is created by providing users with visual, auditory, and tactile sensory experiences. From the perspective of performance psychology, this immersive experience and imaginative guidance has theoretical basis and guiding significance for the practice and teaching of vocal music singing [8-10].

2 VIRTUAL VOCAL PERFORMANCE TEACHING PLATFORM

In order to make the purpose, technical solutions and advantages of this article clearer, the virtual vocal performance teaching platform proposed in this article will be described in further detail below in conjunction with Figure 2. Through virtual reality technology, a human-computer immersive interactive system for vocal music teaching, situational virtual scenes and high-simulation character models are realized, and the innovative practical application of virtual reality technology in vocal music teaching is demonstrated. Construct a set of high-simulation, multi-dimensional virtual reality

system: create a multi-modal scene model, establish a complete data transmission mechanism, and perform necessary optimization processing for the scene model; use dot matrix technology to accurately simulate facial expressions, and use projection The screen transmission interactive technology binds the virtual character in real time; cooperates with the positioning tracking technology to refine the virtual character's gesture movement, and complete the storage of key data under the multi-view recording of the virtual camera. Practice has proved that the system stimulates students' internal experience, stage presence, scene substitution and other perceptual experiences, so as to solve the problems of singing emotion experience and expression in the learning process of students in a targeted manner, and has strong practical application value.

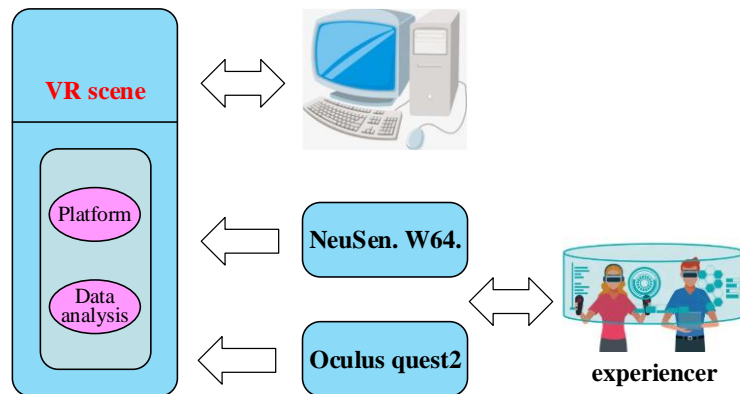


Figure 2: The proposed virtual vocal performance teaching platform.

This article provides a vocal music performance teaching method, including the following steps: 1. Construct a virtual three-dimensional vocal music performance teaching environment model to construct a learner model; 2. The learner wears a VR head-mounted display device so that the learner is located in the scene. Set a location to perform vocal music learning and performance in the virtual three-dimensional vocal music performance teaching environment scene; 3. The image acquisition device captures the image information of the learner's performance, and combines the image information with the virtual three-dimensional vocal music performance teaching environment scene model Fusion; 4. Design experiments, use virtual reality scene stimulation materials to stimulate learners to produce different emotions, and collect learners' brain electrical signals; 5. Combine learners' brain electrical signals from vocal learning when they are not using VR headsets, and Use VR equipment to compare the EEG signals after vocal music learning, and get the influence degree of different emotions generated by the learner under the stimulation of virtual reality scene on the singing state. According to the obtained results, adjust the virtual three-dimensional vocal music performance teaching environment scene model or adopt other ways to further enhance the teaching effect.

The construction of the interactive system of the virtual simulation teaching experiment platform for vocal music performance, using virtual reality technology to build a brand-new virtual space, such as an immersive vocal performance stage, allows participants to have a full range of immersive experience and achieve the effect of isolation from the real outside world. Participants are transformed into virtual characters and devote themselves to teaching-related heuristic and experiential teaching activities. The main system of the hardware equipment of the virtual simulation platform includes a head-mounted display system, data glove mutual equipment and sound sampling equipment, Insta360 pro2, remote multi-person transmission equipment system, etc. The main system of the virtual simulation platform software is based on Unity engine editing software and 720vr platform, Utovr video transmission software system, etc.

2.1 Material and its Preparation System

The basic functions of the multifunctional stage setting system include scene prop layout, stage lighting setting, 3D music sound effect setting, special effect creative tools, combined with image stabilization output, virtual microphone, VR video and audio recording, VR panoramic camera shooting, third angle In addition to teaching functions such as camera output, virtual simulation resource storage and retrieval, intelligent voice, intelligent AI and other technologies, "what you see is what you get" preview the movement of stage modules and set props in real time, bringing the static stage art of the two-dimensional world The form is upgraded to a high-dimensional dynamic interactive space. VR+ stage performances allow students to be immersive, such as being in a real stage scene or song content scene for singing practice and learning.

Acquisition, production and storage system of material library. Model, animation, and special effects are built through MAYA three-dimensional modeling software and AE special effects software. Use Noitom motion capture system and Leap motion gesture recognition system to create accurate and natural motion interaction materials, such as hands, body and facial expressions. The initial dynamic 3D model material and motion state data will be obtained, and the motion data will be extracted, detected and processed, and then transferred and transferred. The storage system is based on Mysql or SQL Server and supports PC and mobile terminal access. Teachers and students can extract the preset scene props, character actions, background music materials, stage lighting, etc. in the material library in real time, and call them in the virtual reality environment. Students and teachers can also make their own materials in the material library to gradually enrich and improve the material library.

This article is based on the following virtual reality vocal performance stage to illustrate the specific VR scene optimization method: Model creation method Model is very important in the production and experience of virtual reality. The structural accuracy of the model, the distribution of the patch, the accuracy and other issues will directly affect the degree of simulation and interaction of virtual reality. The scene model takes a T-shaped stage scene as an example. The main production method is the following 3 steps: 1) First, use the spline editing in 3ds Max to create a 3000cm (length) × 2200cm (width) × 1000cm (height) T Type stage, convert it into polygon editing, and weld each vertex into a whole to facilitate subsequent wiring and connection of each boundary; 2) Secondly, use grid wiring to process the details of the overall model, cooperate with connection, extrusion, and chamfering , Insert and other functions to refine the local structure of the stage model. For the shape of the center of the stage, the background, and the extension stage, the overall bridging process can be performed after independent modeling; 3) Finally, use geometric lofting with polygon editing, Create auxiliary models such as the auditorium around the stage and the top light stand. During the modeling process, mirroring and copying simple models can be used as the main method to gradually enrich the overall scene. The character model should be created under the box element. Use polygon editing to route the character's face and limbs as a whole, with quadrilateral wiring as the main route. Try to ensure that the main features of the facial features, limb joints and other areas that require virtual reality animation movement are focused on wiring, and the structure is refined. In some areas that do not participate in the animation movement, the number of model faces can be effectively controlled by means of collapse, patch merging, etc., as shown in Figure 3. The unavoidable triangle wiring in the model is placed in a hidden area where the character does not participate in the animation calculation, so as to avoid the model's unfavorable phenomena such as face wrinkles during the virtual reality animation process.

2.2 The Optimization Method of the Model

Import the model as a whole into Unity3D, set the frame rate of the preview virtual reality FPS frame rate to 70~90, detect the normals and vertices closure of the model face in the engine, and in the blueprint interface, through the method of code implantation Perform secondary optimization on the subtle parts of the scene to meet the optimization work of the model's geometric segmentation, spatial coordinates, patch processing, rendering and baking.

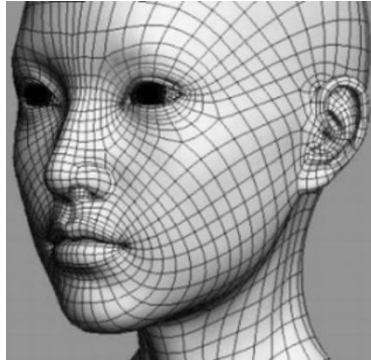


Figure 3: Facial features.

The image acquisition device captures the image information of the learner's performance, and integrates the image information with the virtual three-dimensional vocal music performance teaching environment scene model; the solution provided in this article can capture the learner's facial conditions, gestures, or other physical actions. Now let's make a detailed introduction to the technology of face capture and gesture capture: The method of face capture refers to the process of using mechanical devices, cameras and other equipment to record human facial expressions and actions, and convert them into a series of parameter data. Today's technology is relatively mature, and optical motion capture is widely used, which accomplishes the task of motion capture by monitoring and tracking specific light points on the target. Common optical motion capture is mostly based on the principles of computer vision. Theoretically speaking, for a point in space, as long as it can be seen by two cameras at the same time, the position of the point in space at this moment can be determined based on the images taken by the two cameras at the same time and the camera parameters. When the camera continuously shoots at a high enough rate, the trajectory of the point can be obtained from the image sequence.

Due to the structured light principle adopted by the system, it is necessary to determine the face shape by projecting light in the direction of the face, and then reading the light information data on the surface of the object. For this reason, when choosing a face acquisition device, in addition to a distance sensor, microphone, and front camera, it also needs to have an infrared lens, floodlight, floodlight sensor and dot-matrix projector arranged in sequence. Under normal circumstances, the dot matrix projector can project a dot matrix composed of more than 30,000 invisible light points to the human face. The dot matrix pattern needs to be read through an infrared lens and combined with the face captured by the front camera. Simultaneous calculation, and then obtain the depth information of facial expressions, that is, the real three-dimensional model of the face.

3 FUNCTION ANALYSIS OF VIRTUAL VOCAL MUSIC PERFORMANCE TEACHING PLATFORM

Use virtual reality technology to construct a new virtual space, such as an immersive vocal performance stage, so that participants can have a full range of immersive experience and achieve the effect of isolation from the real outside world, so that participants can become virtual characters and devote themselves to enlightenment and experiential teaching activities. The main system of the hardware equipment of the virtual simulation platform includes a head-mounted display system, data glove interaction equipment and sound sampling equipment, In-sta360pr02, remote multi-person transmission equipment system, etc. The main system of the virtual simulation platform software is based on unity engine editing software, 720vr platform and utovr video transmission software system. The error variation is shown in Figure 4.

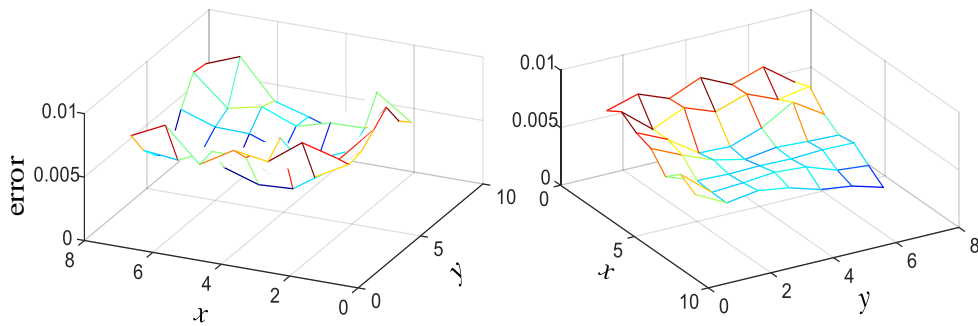


Figure 4: Error variation.

3.1 Material and its Preparation System

Multifunctional stage setting. The basic functions of the system include scene prop layout, stage lighting setting, 3D music sound effect setting and special effect creative tools, combined with image stabilization output, virtual microphone, VR video and audio recording, VR panoramic camera shooting, third-angle camera output, virtual simulation resource storage Using intelligent voice, intelligent AI and other teaching functions, "what you see is what you get" previews the movement of stage modules and set props in real time, and upgrade the static stage art form of the two-dimensional world to high-dimensional dynamic interaction Space allows students to be immersive, such as being in a real stage scene or song content scene for singing practice and learning.

Material library acquisition, production and storage system. Model, animation, and special effects are built through MAYA three-dimensional modeling software and AE special effects software. Use Noitom motion capture system and Leapmotion gesture recognition system to create accurate and natural motion interaction materials, such as hands, body and facial expressions. The initial dynamic 3D model material and motion state data will be obtained, and the motion data will be extracted, detected and processed, and then transferred and transferred. The storage system is in Mysql or SQLSeIVer, and supports PC and mobile terminal access. Teachers and students can extract the preset scene props, character actions, background music materials, stage lighting, etc. in the material library in real time, and call them in the virtual reality environment. Students and teachers can also make their own materials in the material library to gradually enrich and improve the material library. The sound simulation is shown in Figure 5.

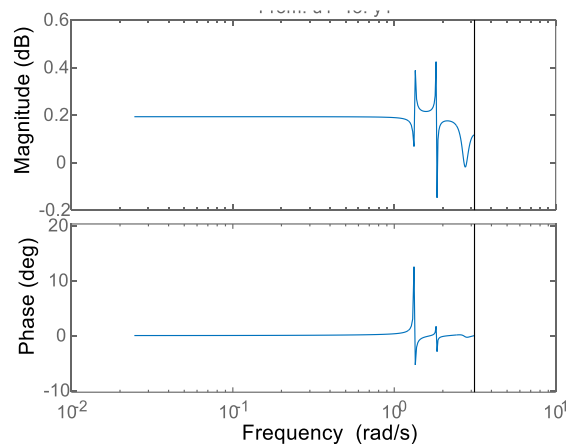


Figure 5: Sound simulation.

3.2 Teaching Implementation System

The remote multi-person real-time collaborative rehearsal system is a remote multi-person collaborative system based on the wide-area Internet, breaking the traditional restrictions on the development of teaching applications and the restrictions on the number of people. Thanks to the high speed and low latency of 5G, teachers, students and piano or band accompaniment will be able to share this system in real time in different places. Online teaching system In the VR virtual environment, the teacher can create one-to-one individual rooms, or one-to-many rooms, and can set whether to watch, mute, speak in order, lock the room and other functions, through multi-person voice, multi-person Video data transmission mode for online teaching. To achieve the establishment of a multimedia vocal music resource library, students can call multimedia learning resources at any time, and realize online personalized and autonomous learning mode. The amplitude variation is shown in Figure 6.

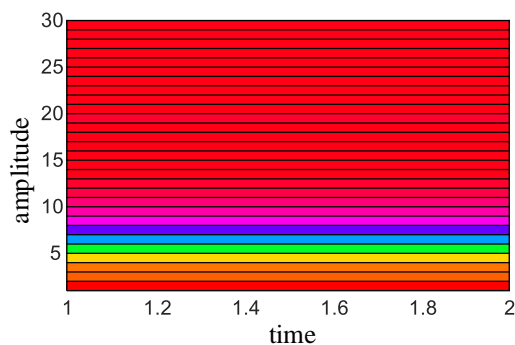


Figure 6: Amplitude.

3.3 Scoring Evaluation System

Through the custom compiled scoring evaluation system, it can effectively track and analyze the learning process of students after class. Students record audio and video on the platform, upload to the cloud server, and the teacher downloads from the cloud server and gives effective feedback in time and suggestions for improvement. The assessment system has user identity management, user authentication and authorization level recognition and other management functions, as well as virus defense functions. Teachers can issue announcements, upload learning resources, create new tasks, customize assessment time, and support students' internal discussion, upload and release Works etc. The radar map is shown in Figure 7. The predicted values are shown in Figure 8.

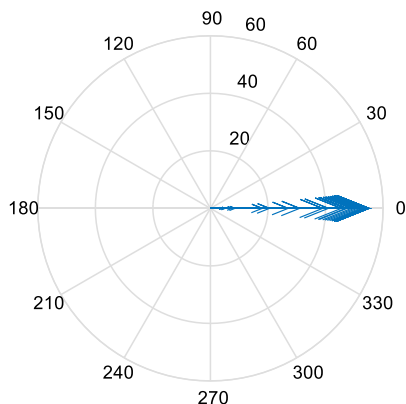


Figure 7: Radar map.

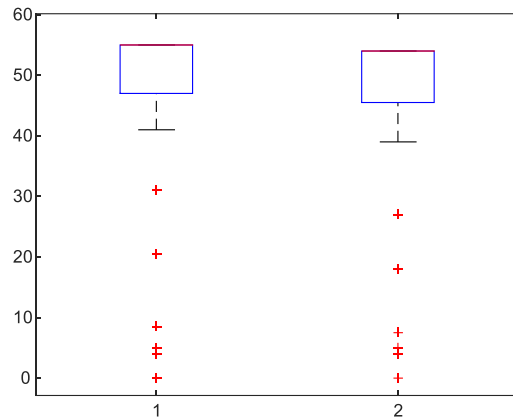


Figure 8: The predicted values.

4 CONCLUSION

In the past few years, under the guidance of the rapid development of information technology and the concept of smart education, a new era of "information technology + education" has been opened, and a new chapter in the development of education informatization has been entered. As an important supporting technology for smart education, virtual reality technology is subverting the traditional classroom learning and teaching mode of vocal music performance. This article uses computer-aided technology to build a set of high-simulation, multi-perceptual dimension virtual reality system; creates a multi-modal scene model, establishes a complete data transmission mechanism, and performs necessary optimization processing for the scene model; uses lattice technology Accurately simulate facial expressions and bind virtual characters in real time with the help of screen projection and transmission interaction technology; coordinate with positioning tracking technology to refine the gestures of virtual characters, and save key data under the multi-view recording of the virtual camera. The simulation training platform is mainly to construct a virtual environment through a combination of software and hardware to train students in operation; the platform should be highly similar to the actual equipment and instruments, and strive to achieve the best visual and tactile experience. The simulation training platform can effectively improve the teaching effect and efficiency, and there are many benefits.

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