Research Article

Artificial Intelligence in Construction of English Classroom Situational Teaching Mode Based on Digital Twin Technology

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It is combined the digital twin technology to construct the English classroom situational teaching mode. The system uses advanced virtual reality technology and computer image technology and combines with video and audio synchronization processing technology to provide a new set of methods for students’ language learning. The scene interactive teaching system’s graphics rendering server produce and create 3D virtual scenes or actual photos in real time. Furthermore, according to the English classroom teaching situation, this paper constructs the functional modules of the situational teaching system, conducts an in-depth analysis of the system implementation methods, expresses the system core algorithm flow in the form of diagrams and tables, and obtains the overall system framework. Finally, it is evaluated the effect of the English classroom situational teaching model proposed in this paper through experimental research. From the experimental results, it can be seen that the teaching model proposed in this paper is very effective.

1. Introduction

With the rapid development of video capture, graphics and image processing technology, network technology, and other technologies, it has become a reality to simulate real life scenes on a computer by constructing virtual reality scenes. It is needed for a system, which allow students to practice language dialogue in an environment same as a real scene, so that their listening and speaking ability in foreign languages can be effectively exercised. At the same time, the system can use cartoon characters to communicate with users. In addition, it improves the interest of elementary and middle school students in learning foreign languages and enables students to learn languages in an atmosphere of interest. The system is to use virtual technology to simulate teaching scenes that are difficult to explain and to visualize it so that users can better learn related skills under visualization and participation [1].

Multimedia technology has increased swiftly with the advancement of science and technology, and its application has expanded to all facets of the national economy and social life, resulting in massive changes in human production techniques, working ways, and even lifestyles. Multimedia technology, therefore, has a good impact on education and may give students with the best possible learning environment. The multimedia technology utilized in education is known as the situational interactive teaching system. The system may perform virtual situational teaching, practice language listening, and speaking in real-life circumstances and includes a number of features and functions that are especially useful in educational and instructional procedures [2].

In our nation, the English classroom is the primary location for students to improve their language skills. How instructors plan classroom practice activities and give as many chances for language practice as feasible has a critical role in enhancing students’ English proficiency, particularly in listening and speaking, throughout the teaching process. As a result, the situational interactive teaching system creates an excellent practice environment in the English classroom by recreating difficult-to-explain teaching settings so that students may practice English hearing and speaking in
a virtual setting to improve their listening and speaking skills. Multimedia technology has unique elements such as human-computer interaction and instant response that are not found in any other medium. The multimedia computer also integrates the television’s audio-visual function with the computer’s interactive function to create a novel and colorful human-computer interaction approach that includes both graphics and text. This interactive strategy is crucial to the teaching process because it may successfully pique students’ interest in learning, create a strong desire to study, and develop learning motivation. Multimedia computers are the only ones that have interactivity. Multimedia computers, exactly because of this feature, are not only a tool of teaching, but also a significant role in transforming conventional teaching methods and even teaching concepts. [3].

It is combined the digital twin technology to construct the English classroom situational teaching mode, and the English classroom is the main practice place for students. In the teaching process, this paper introduces or creates vivid and concrete scenes, which is conducive to the construction of meaning for students to generate communicative motivation.

2. Related Work

The situational teaching method was born in the United Kingdom. The situational teaching method requires teachers to construct purposeful situational scenes, situational cases, and situational tools for the teaching content before teaching [4]. In the situational teaching scene, the instructor needs to use simple or complex “scene props” (teaching tools) according to the course to induce learners to think independently and make them enter the role in the built environment to deepen their understanding of teaching content [5].

It is same with situational MOOC videos. Among them, the instructor can combine the content displayed in text, pictures, and videos with real work scenes, life scenes, and learning scenes, which is beneficial to improve the learning efficiency of learners. Emotional experience is another feature of the situational teaching method. The application of emotional experience in the situational teaching method is to eliminate learners’ resistance and fatigue caused by long-term boring learning. The sublimation of emotional experience will enable learners to connect with their own reality in the learning environment, thereby gaining the driving force for learning [6].

The literature [7] carried out an educational project that spread the concept of wave energy to high school students based on physics and developed a virtual reality system combining software and hardware to simulate the interaction between buoys and waves for students to experience. The literature [8] used experiential learning to explain the differences in subject interest. The research results show that male students are more interested in experiential learning in physics, while female students are more interested in experiential learning in biology and chemistry. Therefore, future teaching can be considered to match the students’ interests and deepen the connection with students’ lives. The literature [9] conducted research on experiential learning in English subject based on digital software. The research results proving that experiential learning can increase students’ interest in English learning through rich language experiments, and students can use a pleasant way to practice language and grammar, thereby improving learning efficiency.

A study on the impact of experiential learning on teachers’ classroom practice was published in the literature [10]. The findings reveal that instructors have a deeper comprehension of things and a better understanding of themselves as a consequence of their own personal experiences. When they explain things to pupils, they often produce a variety of learning impacts as well as a unique experience effect for themselves and others. The literature [11] created experiential learning classes for students and documented how students changed over the process. Students are able to apply what they have learned in earlier classes to real-world situations while also increasing their writing and communication abilities, as well as their ability to evaluate and synthesize data. These abilities are necessary for academic success in a number of fields. The literature [12] provided a way for preservice teachers to engage in experiential learning activities to improve their topic knowledge and abilities. The suggested framework may be used to teach a variety of courses in a variety of settings. Project study on experiential learning in games was undertaken in the literature [13], in which students participated in games to experience and learn. The findings of the study demonstrate that using an experiential learning paradigm might make teaching and learning games more effective and enjoyable. The present circumstances and motives for using experiential learning in the classroom were examined in the literature [14]. Furthermore, it is considered that instructors lack the competence to manage everything in the classroom, that teachers lack the abilities to employ learning aids, that teachers do not completely get the spirit of the new curriculum, and that teachers consistently misuse numerous experiential techniques.

3. Mapping Rules from Image to Sound

The conversion from image to sound is mainly reflected in mapping image features to sound parameters. Image features usually refer to the significant basic features or characteristics in the image. Feature extraction is to extract the physical characteristics, geometric characteristics, and other information of the target from the image, such as color, brightness, shape, area, curvature, and distance. The sound parameters usually include frequency, amplitude, tone, duration, and stereo position. Usually, one dimension of image information is mapped to a certain dimension parameter of sound, or several dimensions of image parameters are mapped to sound output simultaneously. When the users with visual impairment are in the mobile state, it is needed to quickly understand the surrounding environment, especially the situation in the direction of advance, in order to make the choice of avoiding or advancing. In this case, the demand for specific target recognition is not high, and the speed requirement is put in the first place, to quickly reflect the information collected by the camera to the user with some simple prompt effect [15].
3.1. Mapping from Image to Sound. In order to obtain high resolution, the image is expressed as sound in the form of time division multiplexing. Whenever the first \((k - 1)\) images are processed, the new \(k\)-th image is sampled, digitized, and cached as an \(M \times N\) pixel matrix \(P^k\). This process takes \(\tau\) seconds. In this process, a recognizable logo is placed at the beginning of a new image or at the end of the previous image. The value \(P_{ij}^{(k)}\) of each element in the pixel matrix is a value of an image gray tone \(G\), such as \([16]\):

\[
P^{(k)} = \left(\left(\begin{array}{c} P_{ij}^{(k)} \\ P_{ij}^{(k)} \end{array}\right), P_{ij}^{(k)} \in \{g_1, ..., g_G\}, i = 1, \ldots, M, j = 1, \ldots, N.\right)
\]

Therefore, when the image starts to be converted to sound, it starts from one of the \(N\) columns at the same time and starts from the \(j\)th column \([19]\). Figure 1 describes the conversion principle of a simple example \([17]\). The image in the example is a \(8 \times 8\) picture with 3 kinds of gray tones \((M = N = 8, G = 3)\).

During mapping conversion, for each pixel, the vertical axis position corresponds to the frequency, the horizontal position corresponds to the time axis, and the brightness corresponds to the oscillation amplitude. It takes \(T\) seconds to obtain a new pixel matrix \(P^k\). This process is generated in \(T/N\) seconds. On the other hand, each column \(j\) in the column excites a corresponding sinusoidal oscillation in the frequency range of the sound. Based on different forms of quadrature sinusoidal oscillators, we assume that their frequencies are all integer multiples of some fundamental frequencies. It will ensure that the information of these sinusoidal oscillation waves is well preserved in the conversion from geometric space to Hilbert space. A pixel \(i\) at a higher longitudinal position corresponds to a higher frequency oscillating wave \(f_i\). The greater the brightness of the pixel expressed in the form of \(P_{ij}^{(k)}\), the higher the amplitude of the corresponding oscillating wave. When \(M\) oscillating signals in the same column are superimposed together, the mapped sound is defined in \(T/N\) seconds. Then, the \((j + 1)\)-th column is converted into sound, and this process is repeated until the \(N\)-th column of the rightmost column is converted into sound. From the beginning of the conversion, the total time is \(T\) seconds \([18]\). Subsequently, it still takes \(\tau\) seconds to obtain a new pixel matrix \(P^{(k+1)}\). At the same time, the image separation system continues to work to prepare material for the next mapping. Make sure that the time \(\tau\) to acquire the image is much less than the conversion time \(T\), that is, \(\tau \ll T\). Once a new pixel matrix is buffered, the image-to-sound mapping conversion immediately starts from the leftmost column. Therefore, every \(\tau + T\) seconds, this conversion returns to a specific column \([19]\).

\[
\omega_i = 2\pi f_i.
\]

The conversion formula can be expressed as

\[
s(t) = \sum_{i=1}^{M} P_{ij}^{(k)} \sin \left(\omega_i t + \phi_i^{(k)}\right).
\]
applied, because the current timing method can meet the basic requirements without more hardware investment \[22\].

The \( M \times N \) brightness value is transmitted in \( T \) seconds, and each brightness value is selected from the possible set of \( G \). The transmission speed per second reaches \( I \) bits, which is expressed by the formula:

\[
I = \frac{MN \cdot 2 \log (G)}{T}
\]

(7)

In order to prevent the loss of information during the conversion process, we need to strictly limit the values of \( M, N, G \), and \( T \), and even we need to take the human ear into consideration.

The brightness value of \( G \) is allowed to be superimposed in the process of corresponding to the amplitude of the signal. The amplitude conveys the information of the image, and these periodic signals themselves and their superposition together reflect the given amplitude, even if their number is large or even unlimited. When monitoring the information of the Fourier parameters, the brightness range of \( G \) can be reproduced within the range that the human ear can recognize. For the convenience of analysis, we will consider a very simple image sequence: all images are black, and only a bright pixel \((i',j')\) exists in the \( k\)-th image, such as

\[
P_{ij}^{(k)} = 0, \forall i, j \setminus \{i = i', j = j', k = k'\}.
\]

(8)

By lowering the pitch,

\[
s(t) = \begin{cases} P_{ij}^{(k)} \sin (\omega_2t) & t^{(1)} \leq t < t^{(2)} \\ 0 & \text{otherwise} \end{cases}.
\]

(9)

Among them,

\[
t^{(2)} - t^{(1)} = \frac{T}{N}.
\]

(10)

when ignoring the influence of horizontal synchronization confirmation, the Fourier transform can significantly eliminate the crosstalk between multiple sinusoidal signals that occurs within \( T/N \) seconds, and the isolation frequency step \( \Delta f \) between the signals can be set to \( 2/(T/N) \) Hz. In this way, the oscillation values of two adjacent pixels in the vertical position can be well represented. For the equidistant frequency stepwise setting \( \Delta f = B/(M - 1) \), the bandwidth is \( B \) Hz. At this time, the crosstalk limit becomes

\[
(M - 1)N \leq \frac{B \cdot T}{2},
\]

(11)

\[
B = 5\text{kHz}, T = 1s, M = N, M \leq 50.
\]

The images used in this experiment are assumed to be “frozen” state, which can be converted at least in the \( t \) time range without losing the current image content due to the new scene transformation. However, the human brain also has limitations in the time domain of receiving and understanding information. An excellent way is to have a thorough comprehension of the prior information, so that when the next picture appears, it is only sensitive to the parts of the image that have changed. Although the visual reaction time for typical individuals is just a few percent of a second most of the time, it is sufficient to allow him to recall significant data. A bystander, for example, will notice when a door is opened or a coffee cup is taken up. People will evaluate more environmental information if there is more time. Naturally, the brain learns the necessary information in a matter of seconds, such as speaking or moving. As a result, our conversion time unit \( t \) is roughly 1 second, and the corresponding time is substantially less than 1 second, allowing us to prevent fuzzy pictures while still giving us enough time to convey image data to the sound channel. The human auditory bandwidth is about 20 kHz, but the available bandwidth is usually no more than 5-6 kHz.

In addition, it should be noted that the quality of the conversion also depends on the situation of the image. The situation corresponding to the above formula is the situation where there are some bright pigments in each column, assuming a completely black background. The greatest crosstalk must occur between the closest points, but it is actually found that crosstalk will also occur between two bright spots with a large distance. Therefore, it is easier to find small bright spots on a dark background than dark spots on a bright background.

In order to meet the higher-level needs of users, another part of the experiment is to add part of the content of pattern recognition in a static state to help users understand the shape characteristics of the target object. For different
situations in a changeable environment, image features must be invariant to their translation, rotation, and scale transformation. That is, no matter what kind of translation, rotation, and zooming in or zooming out of the recognized image, it can still be correctly recognized.

For the continuous gray function \( f(x, y) \), the \((p + q)\)-order two-dimensional origin moment \( M_{pq} \) is defined as

\[
M_{pq} = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} x^{p} y^{q} f(x, y) \, dx \, dy, \quad p, q = 0, 1, 2.
\]

\( f(x, y) \) is a piecewise continuous bounded function and has a nonzero value in a finite area on the \( x \) and \( y \) planes. According to the uniqueness theorem, each moment is uniquely determined by \( f(x, y) \). Correspondingly, \( f(x, y) \) is uniquely determined by its moments. In addition, the \((p + q)\)-th order central moment \( \mu_{pq} \) of \( f(x, y) \) can be defined.

\[
\mu_{pq} = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} (x - \bar{x})^{p} (y - \bar{y})^{q} f(x, y) \, dx \, dy, \quad p, q = 0, 1, 2.
\] (13)

For a \( M \times N \) discrete digital image \( f(i, j) \), its \( pq \)-order geometric moment and central moment are, respectively,

\[
m_{pq} = \sum_{i=1}^{M} \sum_{j=1}^{N} i^{p} j^{q} f(i, j),
\]

\[
\mu_{pq} = \sum_{i=1}^{M} \sum_{j=1}^{N} (i - \bar{i})^{p} (j - \bar{j})^{q} f(i, j), \quad p, q = 0, 1, 2.
\] (14)

In the formula,

\[
\bar{x} = m_{10}/m_{00}, \quad \bar{y} = m_{01}/m_{00}
\] (15)
is the center of gravity of the image, and \( m_{00} = \mu_{00} \) can be obtained. For grayscale images, \( \mu_{00} \) is equivalent to the quality of the image. However, for a binary image, \( \mu_{00} \) is equivalent to the area of the image.

The geometric moment and central moment of the image can describe the shape of the image, and the central moment has nothing to do with the translation of the image. The zero-order central moment \( \mu_{00} \) is used to normalize the other central moments, and the normalized central moment of the image can be obtained [23]:

\[
\eta_{pq} = \frac{\mu_{pq}}{\mu_{00}} \quad y = (p + q + 2)/2. \tag{16}
\]

The English classroom scenario teaching method is constructed using digital twin technology in this article. To assess object depth, defocus 3D measurement directly leverages the link between object depth, camera settings, and picture ambiguity. The idea of 3D measuring is shown in Figure 2.

Because of the optical defocus, the imaging system becomes the result of the scene and the imaging system. Fuzzy edges in the image may result from the sharp edge of the scene being defocused and blurred by the imaging system or the result of the soft edge of the scene being sharply focused and imaged by the imaging system. Therefore, it is necessary to capture at least two images with different defocus degrees of the scene simultaneously and then solve the defocus value \( u \) to eliminate the influence of the unknown light intensity distribution of the scene on the defocus value. Two images with different degrees of triangulation are obtained by changing the distance \( s \) from the image detector to the lens. Figure 3 shows the imaging principle of a telecentric lens.

Three-dimensional virtual sceneries or real-life photos must be loaded into the English scene interactive education system. After the matting process, the system host executes digital real-time synthesis of the performance picture and the three-dimensional virtual scene or actual image to accomplish integration. Finally, the synthesized video images are exported to a streaming media publishing system or a huge screen for onsite instruction. Simultaneously, the learning material in the classroom may utilize the situational interactive teaching system’s local collection unit, and it can be saved in real time for subsequent use. Figure 4 depicts the system structure diagram.

The main function of the video capture module is to use the camera to collect real-time video and real-time sound collection or select the recorded video to add to the selected scene to perform video synthesis. This module has some controls to control the playback, pause, and stop of the loaded video. When we click the keying button, we can click the background color that needs to be keyed out in the capture video frame. At the same time, we can drag the slider or manually enter the parameters to adjust the threshold of the

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**Table 1: Statistical table of the digital effect of the English classroom situational teaching model based on the digital twin technology.**

| No. | Situational evaluation | No. | Situational evaluation | No. | Situational evaluation |
|-----|------------------------|-----|------------------------|-----|------------------------|
| 1   | 78.47                  | 28  | 93.92                  | 55  | 79.16                  |
| 2   | 90.65                  | 29  | 90.11                  | 56  | 84.87                  |
| 3   | 87.34                  | 30  | 77.95                  | 57  | 88.73                  |
| 4   | 86.82                  | 31  | 87.44                  | 58  | 84.68                  |
| 5   | 89.52                  | 32  | 77.76                  | 59  | 84.58                  |
| 6   | 85.58                  | 33  | 77.63                  | 60  | 81.84                  |
| 7   | 86.32                  | 34  | 83.17                  | 61  | 92.03                  |
| 8   | 86.45                  | 35  | 87.37                  | 62  | 82.95                  |
| 9   | 92.88                  | 36  | 78.50                  | 63  | 82.76                  |
| 10  | 92.09                  | 37  | 92.58                  | 64  | 85.64                  |
| 11  | 87.56                  | 38  | 76.61                  | 65  | 82.42                  |
| 12  | 77.28                  | 39  | 87.55                  | 66  | 86.86                  |
| 13  | 92.80                  | 40  | 91.08                  | 67  | 80.34                  |
| 14  | 87.11                  | 41  | 78.20                  | 68  | 88.42                  |
| 15  | 85.69                  | 42  | 80.88                  | 69  | 81.59                  |
| 16  | 90.33                  | 43  | 85.75                  | 70  | 84.01                  |
| 17  | 88.64                  | 44  | 89.77                  | 71  | 77.39                  |
| 18  | 86.00                  | 45  | 79.77                  | 72  | 91.54                  |
| 19  | 92.87                  | 46  | 84.85                  | 73  | 89.53                  |
| 20  | 81.98                  | 47  | 77.96                  | 74  | 93.95                  |
| 21  | 92.09                  | 48  | 79.84                  | 75  | 90.42                  |
| 22  | 80.67                  | 49  | 92.19                  | 76  | 78.11                  |
| 23  | 93.95                  | 50  | 90.92                  | 77  | 77.06                  |
| 24  | 80.77                  | 51  | 93.18                  | 78  | 86.98                  |
| 25  | 82.99                  | 52  | 77.62                  | 79  | 77.42                  |
| 26  | 79.74                  | 53  | 84.30                  | 80  | 80.28                  |
| 27  | 79.16                  | 54  | 81.08                  | 81  | 91.92                  |

---

**Figure 8: Statistical diagram of the digital effect of the English classroom situational teaching model based on the digital twin technology.**

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![Figure 8](image-url)
keying and crop the input video. This module is mainly used to collect and process video and audio. The design of the video acquisition module is shown in Figure 5.

The function of the camera animation is to set the camera animation in the virtual scene, push and pull the lens, manually set the key frame, and create the camera animation to make the synthesized video more colorful. The design of the control module is shown in Figure 6.

The English scene interactive teaching system uses the backdrop to call the standard virtual scene model sequence file created by digital twin technology and conducts real-time three-dimensional filling and rendering on the Open-GL graphics platform in response to camera parameter adjustments. Figure 7 depicts the scene management module’s design.

### 4. System Test

This paper constructs an English classroom situational teaching model based on digital twin technology and constructs a corresponding system. On this basis, the performance of the system is verified. Therefore, this paper verifies the digital transformation effect of the system constructed in this paper and evaluates the quality of English classroom situational teaching on this basis. First of all, this paper carries out the evaluation of the digital processing effect of the English teaching resources of the system constructed in this paper, as shown in Table 1 and Figure 8.

According to the above analysis results, the English classroom situational teaching model based on digital twin technology developed in this paper can effectively transform the traditional teaching model into a digital three-dimensional teaching model, providing students with a spatial learning experience and a sense of immersion. This article uses scoring to assess the effectiveness of the English classroom situational teaching paradigm on this foundation. Table 2 and Figure 9 illustrate the outcomes.

From the above analysis results, the English classroom situational teaching model based on digital twin technology constructed in this paper has certain effects and can effectively improve the quality of English teaching.

### 5. Conclusion

It is combined the digital twin technology to construct the English classroom situational teaching mode, and the English classroom is the main practice place for students. It is conducive to the construction of meaning for students to generate communicative motivation by introducing or creating vivid and concrete scenes in the teaching process. Moreover, the virtual scene provided by the situational interactive teaching system can provide an intuitive and vivid image, the performance in the virtual scene reproduced by a large screen or projection can allow students to feel the scene and produce imagination and association through vision and hearing, and it can stimulate students’ interest in learning. At the same time, the situational interactive teaching system uses advanced virtual reality
technology and computer image technology, and it combines video and audio synchronization processing technology to provide a set of new methods for students' language learning. In addition, the graphics rendering server of the scene interactive teaching system renders and generates three-dimensional virtual scenes or real-life images in real-time. Finally, it is combined with experimental analysis to prove the proposed method's effectiveness further.

**Data Availability**

The data used to support the findings of this study are included within the article.

**Disclosure**

Preprint has previously been published [24].

**Conflicts of Interest**

The authors declare no conflicts of interest.

**Authors’ Contributions**

Shan Gu drafted the manuscript, Rongrong Yang contributed to the programming and data analysis, Si Zhang and Yuji Miao compiled the questionnaire, Shan Gu and Si Zhang collected the data, and Shan Gu designed the study and revised the manuscript. All authors provided critical revisions and approved the final manuscript.

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