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Retraction

Retracted: Immersive Virtual Reality Teaching in Colleges and Universities Based on Vision Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

1. Discrepancies in scope
2. Discrepancies in the description of the research reported
3. Discrepancies between the availability of data and the research described
4. Inappropriate citations
5. Incoherent, meaningless and/or irrelevant content included in the article
6. Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] Y. Liu, T. Liu, and Q. Ma, "Immersive Virtual Reality Teaching in Colleges and Universities Based on Vision Sensors," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 5790491, 14 pages, 2022.

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Research Article

Immersive Virtual Reality Teaching in Colleges and Universities Based on Vision Sensors

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With the progress of society and the development of economy, people pay more and more attention to education, and traditional teaching methods are gradually unable to meet the modern teaching system. As a leader in modern information technology, virtual reality technology has developed rapidly in recent years, and virtual reality technology has also been introduced into many fields, such as teaching. Based on the immersive and extended characteristics of virtual reality, this paper proposes a virtual reality active visual interaction method based on the visual sensor. Based on virtual teaching, after 3 months of learning, the average, standard deviation, and average standard error of the experimental group's performance are higher than those of the control group. Compared with the control group, the experimental group's performance has increased by 8.25%. The difference is statistically significant. Learning significance ($P < 0.05$), immersive virtual reality teaching has played a significant role in the effect, which can greatly improve the cognitive experience of students and achieve a good learning experience and effect.

1. Introduction

The continuous renewal of technology means the continuous development of the information technology revolution and the emergence of today's hot spot immersive virtual reality technology. As a new medium, immersive virtual reality enables more information to be transmitted, which makes it easier for people to obtain, process, and express information. The virtual world is immersive and entangled. Everything in the virtual reality world has its specific symbol information, and the experiencer in the virtual world will feel the cognitive and thinking changes it brings to humans. However, only relying on the information conveyed by the hot media is far from enough for people to deeply understand the real world and to reshape the real world. Immersive virtual reality teaching can solve teaching scenarios that cannot be achieved in traditional classroom teaching. It can be three-dimensional and visualize abstract knowledge content. Students wearing virtual reality equipment can be completely immersed in the constructed virtual reality classroom environment. The things in the interaction get the feeling and experience like reality. Such a game-like, traversing, and experiential classroom allows students to enjoy learning and at the same time promote the development of their cognition [1].

At present, there are still some problems in classroom teaching, such as students' lack of interest, lack of mastery of key and difficult knowledge, and poor practical ability. If the immersive virtual reality system is applied to classroom teaching, it can build a three-dimensional visual scene of things, let students experience the occurrence and development process of things, and greatly increase the interest in the teaching process. Displaying objects can increase students' perceptual cognition, give full play to students' initiative, and improve students' understanding and mastery of knowledge. In addition, the virtual reality system has good interactivity, which can timely feedback the students' mastery of knowledge, so that teachers can timely adjust the scheme and teach students according to their aptitude, which is more conducive to the breakthrough of students' key and difficult points in knowledge and the improvement of the education level.

The rapid development of immersive technology has opened up possibilities for the use of augmented reality, mixed reality, and virtual reality in education. Nunes et al. outlined a study that integrated two different technologies through a solution called Sloodle. The main focus is to demystify the use of this solution, introduce the main process of installing and inserting this resource, and evaluate the effectiveness of these resources as supporting tools in the teaching of computer engineering courses. The application used in the research is IDEOne, an online software for algorithm exposure, and Sloodle as a virtual world. The analysis confirmed that the combination of the use of the virtual world and the use of Sloodle's Moodle is an effective alternative teaching and learning process, which can inspire students and stimulate immersion in the performance process [2]. Ma mainly learns English skills in the home virtual reality technology education process based on artificial intelligence and machine learning. Through comparative experiments on two first-year university students, the experimental class provides fascinating situational education based on virtual reality technology from the perspective of constructivism, while the control class provides standard multimedia and traditional educational equipment. Research results show that immersive virtual reality teaching can effectively improve students' English learning ability [3]. In recent years, a new wave of virtual reality (VR) and immersive media has been welcomed by audiences and creators around the world. Dooley et al. reports on six case studies from three Australian universities to explore the nature of the teaching-research relationship surrounding immersive media practices. The academic experience is diverse and complex, and various inquiry-based learning methods are used at the undergraduate and graduate levels, covering areas such as writing, production, postproduction, and viewing. Research on these aspects enables students to seek knowledge and new understanding of media forms, and Dooley et al. believes that this experience is essential for the development of higher-level skills [4]. Garstki et al. outline a pilot project that uses previously captured 3D data in a large-scale immersive environment to supplement the teaching of basic archaeological concepts in the introductory course of anthropology for undergraduates. The flexibility of the platform allows the investigation of excavation trenches in three dimensions, enhances the understanding of excavation methods, and provides additional insights into the selection of excavators. In addition, the virtual survey of cultural relics provides students with a more complete way to interact with objects on the other side of the world. The teacher-led immersive virtual experience has great potential to expand archaeological interest and strengthen the teaching of archaeological concepts. They allow students to interact with content in the presence of each other under the guidance of experts [5]. Stoji et al. presented a literature review on the application of augmented reality and virtual reality in geography education. Based on their digital skills and willingness to use immersive virtual reality technologies such as mobile devices in the education process, geography teachers can be divided into four groups using group analysis. These groups include (1) self-confidence and innovation, (2) traditional methods, (3) optimistic but low math skills, and (4) pessimistic but numerically trained teachers. Teachers (especially the first batch of teachers) especially admire the potential of immersive technology in practical applications, especially the content of physical geography and geographic area teaching [6]. Mystakidis and Berki take advantage of the availability of visualization and simulation in a 3D immersive learning environment, as well as the appeal of storytelling and game-based learning. The "standard" hybrid narrative of book evolution makes learning problematic and integrated and creates environments. Another study is aimed at investigating teachers' perceptions of the effectiveness of 3D virtual immersive environments, focusing on students' learning and thinking skills in the areas of social cognition, psychomotor, and emotion [7].

The innovations of this article are as follows: Firstly, in terms of research content, although the previous literature and writings involved the practical teaching of immersive virtual reality in colleges and universities, they did not form a systematic exposition, especially in China. The research on reality teaching has just started, and its content settings, theoretical basis, connotation requirements, basic principles, etc. are not very clear. However, this article focuses on studying immersive virtual reality teaching in colleges and universities through data collation, experience induction, and empirical research. The basic connotation, principles, methods, etc. of the second is the research perspective and teaching form. This article jumps out of the traditional practical teaching category and organically combines teaching activities and virtual reality technology based on visual sensors to form an interdisciplinary and multifield research system, improve the transmission speed of information, reduce the visual delay, and enhance the visual immersion of virtual reality; for the same group of nodes, the consistency control strategy of scene roles and dynamic entity attributes is adopted, and the prediction algorithm is designed to meet the needs of multiple users. The dynamic collaboration is consistent between the two, thus ensuring the consistency of the user's visual effects. From the research perspective of immersive virtual reality teaching in colleges and universities, in terms of teaching form, it can provide useful exploration and reference for the current research and teaching status.

2. Design of Immersive Virtual Reality Teaching Method Based on Visual Sensor

2.1. Virtual Reality. The virtual reality system is a computer simulation system created by virtual reality-related technologies that can experience the virtual world. The virtual reality system is also composed of hardware and software. Among them, according to the degree of interaction and intrusion, virtual reality systems can be divided into four categories: desktop virtual reality systems, augmented virtual reality systems, immersive virtual reality systems, and network distributed virtual reality systems. Virtual reality technology, like other emerging science and technology, is a new technology produced by the mutual penetration and integration of different disciplines [8–10]. "Virtual" refers to the meaning that it is made by computer and does not exist in

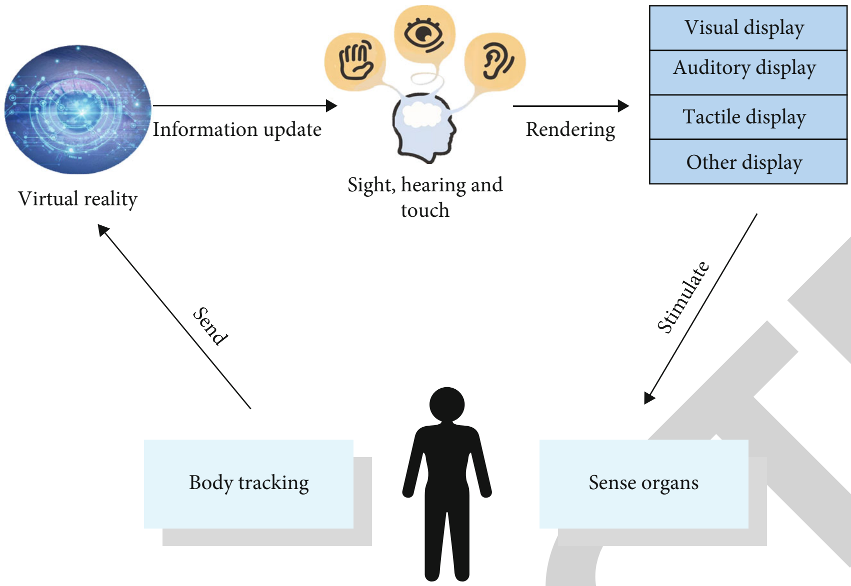

Figure 1: Features and conceptual models of virtual reality.

a traditional physical form. "Reality" generally refers to all things or environments that exist between heaven and earth on an objective level or in the sense of effectiveness. It can be a real object in reality, or an imaginary and impossible object or situation [11, 12]. The conceptual model of virtual reality is shown in Figure 1.

The characteristics of virtual reality are interactivity, conception, and immersion [13, 14]. It also has functional units including vision, hearing, and touch, allowing you to get a deeper sense of immersion in the virtual world. In the virtual reality system, visual immersion is very important. The visual output device transmits the graphic information in the virtual reality system to the user [15, 16]. In order to make users have an immersive visual presence, higher requirements are put forward for visual output devices. For example, the visual output system requires high-precision resolution and high-frequency refresh rate and can provide binocular-separated stereo disparity signal [17]. Auditory immersion is also very important. In virtual reality scenes, synchronized stereo surround sound effects and visual images can further enhance the overall experience of the virtual scene for users. In the system, not only is it necessary to provide simulated sound effects that simulate various real environments, but more importantly, it is necessary for users to feel that they are in the three-dimensional space of the virtual environment and can judge the location of the sound source with both ears [18, 19]. For example, when an airplane flies overhead, it feels changes in the sound of approaching from the front, passing over the head, and moving away from the back. The sense of real experience brought by auditory immersion can enhance or compensate for visual immersion and experience to a certain extent. In the virtual scene, in order to achieve a deep level of tactile experience, it needs to be completed with the help of a part of advanced hardware interactive equipment, for example, steering wheel, joystick, cockpit, and force feedback gloves with force feedback function [20]. The user's operation in the system is processed and fed back in real time through the virtual reality engine, so that the user can get the force feedback and gravity feedback in the simulated virtual environment, for example, driving a car in a virtual environment can not only see the changes in the picture and the noise of the engine during operation but also feel the bumps brought by the road surface information feedback and the changes in gravity and inertia brought about by acceleration and deceleration [21]. In order for the user to interact with the virtual, interactive devices need to be used to achieve an immersive feeling [22]. Figure 2 is an example of an immersive virtual reality system.

A network-based virtual reality environment is a system in which multiple users or multiple virtual environments located at different physical locations are connected to each other through a network. According to the number of shared application systems running in the distributed system environment, the distributed virtual reality system can be divided into a centralized structure and a replicated structure.

2.2. *Virtual Reality Visual Sensor Interaction Technology.*

The vision sensor is the direct source of information for the entire machine vision system. It is mainly composed of one or two graphic sensors, sometimes with light projectors and other auxiliary equipment. The main function of the vision sensor is to obtain enough original images to be processed by the machine vision system. After capturing the image, the vision sensor compares it with the reference image stored in the memory for analysis. As a research hotspot of modern technology, vision sensor technology has deep applications in various fields [23].

2.2.1. *Active Visual Positioning Interactive Technology.*

Visual positioning is very important in virtual reality technology. Immersive virtual reality technology needs to be realized through user cognition, perception, and interaction [24, 25]. It consists of real-time rendering, natural interaction, and three-dimensional tracking [26], where three-dimensional tracking refers to tracking the user's motion

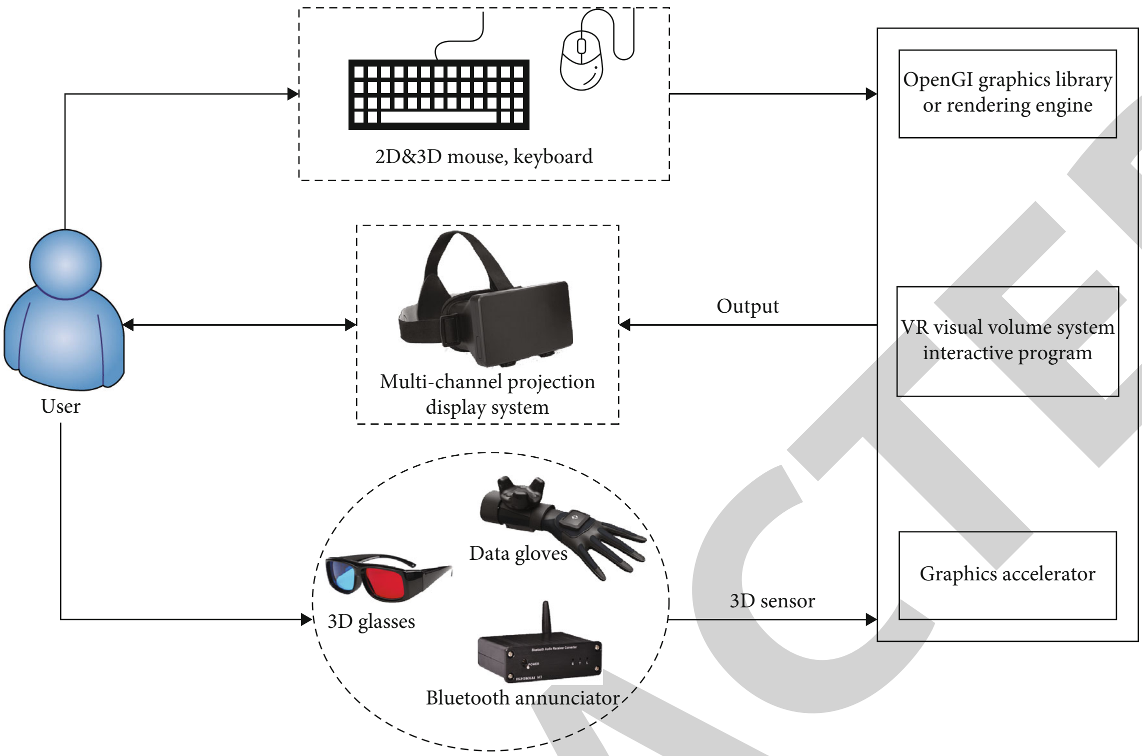

Figure 2: Examples of immersive virtual reality systems.

trajectory and synchronizing it to the visual transformation and position transformation of the virtual scene. In the field of visual sensors, the common passive tracking method was initially generally used, the user's head was used as the target, and the camera captured the target image for tracking, so as to obtain the user's displacement data [27, 28]. The comparison of mainstream virtual reality indoor positioning technologies is shown in Table 1.

It can be seen from the table that computer vision positioning technology is less affected by environmental factors, and the equipment is simple, easy to expand, and more suitable for immersive virtual reality applications in large scenes, but the stability of visual positioning is poor. This article focuses on solving this problem.

The main purpose of camera calibration is to obtain the parameters of the camera, so as to automatically correct the lens distortion through the known parameters in the actual project and reduce the positioning error caused by the camera itself [29, 30]. First, suppose a certain point (x_a, y_a) in the image coordinate system, the coordinate in the camera coordinate system is (X_b, Y_b, Z_b), and the coordinate in the world coordinate system is (X_c, Y_c, Z_c), then the relationship between them can be expressed as

$$\begin{bmatrix} Rx_a \\ Ry_a \\ R \\ S \end{bmatrix} = T \begin{bmatrix} X_b \\ Y_b \\ Z_b \\ S \end{bmatrix} = T \times I_{ai} \begin{bmatrix} X_c \\ Y_c \\ Z_c \\ S \end{bmatrix}. \quad (1)$$

Among them, T is the internal parameter matrix to be solved, S is the focal length of the camera, and R is the pixel scale factor on the X- and Y-axes.

The image collected by the camera and the logo image in the template library have a transformation relationship such as size and rotation. To calculate the similarity between the two, the collected image must first be normalized, and the logo template$S(x, y)$ and images$G(x, y)$ of the same size, assuming that the template size is $N \times N$, then the matching similarity $K(x, y)$ is

$$K(x, y) = \frac{\sum_x^N \sum_y^N \left[G(x, y) - \bar{G}\right] \left[S(x, y) - \bar{S}\right]}{\left\{\sum_x^N \sum_y^N \left[G(x, y) - \bar{G}\right]^2 \sum_x^N \sum_y^N \left[S(x, y) - \bar{S}\right]^2\right\}}. \quad (2)$$

Among them, $\bar{G}$ and $\bar{S}$ are the average values of the pixels of the collected image and the template image, respectively. Only when the calculated R is greater than the given similarity threshold is the matching considered successful, and then, the information carried by the identifier is determined according to the ID. In the system, different marks carry different types of position information. By combining the relative position and angle between the mark and the camera and the position information of the mark itself, the position of the camera in the world coordinate system can be calculated, thereby realizing positioning [31, 32].

Using squares for the logo layout, the side length of the logo is a, the spacing between the logos is v, and the number

Table 1: Comparison of mainstream virtual reality indoor positioning technologies.

Technology	Infrared optics	Laser	Electromagnetic	Ultrasonic	Computer vision
Precision	0.1-1 mm	0.1-1 mm	0.1-1 mm	0.1-1 mm	0.1-1 mm
Targeting range	1.5 × 1.5 m	4.5 × 4.5 m	Radius 3 m	Radius 30 m	Expandable
Features	Disturbed by light and easily blocked	Low cost, poor stability and durability	The equipment is complex and easily affected by metal devices	Affected by temperature, obvious attenuation, high cost	Low stability

of rows is laid out in a row. The logo ID is accumulated from the origin of the world coordinate system, and the logo ID is designed from 1 and increases from left to right, with the bottom left corner of the layout square as the coordinate origin. Then, the center coordinates (under the world coordinate system) of the ID with ID can be expressed as

$$\begin{cases} X_{id} = [a+v] * ((id-a)\%row - a) + \dfrac{a}{2}, \\ Y_{id} = [a+v] * \left(\dfrac{id-a}{\text{row}} - a\right) + \dfrac{a}{2}, \\ Z_{id} = 0. \end{cases} \quad (3)$$

A certain point (X_o, Y_o, Z_o, A) in the world coordinate system can obtain the point (x_w, y_w, a) of the image coordinate system through a transformation matrix, and their relationship is as follows:

$$\begin{bmatrix} x_w \\ y_w \\ a \end{bmatrix} = \eta W S_{on} \begin{bmatrix} X_O \\ Y_O \\ Z_O \\ A \end{bmatrix}, \quad (4)$$
$$\begin{cases} x_i = s_1 + X_{id}, \\ y_i = s_2 + Y_{id}, \\ z_i = s_3 + Z_{id}. \end{cases}$$

i is the center coordinate of the image plane, which represents the position of the feature point from the world coordinate to the camera coordinate.

2.2.2. Inertial Positioning Technology. In order to solve the problem of the large estimation error of vision in the direction of Guangzhou, the inertial positioning method is used for visual positioning to obtain a precise position. The inertial positioning method is as follows:

$$\begin{bmatrix} \dot{x} \\ \dot{y} \end{bmatrix} = \begin{bmatrix} \cos(\mu(s)) \\ -\sin(\mu(s)) \end{bmatrix} \begin{bmatrix} Q_R \\ Q_L \end{bmatrix}. \quad (5)$$

In the formula, Q_R, Q_L is the velocity component in the coordinate system and μ is the deflection angle in the coordinate system. In order to minimize the error,

$$\begin{aligned} Z_{w+1} &= B_w Z_w + G_w m, \\ Y_w &= C_w Z_w + w_n. \end{aligned} \quad (6)$$

The original parameters of the inertial sensor are used to further modify the visual positioning results to obtain more accurate results.

2.2.3. Principle of Kalman Filter. The Kalman filter is an algorithm that predicts the state of the next moment through a series of incomplete and noise-incorporating measurement data. First calculate the optimal estimate of the current state:

$$\begin{aligned} A_{i|i-1} &= G_i A_{i-1|i-1} + B_i v_i, \\ C_{i|i-1} &= G_i C_{i-1|i-1} G_i^t + Q_i. \end{aligned} \quad (7)$$

Among them, Q is the covariance, $A_{i|i-1}$ is the state prediction result, and G_i is the control quantity of the current state.

Now, with the current state of the system prediction results and its corresponding covariance, combined with the currently collected measurement values Z_i, you can calculate

$$A_{i|i-1} = A_{i-1|i-1} + K_i \left(Z_i - R_i A_{i-1|i-1} \right). \quad (8)$$

Among them, K_i is the Kalman gain:

$$K_i = C_{i|i-1} R_i^t \left(R_i C_{i-1|i-1} R_i^t + S_i \right)^{-1}. \quad (9)$$

So far, the optimal estimated value $xk \mid k$ of the current state has been obtained. In order for the system to continue to run, the covariance of the corresponding state needs to be updated.

$$C_{i|i} = (J - K_i R_i) C_{i|i-1}. \quad (10)$$

For the application scenario of this article, the state matrix includes three variables, namely, acceleration, velocity, and position.

2.3. Image Processing Technology. Calculate different thresholds for different neighborhoods. This method is extremely adaptable. It has obvious advantages when dealing with uneven distribution of image illumination or different targets and backgrounds. The disadvantage is that it is more time-consuming than global thresholds. The ARToolkit tracking and registration method used in this article is based on a fixed threshold for image segmentation, which has better results when the indoor lighting is uniform. Avoid the situation where the mark near the light source cannot be recognized. Therefore, in order to solve this problem, this paper proposes a method combining fixed threshold segmentation and adaptive threshold segmentation. The following focuses on comparing several alternative methods.

2.3.1. Fixed Threshold Segmentation Method. The simple and direct global threshold segmentation method is the fixed threshold segmentation method. According to a given threshold S, when the pixel gray value $P(x, y)$ is greater than (or less than or equal to) the threshold, this is classified as a target, and the remaining pixels below are classified as the background, and the corresponding gray value changes are made. The changed pixel gray value is recorded as $Q(x, y)$, which is

$$Q(x, y) = \begin{cases} 0 \le P(x, y) \le S, \\ S \le P(x, y) \le 255. \end{cases} \quad (11)$$

This method is suitable for images where the target and the background are completely separated. In this system, the ceiling is white and the logo is a black foreground plus white background. When the illumination is uniform, a simple fixed threshold segmentation method can be used to segment the logo.

2.3.2. OTSU's Global Threshold Segmentation Method. When the threshold is S, the image can be divided into two pixel sets P_0 and P_1, where the proportion of the number of pixels inP_0andP_1,$n_0$andn_1, and the average gray level are$m_0$andm_1. Then, the between-class variance of P_0 and $P_1$is

$$\partial^2(S) = n_0(m_0 - m)^2 + n_1(m_1 - m)^2. \quad (12)$$

We find the best state of the threshold S, calculate each threshold separately, and find the largest interclass variance.

$$S^* = \operatorname{Arg}\left\{\max_{0 \le S \le 255} \lambda^2(S)\right\}. \quad (13)$$

2.4. Fault-Tolerant Algorithm Based on Visual Positioning

2.4.1. Acceleration Preprocessing. Assuming a point A in the world coordinate system, and the corresponding points in the camera coordinate system and the sensor coordinate system are A_{c1}, A_{c2}, A_{s1}, and A_{s2}, then there is the following conversion relationship between these points:

$$\begin{aligned} A_{c1} &= C_{12}A_{c2}, A_{c1} = S_c A_{s1}, \\ A_{s1} &= S_{12}A_{s2}, A_{c1} = S_c A_{s2}. \end{aligned} \quad (14)$$

The following can be obtained by the above formula: $C_{12}S_c = S_c S_{12}$. Suppose further that every conversion matrix can be represented by the rotation matrix W and the translation vector d, then the above formula can be expressed as

$$\begin{bmatrix} W_{C_{12}} d_{C_{12}} \\ 0^S \end{bmatrix} \begin{bmatrix} W_{S_c} d_{S_c} \\ 0^S \end{bmatrix} = \begin{bmatrix} W_{S_c} d_{S_c} \\ 0^S \end{bmatrix} \begin{bmatrix} W_{S_{12}} d_{S_{12}} \\ 0^S \end{bmatrix}. \quad (15)$$

The expanded available is

$$\begin{aligned} W_{C_{12}} W_{S_c} &= W_{S_c} W_{S_{12}}, \\ W_{C_{12}} d_{S_c} + d_{C_{12}} &= W_{S_c} d_{S_{12}} + d_{S_c}. \end{aligned} \quad (16)$$

The $W_{C_{12}}$ and $d_{C_{12}}$ translation vectors and the rotation matrix W are all orthogonal matrices. To solve the rotation matrix W_{S_c} and the translation vector d_{S_c} between the camera and the sensor, at least the above four relational expressions are required. The four relational expressions can be obtained by moving the camera to three different positions. In order to reduce the calibration error, you can calculate through multiple data and finally obtain the rotation matrix W_{S_c} and translation vector d_{S_c} between the camera and the sensor.

2.5. Kalman Filter Position Estimation. For the application scenario of this article, the state matrix includes three variables, namely, acceleration, velocity, and position, and the state matrix$A = [R, S, L]^T$. The following is only the description of the displacement in the X-axis direction. According to Newton's law of inertia, we can get

$$\begin{bmatrix} R_i \\ S_i \\ L_i \end{bmatrix} = \begin{bmatrix} R_{i-1} \\ S_{i-1} + R_{i-1}\nabla t \\ L_{i-1} + S_{i-1}\nabla t + \left(\dfrac{1}{2}\right) R_{i-1}\nabla t^2 \end{bmatrix}. \quad (17)$$

Among them, the initial value of each prediction model is based on the visual positioning result as L_{i-1}. From the above formula, we can see that corresponding to the Kalman filter,

$$K_i = \begin{bmatrix} 1 \\ \nabla t \\ \left(\dfrac{1}{2}\right) R_{i-1}\nabla t^2 \end{bmatrix}. \quad (18)$$

For the matrix, obtaining the corresponding acceleration, velocity, and position covariance values based on experience and multiple tests can achieve better results. Since the initial position value is obtained from the visual positioning result, the irrelevance of the state should be small. So we take 1 as the covariance value of the displacement. The covariance error of the acceleration is the largest because the acceleration is obtained through coordinate transformation from the accelerometer to obtain the acceleration in the camera coordinate system. Through the above calculation, the current position value L_i can be obtained.

3. Design of Immersive Virtual Reality Teaching Experiment in Colleges and Universities Based on Visual Sensor

3.1. Teaching Link of Immersive Virtual Reality. Aiming at the practical application in education and teaching, positive psychology has emerged in the development of a variety of concepts and methods, such as positive attitude, positive qualities, positive emotions, positive organization, well-being, and positive immersive experiences. This article implements the "active immersion experience virtual reality" teaching. The basic links include careful design, situation introduction, creation of atmosphere, love entry, questioning and setting questions, inquiry and discussion, comprehensive understanding, study and resolution, free expression, sharing feedback, specific application, and incisive comment.

The relationship between the immersion experience state and the course teaching links is shown in Figure 3, which gives a rough guide to the possible immersion state in the course teaching links. In fact, in the course implementation link, the relationship between each link and the immersion state is not absolute. Often, multiple links penetrate each other. For example, when implementing situational introduction, students will also have a pleasant experience and a change in their sense of time.

3.2. Subject. Experiments on the immersive virtual reality teaching system in colleges and universities designed based on vision sensors in this article. The subjects and courses selected for the experiment are chemistry courses. The subject of the questionnaire survey is a freshman major in a college. The overall level of the two groups is equivalent, students from each segment are selected, there will be no uneven level of level, and the research results will not have an impact. Grouped by class, the experimental group uses immersive virtual reality teaching. The control group used traditional teaching methods to teach. Among them, the experimental group and the control group each have 30 people. The experimental results will not be biased due to the small number of people. Simple educational quasiexperiments are implemented to compare the teaching effects. In designing chemical experiment immersive experience teaching, it is necessary to create an atmosphere, enter the emotions, establish clear goals, ask questions, organize investigations, and integrate behavioral awareness; teachers apply appropriate skills, control the atmosphere, make students focus on tasks, and allow students to express themselves freely, with full feedback, so that students share pleasure.

3.3. Experiment Equipment. The equipment used in the immersive virtual reality teaching experiment includes VR glasses, force feedback gloves, virtual simulation equipment, and multiple large-screen projections, which have realized the stereoscopic vision and auditory effects of a large change, so that multiple users can have a complete sensory experience. With a sense of involvement, participants can get a fully immersive three-dimensional interactive experience.

3.4. Questionnaire Survey. A questionnaire survey was conducted on the subjects. The questionnaire survey method is supplemented by the interview method, combined with the experience sampling method and the analytic hierarchy process, to effectively analyze the survey data and construct an evaluation index system with three levels of indicators such as learning motivation, attention, and learning adaptation. The main content of the questionnaire survey is the subjects' attitudes and main opinions on immersive virtual reality teaching. This questionnaire uses SPSS17.0 for statistics, with a confidence interval of 0.05.

4. Immersive Virtual Reality Teaching in Colleges and Universities Based on Visual Sensors

4.1. Experimental Analysis of Visual Sensor Positioning Method

4.1.1. Accuracy Verification. This experiment uses Chinese characters for the layout. Each Chinese character represents a different position coordinate. When the optical axis of the camera is perpendicular to the marking plane, we can accurately calculate the position coordinate of the camera. For example, the X-axis coordinate represented by the target is 120 mm. We put the camera's optical axis perpendicular to the center of the logo and keep it still and then intermittently block the logo to make the visual positioning and fault tolerance methods work in turn. Taking the X-axis position data as an example, the obtained positioning data are shown in Figures 4 and 5.

Finally, the average error value is calculated to be 17.1324 mm, which is a good combination of the high accuracy of visual positioning and the robustness of the inertial method, which realizes the positioning when the occlusion is expressed.

4.1.2. Robustness Comparison. In the process of walking along the positive direction of the X-axis, when walking to a fixed position, it suddenly accelerates back and forth. After many repeated experiments, for the same segment of the walking process, experiments were carried out using the visual positioning method based on the logo and the method in this paper. Figures 6 and 7 show the experimental results. In Figure 6, the solid line represents the X-axis coordinate change, the dashed line represents the Y-axis coordinate change, and the dotted line represents the Z-axis coordinate change. From the data in the figure, it can be seen that when the sampling times are less than 200 times, the visual positioning method based on the mark and the positioning result of this method are basically the same, reflecting that the user's movement trajectory is walking in the positive direction of the X-axis. After more than 200 sampling times, the visual positioning method based on the logo began to show that the three-axis coordinates of the sampling points

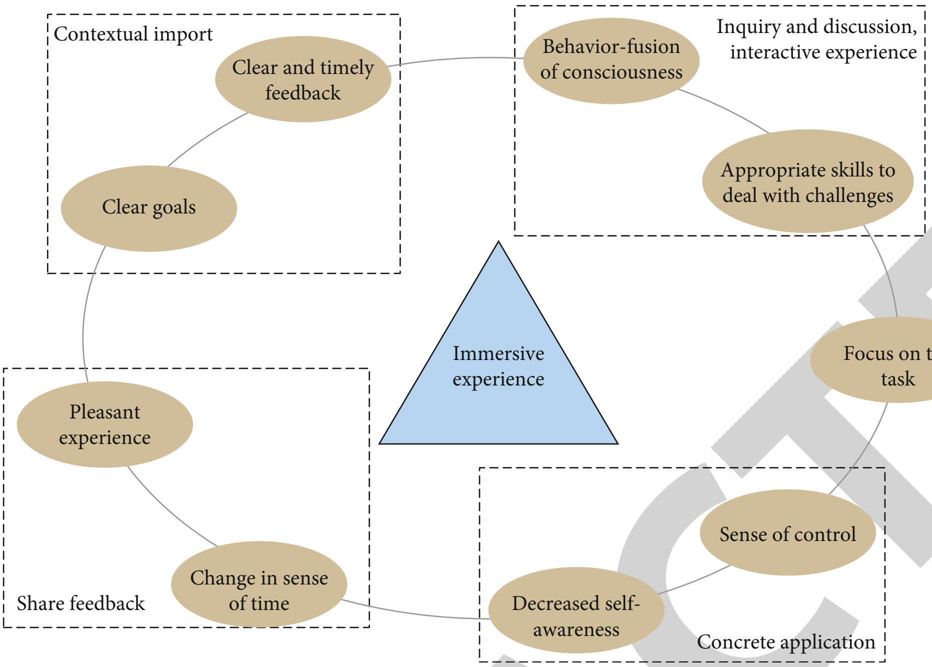

Figure 3: The relationship between the state of immersion experience and the course teaching links.

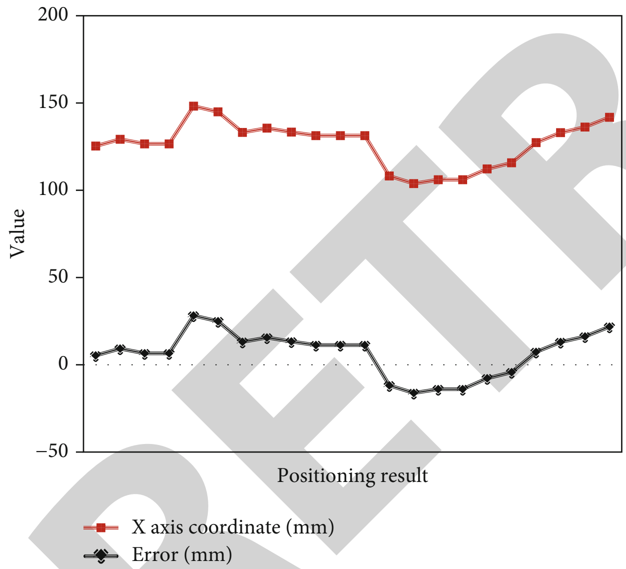

Figure 4: *X*-axis positioning data.

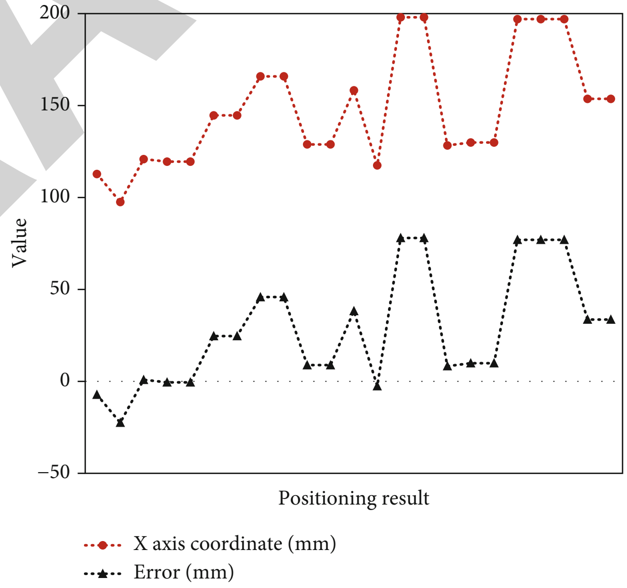

Figure 5: *X*-axis positioning results and errors.

were all 0 for a long period of time. The axis coordinate has a reentrant movement, and the reflected user behavior may be a sudden shaking of the user, which is the user's behavior during the experiment.

When dealing with some sudden user behaviors or other unfavorable environmental factors, the positioning method in this paper can better restore the user's actual motion trajectory and has stronger robustness. However, it can be seen from the figure that there is still a small amount of noise. This is because the visual positioning algorithm has not completely failed, and some noise will be generated when the two data are fused. However, a small amount of noise will not affect the user's experience in the virtual reality environment.

4.1.3. Single Frame Time-Consuming Comparison. For different walking distances, the single frame refresh time is compared, and the results obtained are shown in Table 2.

It can be seen from Table 2 that the single frame time-consuming positioning method of this article is not much different from the logo-based visual positioning method, because in the entire user movement process, the part of the visual positioning failure only accounts for a small part.

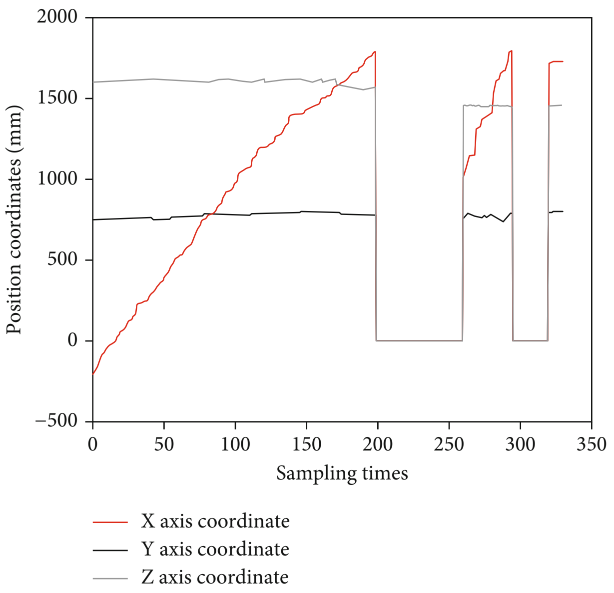

Figure 6: The positioning result of the visual positioning method.

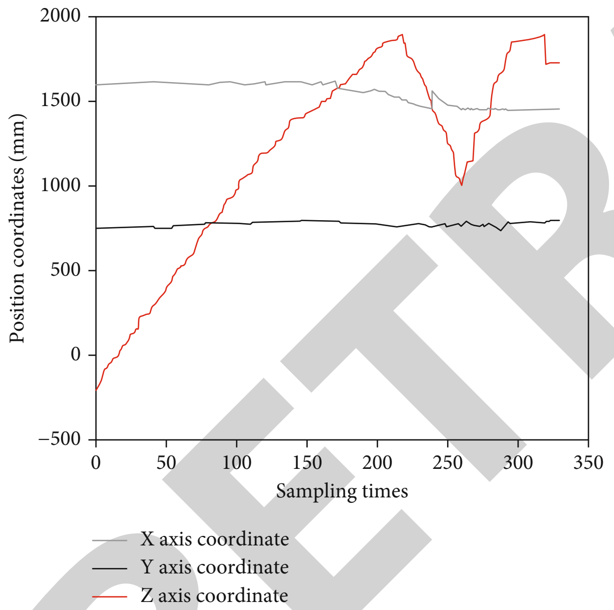

Figure 7: The positioning results of the method in this paper.

Table 2: Single frame time-consuming comparison.

Walking distance (m)	Single frame time (ms)	
	Logo-based visual positioning method	Method of this article
2	8.196	8.241
5	8.627	9.035
10	10.157	10.583

Table 3: Performance comparison of positioning methods.

Method	Recognition rate (%)	Single frame time (ms)
Fixed threshold visual tracking	55.2	49
Adaptive visual tracking	97.8	117
Light detection visual tracking	98.2	81

The refresh rate is very fast (up to 800 HZ), and the increase in time is mainly due to the calculation process of the acceleration integration algorithm, so the time consumption of a single frame does not increase much, which can fully satisfy the user's immersive experience.

Since the maximum acquisition speed of the camera used in the experiment is 30 frames per second, the speed of the visual tracking algorithm is also limited to a certain extent by the performance of the camera. Aiming at the experimental scene in this article, 1000 frames of images are recognized, and the tracking results are shown in Table 3. From the data in the table, it can be seen that the method proposed in this paper basically achieves the effect of the adaptive tracking algorithm in the recognition rate, and on the basis of it, it reduces the time-consumption and improves the system performance.

4.2. University Immersive Virtual Reality Teaching Research Analysis. In order to compare the effect of immersive virtual teaching in colleges and universities, comparing the performance changes before teaching, 1 month after teaching, 2 months after teaching, and 3 months after teaching with the control group, we can clearly see the teaching effect of the group. The results of the control group and the experimental group are shown in Figure 8.

It can be seen from Figure 8 that the experimental group has no significant effect when compared with the control group after 1-2 months of immersive virtual reality teaching. This is because the experimental group's first exposure to immersive virtual reality teaching has no effect on the teaching system. The methods are very unfamiliar and not well accepted. After 3 months of teaching, compared with the control group, the results of the experimental group increased by 8.25% compared to the control group. It is obvious that the experimental group has a significant improvement in academic performance.

Through the analysis of SPSS software, from the group statistics of the test results in Table 4, it can be concluded that the average, standard deviation, and average standard error of the two classes of students are different, but it can still be seen that the results of the experimental group are higher than those of the control group. Similarly, $P < 0.05$; it can be considered that the immersive virtual reality teaching effect plays a significant role. It can deepen students' impression of on-site professional knowledge and improve their learning efficiency and can encourage students to use textbook knowledge flexibly and integrate and apply it to field training, improving students' practical ability.

4.3. Questionnaire Survey Analysis of Immersive Virtual Reality Teaching. The three factors corresponding to each of the three factors (condition, experience, result, interest, emotion, will, satisfaction) in the experience scale before

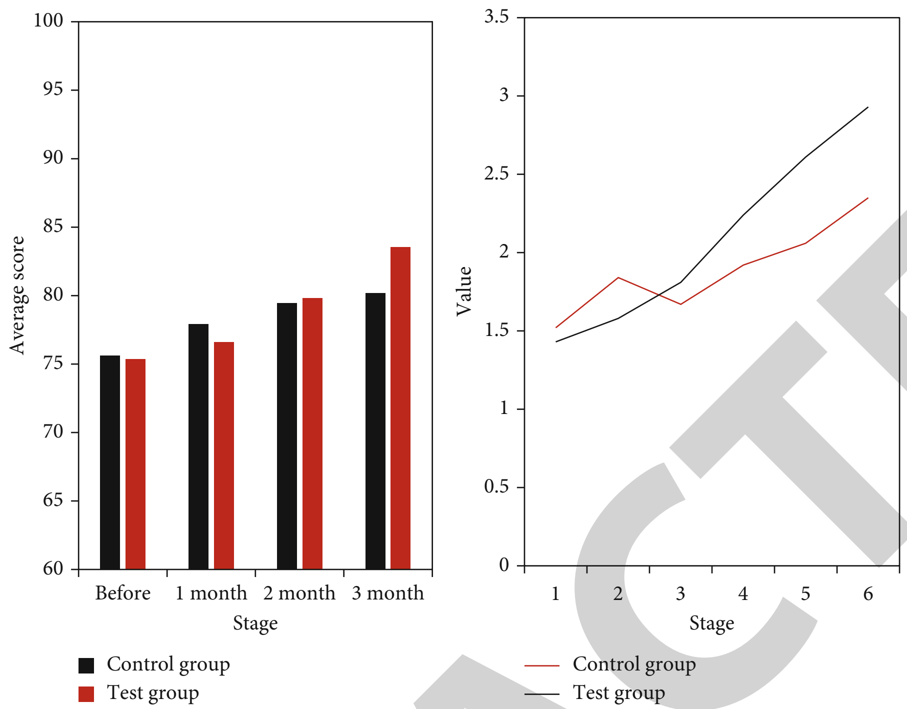

FIGURE 8: Comparison of immersive teaching effects.

TABLE 4: Independent sample test results.

	F	Significance (Z)	t	Degree of freedom	Significance (P)	Average difference	Standard error difference
Control group	0.125	0.741	3.564	92	0.001	2.48352	0.72664
Test group	0.147	0.814	3.618	94.856	0.000	2.51084	0.73012

and after the implementation of the active immersion experience teaching and the data analysis of each question are shown in Figure 9.

Figure 9 is a statistical result of the conditional factors. Q1, Q2, and Q3 correspond to the three problems in the conditional factors. They are clear and timely feedback, clear goals, and appropriate skills to deal with challenges. Counting the scores of the three questions and calculate the average, standard deviation, Tvalue, and sig value. Three of the conditional factors have significant differences after the implementation of the immersive virtual reality teaching strategy. It shows that after the implementation of the teaching strategy for a period of time, the students' learning goals are clearer and firmer, the learning goals are more specific, and the learning motivation is stronger; the learning process becomes more relaxed and free, and the feedback is no longer as deliberate as before the strategy implementation. Thinking and learning behavior are more autonomous and natural; the will to overcome setbacks in the learning process is stronger, the resilience and enthusiasm for learning are greatly improved, and the sense of responsibility for learning is stronger.

Figure 10 is a statistical result of experience factors. Q4, Q5, and Q6 correspond to the awareness of experience behavior, learning concentration, and sense of control, respectively. The three factors of experience factors also have significant differences after the implementation of the strategy. It shows that students feel better about themselves in the learning process than before. Unlike many students who fear and avoid learning before the implementation of the strategy, they like to actively express themselves in learning; they are more focused on learning and devoted to learning. They will have a deeper understanding and focus on what they have learned, and better grasp the learning tasks, learning content, and their own state of learning. The learning process can be actively optimized to achieve better learning results and gain self-confidence.

Figure 11 is a statistical result of the result factor. Q7, Q8, and Q9 correspond to changes in self-consciousness, changes in sense of time, and pleasant experiences, respectively. Out of the three factors, only pleasant experience has a significant difference after the implementation of the strategy. In each of the four topics of reduced self-awareness and changes in the sense of time, only one topic each has a significant difference. It shows that after the teaching strategy has been implemented for a period of time, students feel that it is more enjoyable to study chemistry experiments and are more willing to participate in the study of chemistry experiments. The experimental subjects gradually became interested in psychologically unfamiliar topics at the beginning and then gradually adapted to the virtual reality immersive teaching mode. However, college students are

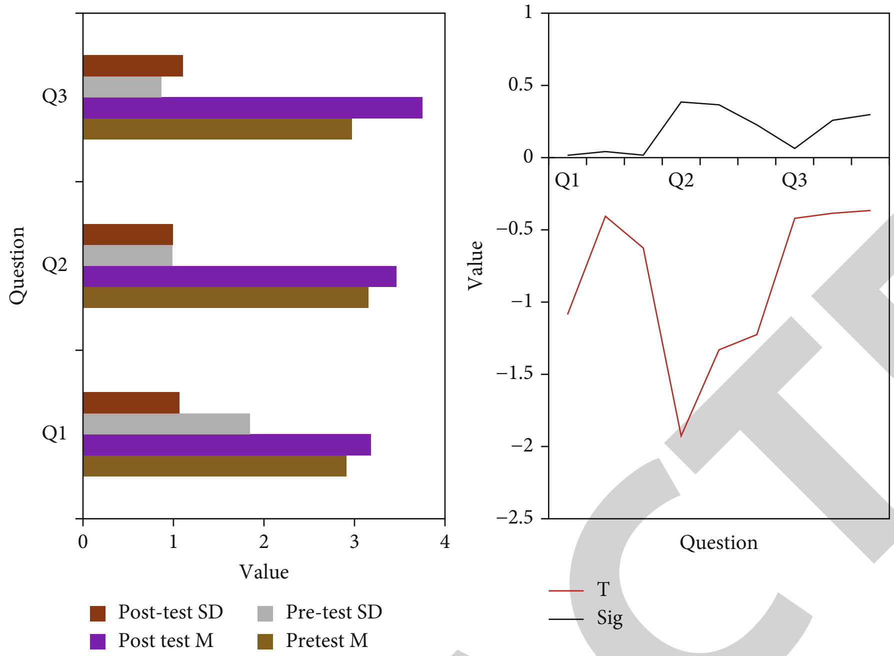

Figure 9: Conditional factor questionnaire statistical results.

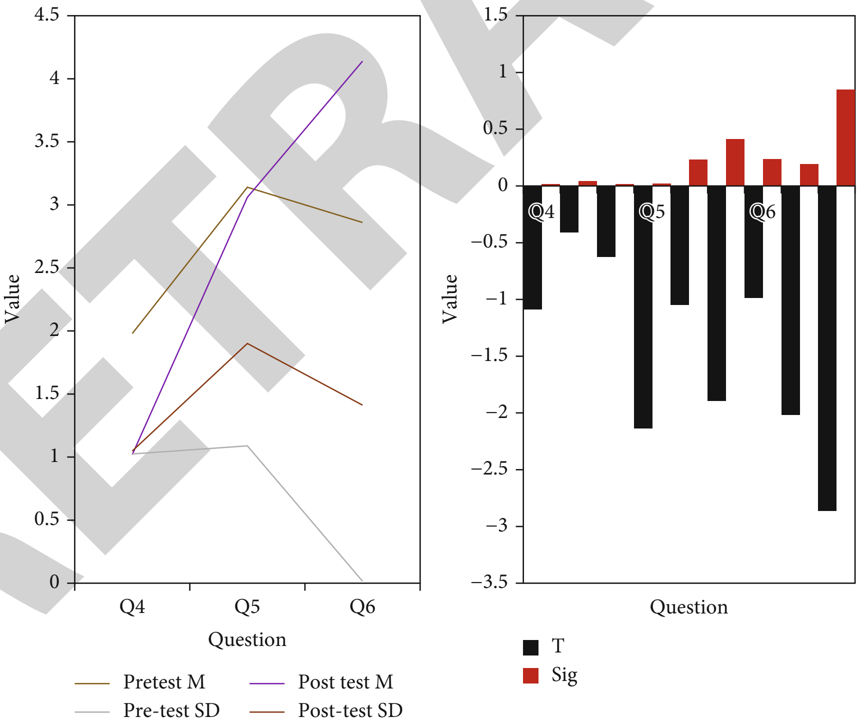

Figure 10: Statistical results of experience factor questionnaire.

older and have a long school age. They have a strong sense of self and a more fixed sense of time. The implementation of immersive and experiential experimental teaching in just a few months cannot achieve the ability to enable students to clearly feel themselves. There is a noticeable change in consciousness and sense of time.

The use of virtual reality technology can enrich the teaching content and move the experiment, practical training, and other skill training to the classroom. It can also properly demonstrate some complex, abstract, natural processes, and phenomena that are not suitable for direct observation and show the teaching content in all directions and

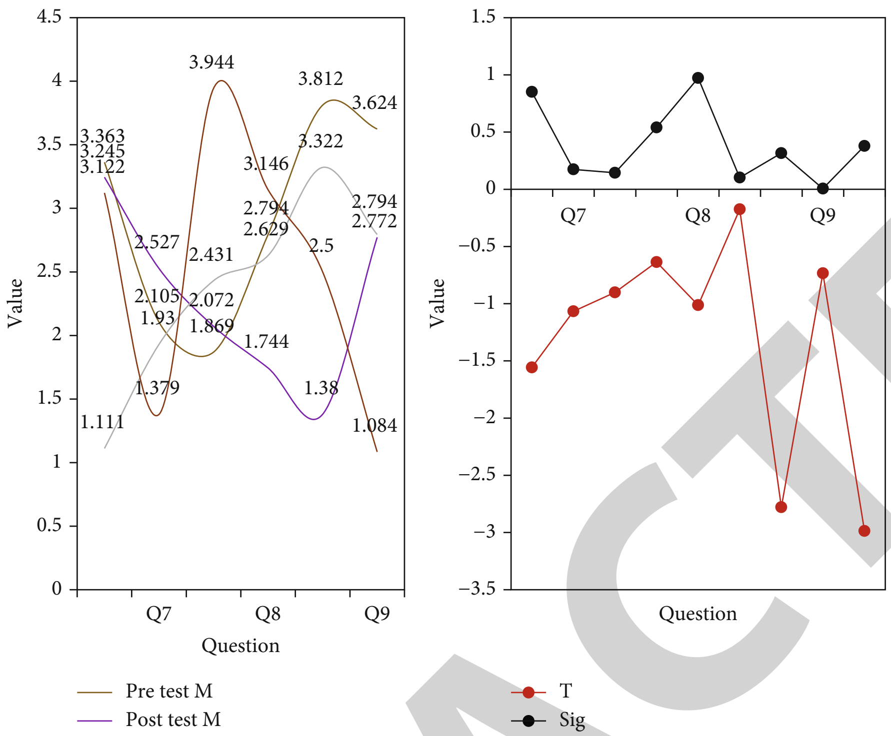

Figure 11: The statistical results of the outcome factors.

multiple angles. The immersive characteristics of the immersive virtual reality display system overcome the traditional lack of reality and lack of interaction. It uses computer technology to build a highly simulated virtual world that is almost the same as the real world, in which learners are immersed physically and mentally. It is easier to reach the realm of physical and mental integration, which effectively improves learning efficiency. In addition, virtual reality technology not only allows students to devote themselves to learning to the utmost extent but also isolates students from the perceptual connection with the world around them, which improves the concentration of learning.

5. Conclusions

Immersion theory provides a valuable reference for school education and teaching. The implementation of active immersion experience in experimental teaching enables teachers to enhance students' immersion experience in teaching work and achieves a multiplier effect with half the effort. Based on visual sensors, this paper studies the immersive virtual reality teaching system in colleges and universities. Experiments show that immersive virtual teaching can effectively improve students' performance, master knowledge, and play a significant role. In the immersive virtual learning system, learners can devote themselves to the virtual world, discuss a topic, or directly participate in virtual experiments and interact with objects as they would in the real world. It can also realize the functions of teaching sharing resources and learning evaluation. However, there are still many problems in the combination of virtual reality and education; for example, when analyzing the status quo of the application of virtual reality systems in teaching, there is a lack of verification by a large-scale questionnaire; in the experimental part, simple educational quasiexperiments are done for only one chapter of the curriculum, and there is a lack of powerful experiments to demonstrate the advantages. The next step is to collect more data on the current situation of the application of virtual reality systems to geography teaching in middle schools and use the questionnaire method to expand the data area in order to obtain more rigorous and more realistic current data. In the process of searching for integration strategies, researchers will inevitably take some detours. Even so, they still have to believe that the integration of virtual reality technology and education disciplines has great potential. How the virtual reality system can better reflect the intelligence of education and teaching remains to be studied and resolved.

Data Availability

No data were used to support this study.

Disclosure

We confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

Conflicts of Interest

There are no potential competing interests in our paper.

Authors' Contributions

All authors have seen the manuscript and approved to submit to your journal.

References

[1] Z. Lv, X. Li, and W. Li, "Virtual reality geographical interactive scene semantics research for immersive geography learning," *Neurocomputing*, vol. 254, pp. 71–78, 2017.

[2] F. B. Nunes, F. Herpich, E. M. H. Do Amaral et al., "A dynamic approach for teaching algorithms: integrating immersive environments and virtual learning environments," *Computer Applications in Engineering Education*, vol. 25, no. 5, pp. 1–20, 2017.

[3] L. Ma, "An immersive context teaching method for college English based on artificial intelligence and machine learning in virtual reality technology," *Mobile Information Systems*, vol. 2021, no. 2, 7 pages, 2021.

[4] K. Dooley, S. Bender, G. Ferris, B. Frankham, A. Munt, and M. Schleser, "Immersive media practices in the classroom: models of the teaching research nexus in an Australian context," *Media Practice and Education*, vol. 21, no. 4, pp. 241–260, 2020.

[5] K. J. Garstki, C. Larkee, and J. Ladisa, "A role for immersive visualization experiences in teaching archaeology," *Studies in Digital Heritage*, vol. 3, no. 1, pp. 46–59, 2019.

[6] I. Stoji, A. Ivkov-Dzigurski, and O. Marii, "The readiness of geography teachers to use mobile devices in the context of immersive technologies integration into the teaching process," *Geographica Pannonica*, vol. 23, no. 2, pp. 121–133, 2019.

[7] S. Mystakidis and E. Berki, "The case of literacy motivation: playful 3D immersive learning environments and problem-focused education for blended digital storytelling," *International Journal of Web Based Learning & Teaching Technologies*, vol. 13, no. 1, pp. 64–79, 2018.

[8] Z. Lv, D. Chen, R. Lou, and H. Song, "Industrial security solution for virtual reality," *IEEE Internet of Things Journal*, vol. 99, pp. 1–1, 2020.

[9] C. Shewell, J. Medina-Quero, M. Espinilla, C. Nugent, M. Donnelly, and H. Wang, "Comparison of fiducial marker detection and object interaction in activities of daily living utilising a wearable vision sensor," *International Journal of Communication Systems*, vol. 30, no. 5, p. e3223, 2017.

[10] G. Lawrence and F. Ahmed, "Pedagogical insights into hyper-immersive virtual world language learning environments," *International Journal of Computer Assisted Language Learning & Teaching*, vol. 8, no. 1, pp. 1–14, 2018.

[11] C. Allison, L. Morgado, J. Pirker, D. Beck, J. Richter, and C. Gütl, "Communications in computer and information science," in *Immersive Learning Research Network*, vol. 621, pp. 73–84, REVRLaw: An Immersive Way for Teaching Criminal Law Using Virtual Reality, 2016.

[12] R. Mayne and H. Green, "Virtual reality for teaching and learning in crime scene investigation," *Science & Justice*, vol. 60, no. 5, pp. 466–472, 2020.

[13] M. D. Miller, G. Castillo, N. Medoff, and A. Hardy, "Immersive VR for organic chemistry: impacts on performance and grades for first-generation and continuing-generation university students," *Innovative Higher Education*, vol. 46, pp. 1–25, 2021.

[14] R. Dacombe and E. A. Morrow, "Developing immersive simulations: the potential of theater in teaching and learning in political studies," *Political Science and Politics*, vol. 50, no. 1, pp. 209–213, 2017.

[15] D. Calderon and D. M. Rivera, "Educational software for the teaching of astronomy using immersive virtual reality," *Indian Journal of Science and Technology*, vol. 11, no. 46, pp. 1–8, 2017.

[16] Z. Lv, A. Halawani, S. Feng, S. Ur Réhman, and H. Li, "Touchless interactive augmented reality game on vision-based wearable device," *Personal and Ubiquitous Computing*, vol. 19, no. 3-4, pp. 551–567, 2015.

[17] L. Ramey, D. Neville, S. Amer et al., "Revisioning the global middle ages: immersive environments for teaching medieval languages and culture," *Digital Philology A Journal of Medieval Cultures*, vol. 8, no. 1, pp. 86–104, 2019.

[18] B. Cascella and J. M. Jez, "Beyond the teaching assistantship: CURE leadership as a training platform for future faculty," *Journal of Chemical Education*, vol. 95, no. 1, pp. 3–6, 2018.

[19] U. Khan and A. Bakhiet, "Implementing a unique immersive near-peer-led clinical skills educational bootcamp for early-year clinical medical students," *Postgraduate Medical Journal*, pp. 1–5, 2021.

[20] D. Beck, "Special issue: augmented and virtual reality in education: immersive learning research," *Journal of Educational Computing Research*, vol. 57, no. 7, pp. 1619–1625, 2019.

[21] P. Yan, B. M. Slator, B. Vender, W. Jin, and V. Aggarwal, "An approach to designing and implementing intelligent tutors in immersive virtual environments," pp. 319–343, Springer International Publishing, 2016.

[22] A. Muslem and M. Abbas, "The effectiveness of immersive multimedia learning with peer support on English speaking and reading aloud," *International Journal of Instruction*, vol. 10, no. 1, pp. 203–218, 2017.

[23] H. Song and M. Brandt-Pearce, "A 2-D discrete-time model of physical impairments in wavelength-division multiplexing systems," *Journal of Lightwave Technology*, vol. 30, no. 5, pp. 713–726, 2012.

[24] G. Han, "Application of virtual reality technology in swimming teaching," *Applied Mechanics & Materials*, vol. 475, no. 11, pp. 1230–1234, 2016.

[25] M. Lou, "A virtual reality teaching system for graphic design course," *International Journal of Emerging Technologies in Learning*, vol. 12, no. 9, pp. 117–129, 2017.

[26] G. C. Chen, C. H. Lin, C. M. Li, K. S. Hsieh, Y. C. Du, and T. Chen, "Virtual-reality simulator system for double interventional cardiac catheterization using haptic force producer with visual feedback," *Computers & Electrical Engineering*, vol. 53, pp. 230–243, 2016.

[27] W. Zuo, "Design and implementation of digital art teaching system based on interactive virtual reality," *IPPTA: Quarterly Journal of Indian Pulp and Paper Technical Association*, vol. 30, no. 7, pp. 587–594, 2018.

[28] S. Wan, L. Qi, X. Xu, C. Tong, and Z. Gu, "Deep learning models for real-time human activity recognition with smartphones," *Mobile Networks and Applications*, vol. 25, no. 2, pp. 743–755, 2020.

[29] L. Zeming, "Design and implementation of a Korean language teaching system based on virtual reality technology," *Agro Food Industry Hi Tech*, vol. 28, no. 1, pp. 2156–2159, 2017.

[30] J. Xu and T. Li, "The application of artificial intelligence and virtual reality in the auxiliary teaching of American science fiction literature," *Journal of Intelligent and Fuzzy Systems*, vol. 6, pp. 1–10, 2021.

[31] M. Sturari, D. Liciotti, R. Pierdicca et al., “Robust and affordable retail customer profiling by vision and radio beacon sensor fusion,” *Pattern Recognition Letters*, vol. 81, pp. 30–40, 2016.

[32] Y. Tang, G. Han, K. Hu, L. Shaohui, and W. Ting, “Design of a new type of small wireless active omni-directional vision sensor,” *Yi Qi Yi Biao Xue Bao/Chinese Journal of Scientific Instrument*, vol. 37, no. 3, pp. 553–560, 2016.