Fuzzy Systems and Data Mining VIII
A.J. Tallón-Ballesteros (Ed.)

doi:10.3233/FAIA220404

Real-Time Interaction VR Design of Role-Based Autonomous Experiment on ERP

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Abstract. This study applied VR technology to the ERP simulation experiment teaching, introducing the optimized collision detection algorithm. In the established virtual ERP simulation experiment environment, the data visualization operation is carried out on the very important data content in the ERP experiment, so that the system can predict the students' operation in real time when the students interact. Thus, it reduces the unreality of the interaction. In addition, we improve the AABB bounding box based on B+ tree storage to improve the efficiency of inter-model collision detection and reduce the occupation and consumption of system memory during detection. Finally, the framework of Bayesian predictive filtering algorithm is introduced to predict the students' simple interactive operation and the orientation of object model. This model optimizes the whole immersive experience teaching of ERP based on VR technology, and makes a certain contribution to meet the talent demand in the context of big data.

Keywords. Immersion, real-time, ERP, VR, autonomous experiment

1. Introduction

Most of the implementation of intelligent teaching system is mainly focused on primary and secondary education and part of higher education [1][2]. There is very little about study for the combination of big data and intelligent ERP teaching system. Our study builds on a gap in existing study, introducing intelligent ERP system. We use the establishment of a large database and the mixed teaching practice to break through the shackles of the traditional teaching mode and stimulate the students' self-learning ability. Through the independent experiment after class, we can give full play to the role of the operator, and allow students to practice the account set of the intelligent ERP by role, to achieve a more practical learning effect.

There are many ways to improve the VR immersive experience, one of the key points is to improve the authenticity of users' touch and response when users operate in a virtual environment [3]. And the VR devices alone provide performance to improve this authenticity is not entirely reliable [4][5]. Therefore, the collision detection algorithm is applied to VR scenes, combined with the auxiliary of Bayesian predictive filtering algorithm model and B + tree, to improve the authenticity of touch and reactions between the internal models of the system, fulfilling the immersion needs of users for virtual environment interaction [4] [7]. Based on fully understanding the big data, the

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role division of enterprise personnel and the basic concepts and principles of ERP system, the ERP role-based independent experimental system based on big data is designed to meet the new needs of modern enterprises under the background of big data [8].

2. ERP immersive real-time sub-role V R autonomous experimental system

We used the intelligent ERP system based on big dada to simulate the scenes by roles [9]. Simulated job roles in specific situations as shown in Figure 1.

CEO												
Sales supervisor	Purchasing supervisor	Finance supervisor		Information supervisor			Production supervisor			Warehouse supervisor	Quality inspection supervisor	Human resource supervis-or
Sales slesman	Procurem-ent salesman	Accoun-tant	Cashier	System analyst	System designer	Programm-er	Schedul-er	Process leader	Production line workers	Warehouse keeper	Inspector	Human commiss-ioner

Figure 1. Simulated position role diagram

According to the above scene simulation post role setting, we give the overall flow chart of the explored objects, as shown in Figure 2.

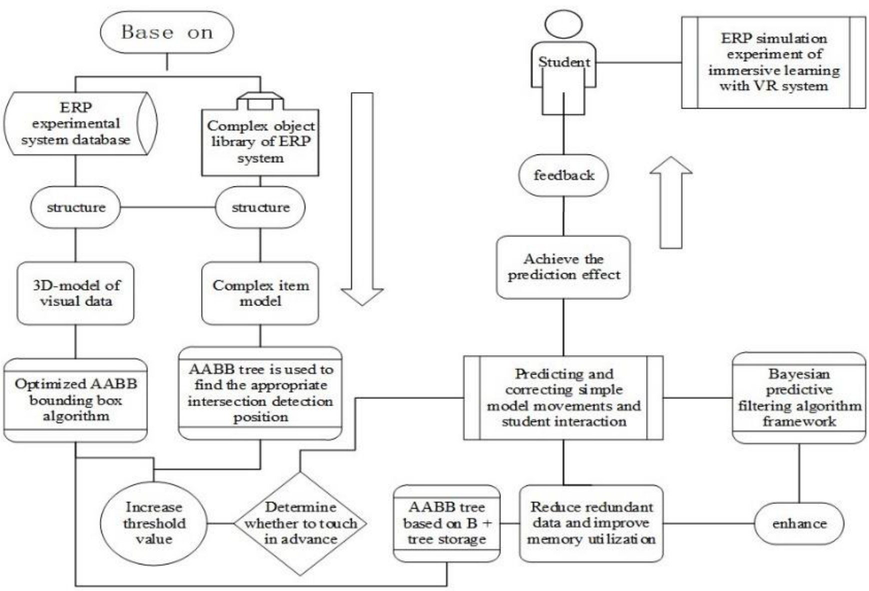

Figure 2. Overall flow chart.

Through the scene simulation in class, students can have a personal experience of enterprise management. After class, they can also practice the account set in different roles to consolidate the learning results. Under the combination of intelligent ERP system, students can experience the enterprise management of different management roles. The account set content will combine big data to make its information symmetry, and realize the real-time update of enterprise data. Each section of operation will no longer form a huge workload due to the independence of the system, but there have the data information exchange, which is more convenient. [10]

3. B + tree reference- - -Bayesian predictive filtering algorithm model

3.1. Collision detection algorithm

Collision detection is an important technique in computer graphics and VR. Accurate collision detection can improve the authenticity of the virtual environment and enhance the immersive experience of interactive operations. The collision detection algorithm is divided into two categories. One is spatial decomposition method and the other is hierarchical bounding box method. Spatial decomposition method is to divide the whole virtual space into a grid of equal volume, and only to collision intersection detect the geometric objects occupying the same grid. The typical spatial decomposition methods are octree method and binary space partition method (hierarchical bounding box method in collision detection). In most cases, we use the hierarchical bounding box method [11]. The basic idea of hierarchical bounding box method is to use simple and slightly larger geometry to surrounded the object to be detected, to approximately describe the detection object. When the containment is completed, we exclude the disjoint part through intersection test to geometry, and gradually build a hierarchy to close to the real detection object model. Then we use this method to judge whether models collide with each other. When applied to VR technology, it can also judge whether a collision occurred during virtual scene interaction. We use the AABB (Axis-Aligned Bounding Boxes) axial bounding box to construct the stereo model of visual data. Model size and data content are selected according to the situation, and the visual data is sampled in the ERP system data list. After model construction was completed, we surround the diorama using the AABB bounding box. At this time, the AABB bounding box surrounded by the data model can be used for collision detection. According to the cost formula $\mathrm{T} = \mathrm{N_v} \cdot \mathrm{C_v} + \mathrm{N_p} \cdot \mathrm{C_p} + \mathrm{N_m} \cdot \mathrm{C_m} + \mathrm{C_d}$, the simple diorama makes the consumption of $\mathrm{C_v}$,$\mathrm{C_p}$,$\mathrm{C_m}$ very small, which will also reduce the value of T overall.

According to the AABB bounding box collision detection algorithm and the optimization idea, we add a threshold $\delta(\delta \geq 0)$ outside the bounding box of an independent visualized data diorama. The increase of threshold is covered outside of Omni bearing bounding box. After adding the threshold δ, the conditions that need to be satisfied at any point on AABB change as follows:

$$\begin{cases} x_{min} - \delta \leq x \leq x_{max} + \delta \\ y_{min} - \delta \leq y \leq y_{max} + \delta \\ z_{min} - \delta \leq z \leq z_{max} + \delta \end{cases}$$

We added the threshold for bounding boxes in order to generate the result of intersection detection when the bounding box surrounding students' hand touches the threshold during correlation detection between bounding boxes. At that time, the system judges that the students' hands have captured the data stereo model, and then makes corresponding feedback, which is transmitted back to the students through the VR device, to achieve the effect of predicting the students' data extraction behavior. The advantage of this is when the system occupies a certain amount of memory due to collision detection or the network speed, equipment problems cause the system delay, and when achieving the prediction effect due to the addition of threshold, the feedback of the system and the direct idea of students are in real time, to ensure that students interact in the VR environment as if it is reality.

3.2. Application of Algorithm B + trees

Although a diorama of visualized data does not need to build an AABB tree for collision detection, complex object models require. Because the nodes in AABB tree constructed by complex object model have redundant data information, this study used Fan Yang's AABB box algorithm to solve the problem of AABB data redundancy and excessive memory usage of AABB trees under complex models, to further reduce the memory consumption of the whole system, and improve the feedback ability of the system to the prediction interaction.

In order to better deal with the backlog of redundant data caused by detecting complex models, we introduced the B+ tree storage method, applied to the AABB tree [12], and reduced unnecessary data processing for the whole system, shortening the calculation time to improve the efficiency of collision detection algorithm. Also, it saves more system memory, for the feedback of algorithm prediction and Bayesian prediction filtering calculation.

3.3. The Bayesian predictive filtering algorithm framework

The application of the Bayesian predictive filtering algorithm framework can better predict the next step of operation and the simple model homing when students conduct immersive interactions.

First, we constructed the framework:

x_d represents the interaction performed by students at t_d. Simulation frequency is f_e. Measurement noise is N_e. The dynamic model is represented by F_e. The measured value M_d is obtained by using the simulation frequency and measurement noise, the measured estimated value is $\widehat{M_d}$. The real value of students' interactive operation is denoted as R_d. The system feedback time is t_{d+1}. The system delay is denoted as $t_{d+1} - t_d$. The true estimate of the student's last interaction is denoted as $\overline{R_d}$. The prediction model is denoted as E_d. The student's future interaction operation moment is denoted as t_p. The true estimate of the corrected student interaction is expressed as $\widehat{R_d}$. The true estimate of the student's next interactive action is denoted as $\widehat{R_{t_d+}t_p}$.

The sample measurement E_d needs to be data corrected to make the system correctly feedback on the next step of the prediction. Firstly, according to the simulation frequency f_e and dynamic model F_e, we captured $\overline{R_d}$ from the motion capture data of students at the last time E_{d-1}.

The Bayesian Filtering Algorithm (BSF) Process:

Fundamental formulae:

$$\mathrm{P}\left(R_d \middle| \mathrm{R}_{1:\ \mathrm{d}-1}\right) = \mathrm{P}(R_d|\mathrm{R}_{\mathrm{d}-1}) \qquad \text{Formula (1)}$$

Where, $R_{1:\ d-1} = (x_1,\ x_1,\ \cdots,\ x_{d-1})$, that is, $\mathrm{P}\left(R_d \middle| \mathrm{R}_{1:\ \mathrm{d}-1}\right)$ is recursively converted into the equivalent form of $\mathrm{P}(R_d|\mathrm{R}_{\mathrm{d}-1})$. Namely, the state value at the last moment determines the state value at the current moment.

Dynamic model:

$$R_d = F_e(R_{d-1}, \ W_{d-1}) \qquad \text{Formula (2)}$$

This formula is used to describe the state. The interaction state at time t_d is represented by R_d; F_e is the functional mapping from the state at the previous moment $\mathrm{R_{d-1}}$ to the current R_d; W_{d-1} is the noise at the previous moment.

Measurement model:

$$M_d = E_d(R_d, \ V_d) \qquad \text{Formula (3)}$$

Where, the measured value at time t_d is denoted by M_d, and E_d represents the functional mapping from the real state $R_d$to the measured state M_d, and V_d represents the measurement noise.

Then, the dynamic model can be used to represent students 'interactive actions at the feedback layer, and the measurement model can be used to represent the tracking situation of students' interactive actions at the feedback layer.

During filtering, the following formula is available:

$$\mathrm{P}\left(\mathrm{R_d}\middle|\mathrm{M_{1:\ d}}\right) = \mathrm{C_k P(M_d|R_d) P}\left(\mathrm{R_d}\middle|\mathrm{M_{1:\ d-1}}\right) \qquad \text{Formula (4)}$$

$$\mathrm{P}\left(\mathrm{R_d}\middle|\mathrm{M_{1:\ d-1}}\right) = \int \mathrm{P(R_d|R_{d-1})P(R_{d-1}|M_{d-1})}\, dR_{d-1} \qquad \text{Formula (5)}$$

Here $\mathrm{C_k}$ is the constant coefficient, using the definition:

$$1/_{\mathrm{C_k}} = P\left(M_d\middle|M_{1:\ d-1}\right) = \int P\left(R_d\middle|M_{1:\ d-1}\right) P(M_d|R_d)\, dR_d \qquad \text{Formula (6)}$$

Among them, the posterior probability is represented by$\mathrm{P}\left(\mathrm{R_d}\middle|\mathrm{M_{1:\ d}}\right)$, the prior probability by $\mathrm{P}\left(\mathrm{R_d}\middle|\mathrm{M_{1:\ d-1}}\right)$. The likelihood is represented by $P(M_d|R_d)$, and the transition probability by $\mathrm{(R_d|R_{d-1})}$. Moreover, the likelihood and transition probability can be obtained from the dynamic model formula and the measurement model formula. Therefore, the recursive formula of the Bayesian filtering algorithm can be used to calculate $\widehat{M_d}$, and then the posterior probability can be calculated by using the formulas 4~6 of $\widehat{M_d}$ and $\mathrm{R_d}$.

According to the formula, the Bayesian filtering algorithm needs to pay attention to two main points: prediction and correction. That is, the dynamic model and the measurement model are used to predict the student interaction operation at a given moment, and then we further corrected the predicted prediction value using Equation 4~6 according to the existing measurements. The corrected value is fed back to the students through the feedback layer to predict the simple interaction of simple objects and students.

In conclusion, the main implementation framework of the proposed model is the optimized collision detection algorithm. Then, according to the valid data in the ERP simulation system database, we make a stereo model of data visualization. After then, we increase the threshold value to the stereo model, compensating the students for the delay in the operation. Also introducing the B + trees, it will cut the computing and memory footprint, save space, and reduce the delay. Then, quoting the Bayesian prediction filtering algorithm framework. According to the framework, we simply predict and correct to the students' immersive interaction operation. At the same time, we track and predict simple object motion of visual data, to achieve the effect of students can learn and interact immersively.

4. Experimental result

Based on the existing experiments of the equipment performance and system processing capacity that can be used for the experimental object of this study, we used the optimization model mentioned in this study in the ERP autonomous experiment under the VR technology. In the setting of VR environment, each module realizes data sharing through the server, and connects and coordinates with each other to achieve communication. Users include administrators, teachers, and students. Administrators are responsible for setting relevant parameters of enterprises in different industries and scenarios, as well as maintaining student data. Teachers in the whole system is responsible for the maintenance of student data, student operation process monitoring, including a time control, selection process grasp, do account results query. Most importantly, the optimization model can significantly filter the redundant data information, reduce the number and time of computing, and improve the efficiency of computer operation. At the same time, ensure the normal use of the equipment. Figure 3 is an embodiment of applying the model.

In the virtual ERP experiment, the students do feel part of the virtual scene update and latency of dynamic representation because of the real network broadband fluctuations. But in the virtual and interactive operation, because of the application of the model, make the system and network delay on students' interactional operation greatly reduced. To the general feedback of experimental students, the delay between the virtual interaction and their thoughts in preparing the advance data model, sliding data information, etc. was always 0.75 to 1 second. Compared with the 2-to 3-second delay of the surrounding virtual scene update and transformation and the real-time operation is significantly improved. Its experience is also more immersive, effectively reduce the occurrence of physiological discomfort caused by simulation diseases and 3D vertigo caused by the inauthenticity of the virtual environment. At the same time, the construction of data visualization three-dimensional model also enables students to have a more sensitive judgment and analysis of ERP data. In the end, the better immersive learning significantly increases students' love for ERP course, and improves students' learning ability and ERP practical operation ability.

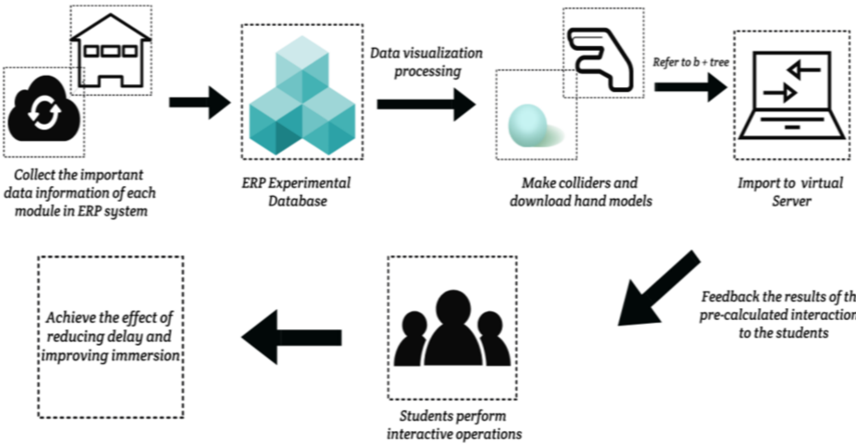

Figure 3. Embodiment

5. Conclusion

On this basis, this study focuses on enhancing the immersive experience of ERP role-based autonomous experiments using VR devices, also promotes the prediction and real-time of interactive operations. Namely, it can let the students feel the fun of ERP autonomous experiment and enhance interest in learning and future work ability. It can also make students have a more profound and more immersive impression on the teaching experiment under VR technology. The application of this model can reduce the hard facilities system requirements of the system memory, equipment performance and broadband network speed. It is helpful to promote the transformation and upgrading of ERP teaching mode for normal educational institutions or universities from traditional realistic classroom teaching to emerging VR-based virtual teaching. Thus, it is a positive significance to promote the reform of traditional teaching mode in the application of VR technology in modern teaching experiments. At the same time, this study has some reference significance to optimize the traditional AABB bounding box collision detection algorithm, which can effectively improve the application effect of the collision detection algorithm in the VR-based ERP simulation experiment.

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