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Innovative mechanism of integrating the concept of aesthetic education into the talent cultivation mode of "garden-school linkage" for agriculture-related higher vocational education under the background of smart agriculture

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SUMMARY: *Intelligent agriculture, as a composite specialty integrating multiple disciplines and multiple technologies, is facing a large talent gap. This paper takes the applied agriculture-related higher vocational colleges and universities as a research sample, and integrates the concept of aesthetic education into the innovation mechanism of talent cultivation mode. In terms of teaching technology and tools, three-dimensional virtual technology is used to build a simulation teaching and training scene in agriculture-related higher vocational colleges, constructing a virtual plant model and a virtual animal model respectively. The scene uses binocular stereo vision measurement to obtain the 3D coordinate data of the required objects, and uses the ICP algorithm to carry out the point cloud fine alignment of the data, thus realizing the 3D data modeling of the objects. In terms of teaching design, a "garden-school linkage" talent cultivation path is proposed under the concept of aesthetic education. In the teaching application of the comprehensive virtual simulation teaching platform and the concept of aesthetic education, the students in the experimental group improved their agricultural theory level between 0.4063~2.125 in each achievement interval, and their agricultural practice level had a significant difference with that of the preexperimental level (p=0.035), and more than half of the students had a positive intention to participate in and interest in this cultivation mechanism.*

KEYWORDS: *virtual simulation teaching; garden-school linkage; intelligent agriculture; talent cultivation; aesthetic cultivation*

1 Introduction

With the rapid development of information technology such as the Internet of Things, big data, cloud computing and other information technologies, smart agriculture, as an emerging technology, is profoundly changing the mode of agricultural production and management [1, 2]. Smart agriculture can not only realize precise planting and intelligent management, but also optimize resource allocation and improve agricultural production efficiency through data

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analysis [3]. Especially in modern agriculture, the application of smart agriculture has penetrated into many aspects such as crop cultivation, pest control, and water utilization [4, 5]. To this end, Tseng et al. used smart agriculture IoT devices to monitor and analyze farm environmental data, and assessed crop adaptation through a three-dimensional clustering method, pointing out that the system can assist decision-making and validate rules of thumb, and emphasizing its practical application value in coping with climate change and optimizing production [6].Tang et al. reviewed the progress of the application of smart agriculture in the precision prevention and control of pests and diseases by analyzing the smart monitoring and spraying systems and other key technologies, pointing out the need to strengthen the construction of digital early warning and green prevention and control systems, and emphasizing the value of continuous research in this field to ensure crop safety [7]. Bwambale et al. reviewed the application of smart irrigation systems in agricultural water conservation by analyzing the monitoring techniques and control strategies, pointing out that closed-loop control is more effective than open-loop and emphasizing that it significantly improves water use efficiency, which is essential for sustainable agricultural production [8]. Mandal et al. explored the convergence of IoT and AI in smart agriculture, analyzing how key elements such as sensing technology and cloud computing can optimize production and pointing out that there are still open issues in the field, while highlighting the future potential of smart technologies to improve agricultural efficiency and profitability [9]. Petrović et al. analyzed the application status of precision agriculture in Central European countries through literature review, pointed out that it can improve the production efficiency and resource utilization, and emphasized that the field needs to be combined with the automation trend to strengthen the technical research and development, in order to promote the sustainable development of agricultural science and technology [10]. In this context, the innovation of talent cultivation mode in agriculture-related higher vocational education is particularly important.

At present, the agriculture-related higher vocational personnel training mode in the curriculum system, practical teaching, teacher training and other aspects has achieved remarkable results, especially the traditional “school-enterprise cooperation” gradually evolved into a more systematic, ecological “garden school linkage” personnel training mode [11, 12]. However, in this process, the goal of talent training is mainly focused on the application of professional skills for agricultural production and services, in the smart agriculture, we must realize that agricultural personnel need to have a “comprehensive development” [13, 14]. This requires that agriculture-related higher vocational should not only focus on the cultivation of skills, but also integrate aesthetic education into the “garden-school linkage” talent cultivation model in the context of smart agriculture [15].

As a new educational concept, aesthetic education is an important part of China's all-round education system [16, 17]. With the help of aesthetic education, students can be cultivated to recognize and understand beauty, to perceive and discover beauty in real life, and then to create beauty. As for the research on the importance of aesthetic education, Zhang studied the core value of aesthetic education for personality formation and cultural identity, pointing out that it can cultivate universal values and enrich the cultural hierarchy, emphasizing its key role in contemporary society [18]. In response to the realities of rural aesthetic education, Tan and Li analyzed the developmental needs under the “five-in-one” framework and proposed a strategy of integrating aesthetic education into the soft culture curriculum, aiming to enhance children's cultural self-confidence, bridge the psychological gap between urban and rural areas, and emphasize its key role in promoting the integrity of personality and the cultivation of aesthetic ability [19]. Shih analyzed the urgency of implementing aesthetic education in the early childhood stage by combing through related studies, pointed out that it plays a key role in broadening the aesthetic experience, and emphasized the significance of such a move in promoting appropriate aesthetic education for young children in Taiwan [20]. By integrating the concept of aesthetic education into the "garden-school linkage" talent cultivation model for agriculture-related higher vocational education under smart agriculture, aesthetic education undertakes the task of cultivating students' ecological beauty, and through this integration, students' ecological aesthetic emotions are cultivated, and their ecological aesthetic appreciation and creativity are improved [21-23].

This paper combines the "garden school linkage" talent training objectives and needs, puts forward the three-dimensional virtual simulation program of its teaching and training platform, and on this basis designs the virtual reality mathematical models of plants and animals respectively. Further, based on the principle of binocular stereo vision measurement, the three-dimensional data of the object is collected, and the coordinates of the point cloud data are iterated according to the error difference, so as to complete the fine alignment of the point cloud data of the object. Under the guidance of the "garden-school linkage" talent cultivation mechanism for agriculture-related higher vocational education that integrates the concept of aesthetic education and human development, we select experimental samples and carry out application experiments to assess the feasibility of the virtual simulation teaching platform for practical training from three perspectives: the theoretical level of the samples, the practical level, and the satisfaction level.

2 Virtual Simulation Teaching of Agricultural Practical Training Based on Point Cloud Alignment

2.1 Virtual simulation of practical training based on three-dimensional technology

2.1.1 Three-dimensional virtual simulation training scenarios

This paper through the agriculture-related vocational colleges and universities at the current stage of practical training status quo understanding, fully aware of agriculture-related vocational colleges and universities as well as cooperative school enterprises face serious practical training problems, which puts forward the need to build a three-dimensional virtual simulation of the real training scene, through the construction of the scene to the real world of practical training into the virtual world of the simulation of the real training. At the same time, it can also be combined with some cases for problem retrospective, which can not only achieve the purpose of solving the problem, but also avoid the danger of some practical training on the personal safety of students to bring some impact.

To this end, a three-dimensional virtual simulation of the simulation world was built based on Unity 3D. After the combination of a practical training courses, practical training requirements for the construction of practical training scenes belong to the case prototype. Three-dimensional virtual simulation of real training platform construction process is shown in Figure 1.

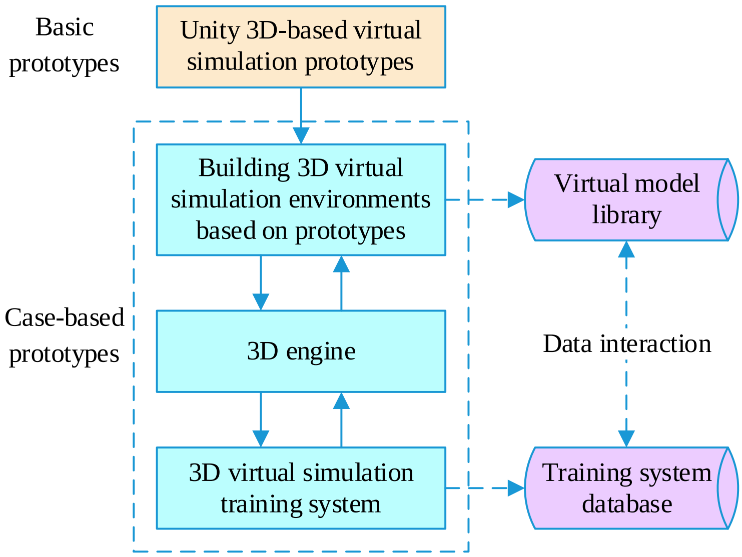


Figure 1: The process of building a 3D virtual simulation training platform

2.1.2 Virtual plant models

Virtual plant is the use of virtual reality technology and virtual agricultural mathematical model, with individual plants as the object of study, on the computer scientific, quantitative simulation of the whole process of plant growth and development in three-dimensional space, so that it has the characteristics of three-dimensional visualization. In realizing the visual simulation of plants, the mathematical model is firstly used to calculate the growth process of plants, and then the computer graphics technology is used to display the morphological and structural changes in the growth and development process of plants.

According to the function completed by the model and the process of simulation, the plant growth model is divided into two major categories of models: growth machine model and visualization model. The growth machine model calculates various parameters or data of the plant growth process based on the known initial information of the plant body and environmental factors. The visualization model uses computer graphics technology to simulate the growth process of plants with two-dimensional or three-dimensional graphics.

According to the talent training requirements of smart agriculture, the system does not require a high degree of accuracy of the three-dimensional model, and the growth machine model is selected in this paper. Taking corn as an example, Ceres-Maize is a growth machine model for corn, which comprehensively takes into account factors such as soil conditions, weather conditions, varietal characteristics and cultivation measures, calculates the growth of corn organs day by day, and can predict the final yield.

Ceres-Maize is an ideal model and does not address external factors such as water, nutrients, pests and diseases, natural disasters, etc. in actual production. In this training system, external anthropogenic as well as natural factors also directly affect the final yield and quality of the crop. In this paper, Ceres-Maize is extended and improved by adding irrigation, fertilization, and disaster modules to make the training more realistic and improve the effectiveness of the training. The relationship of each module is shown in Figure 2:

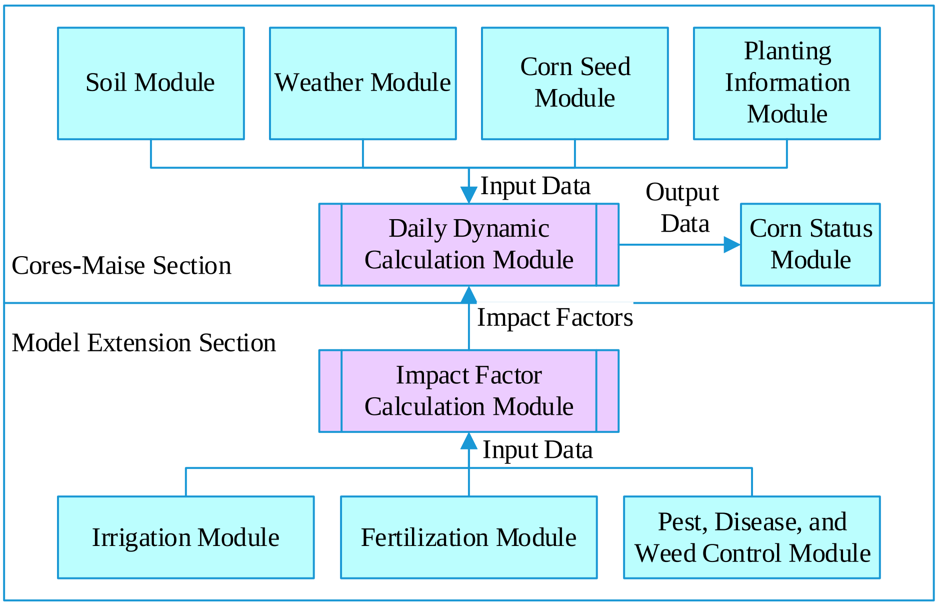


Figure 2: Virtual plant module relationship

(1) Fertilizer application

The Ceres-Maize fertilizer requirement was adjusted as in equation (1) with reference to the discrimination of the extremes of the multivariate quadratic fertilizer effect function and function optimization:

$$\begin{aligned} Y = {} & 379.0490 + 37.1959x_1 - 6.2586x_2 + 24.0806x_3 \\ & +0.2828x_1x_2 - 0.9283x_1x_3 + 0.4025x_2x_3 - 1.6603x_1^2 \\ & -0.1614x_2^2 - 1.0041x_3^2 \end{aligned} \tag{1}$$

$R = 0.9980^{**}$, $F = 585.85^{**}$, $S_{e(\text{Standard error})} = 3.4\left(\text{kg}/667\text{m}^2\right)$, $Y_{\max} = 641.5$

where Y is the direct yield, and x_1, x_2, and x_3 are the total amount of actual fertilizer applied N, P, and K, respectively.

(2) Moisture

Water is sufficient in Ceres-Maize, the loss of atmospheric precipitation and water in the soil are not considered, the water demand is adjusted as follows, the model can dynamically calculate the required water as in equation (2):

$$\text{COE\_Water} = 0.9997 + 0.0105W - 0.94396W^2 \tag{2}$$

$$\text{COE\_Water} \in [0,1]$$

Among them: $\text{W} = (\text{Water demand} - \text{Average water demand}) / \text{Average water demand}$

(3) Disasters

There is little information and even less quantitative research on the impact of pests, diseases and natural disasters on the final yield of crops, in this paper, we use a simple way to simulate the impact of disasters, and interfaces are reserved in the system, so that the relevant research results can be quickly applied. The scientific knowledge base of the system provides references for the application of pests and diseases.

2.1.3 Virtual animal models

In this paper, the most common domestic animal, pig, is taken as an example to design and build a virtual animal model. Referring to the Edinburgh pig model, relevant modules are extended according to the training needs. The Edinburgh pig model is a classic domestic pig growth model, which takes a day-by-day calculation of pig growth and predicts pork quality. The model mainly studies the following two aspects:

(1) Factors required for quantitative study of feed protein content on daily growth of lean meat.

(2) Quantitative analysis of the factors required to quantify the role of energy in the growth process of pigs.

Live pigs in the model consisted of moisture, fat, protein, ash, and digestive tract contents. Maximum protein deposition rate determines the maximum daily protein production and is an important indicator to distinguish pig breeds.

The inputs and outputs of the growth model are shown in Figure 3:

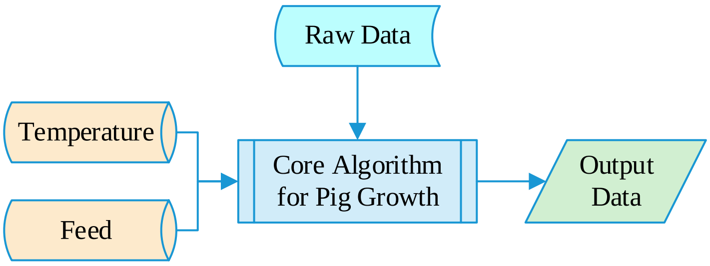


Figure 3: Pig growth module data stream

2.2 Point Cloud Alignment of 3D Data

2.2.1 Principle of binocular stereo vision measurement

Binocular stereo vision refers to a method of obtaining three-dimensional information about an object by simulating the visual principle of the human eye with two cameras. In binocular stereo vision system, the geometrical relationship between the ideal two cameras is shown in Fig. 4. Assuming that the focal lengths of both the left and right cameras are f, the optical axes of the two cameras are parallel to each other and the x axes of each other coincide with each other. The distance between the optical centers O_1 and O_2 of the two cameras is called the baseline distance and is denoted by the letter B. Suppose there is an object point $P(X,Y,Z)$ whose vertical distance, i.e., depth, from the baseline is Z, and the image points of the object point P in the imaging planes of the left and right cameras are p and p', respectively, and the image coordinates of these two image points are (u_1,v_1) and (u_2,v_2), respectively. The difference between the physical coordinates of the two image points in the horizontal direction is called parallax and is denoted by the letter d as $d=u_1-u_2$.

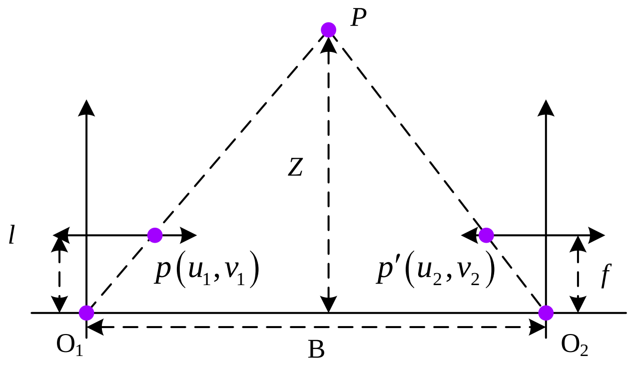


Figure 4: Binocular stereo vision geometric model

In Fig. 4, there is equation (3) from the measurement principle of similar triangles:

$$\frac{B-(u_1-u_2)}{B}=\frac{Z-f}{Z} \tag{3}$$

which in turn yields equation (4):

$$Z=\frac{B}{u_1-u_2}=\frac{B}{d}f \tag{4}$$

From equation (4), it can be seen that when the distance between the optical centers of the two cameras B and the camera focal length f is constant, the depth information Z and the parallax d constitute an inverse relationship. Therefore, as long as the camera focal length is pre-calibrated, and then according to the geometric imaging formula, the three-dimensional coordinates of point p can be calculated as in equation (5):

$$\begin{cases} X=\frac{Z}{f}u_1=\frac{u_1}{d}B \\ Y=\frac{Z}{f}v_1=\frac{v_1}{d}B \\ Z=\frac{f}{d}B \end{cases} \tag{5}$$

2.2.2 Basic Theory of Point Cloud Alignment

(1) Rigid Body Transformation

Rigid-body transformation is often used to calculate the new position coordinates of a rigid body after translation or rotation, or to calculate the position coordinates of the same rigid body in different coordinate systems. In Euclidean space, if an object is observed in different coordinate systems or its position and direction are changed arbitrarily, its angle and length remain unchanged, then it is considered that the shape and size of the object also remain unchanged.

Setting a point P in Euclidean space, the position coordinates of the point P in two different coordinate systems are $p(x,y,z)^T$, $p'(x',y',z')^T$, then there exists a transformation as in equation (6):

$$p' = Rp + t \tag{6}$$

p' is the coordinates under another coordinate system obtained through the positional coordinates p of the point P in one coordinate system after a rotational and translational transformation; $t = (t_x, t_y, t_z)^T$ is a three-dimensional translation vector, which is the positional coordinates of the origin of one coordinate system in the other; R is a 3×3 rotationally transformed matrix, whose determinant whose value is equal to 1, i.e., equation (7):

$$R = \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & r_{22} & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix} \tag{7}$$

It can be seen that finding a rigid body transformation (R, t) that satisfies the above conditions is the purpose of point cloud alignment.

(2) Quaternion representation

The rotation matrix is used to represent the rotational transformation of the rigid body, and the quaternion representation is one of the more commonly used methods to represent the rotation matrix.

A quaternion is a quaternion vector $q = (q_1, q_2, q_3, q_4)$. Using quaternions to describe coordinate rotations allows good numerical solutions to be solved directly from the rotation angle and rotation axis expressions. Any position on the unit sphere in three-dimensional space corresponds only to the two angles φ, θ of rotation about the x-axis and the y-axis, but does not characterize the third angle ϕ of rotation about the z-axis. All three angles of rotation can be represented by adding a new degree of freedom, which gives rise to the unit ball in four dimensions. The unit ball in four dimensions is defined in equation (8):

$$x^2 + y^2 + z^2 + \omega^2 = 1 \tag{8}$$

All three angles of rotation in three-dimensional space can be represented by points on the four-dimensional unit sphere, and the quadratic coordinates of the points on the four-dimensional unit sphere form the unit quaternion. A rotation can be represented by two unit quaternions (q and $-q$), but given a quaternion, there is only one rotation corresponding to it. The angle of a rotation does not normally exceed 180°, so a one-to-one correspondence between a rotation and a quaternion is achieved by attaching a condition such that the first element of a quaternion is positive.

The rotation matrix of the rigid-body transformation is expressed in terms of unit quaternions as equation (9):

$$R = \begin{bmatrix} q_0^2 + q_1^2 - q_2^2 - q_3^2 & 2(q_1q_2 - q_0q_3) & 2(q_1q_3 + q_0q_2) \\ 2(q_1q_2 + q_0q_3) & q_0^2 + q_2^2 - q_1^2 - q_3^2 & 2(q_2q_3 - q_0q_1) \\ 2(q_1q_3 - q_0q_2) & 2(q_2q_3 + q_0q_1) & q_0^2 + q_3^2 - q_1^2 - q_2^2 \end{bmatrix} \tag{9}$$

where $q_0^2 + q_1^2 + q_2^2 + q_3^2 = 1$.

Once the unit quaternion is calculated, equation (9) can be used to calculate the rotation matrix. The rigid body transformation is also represented by seven elements

$(q_1, q_2, q_3, q_4, q_5, q_6, q_7)$, with the unit quaternion being represented by the first four quantities, and the translation by the last three. If the rotation matrix corresponding to the unit quaternion is denoted by R, the rigid body transformation is expressed as equation (10):

$$p' = Rp + (q_4, q_5, q_6)^T \tag{10}$$

2.2.3 Fine Alignment of Point Cloud Data

The point cloud data after coarse alignment by PSO algorithm can make the initial positions of the two groups of point cloud data to be aligned closer and the overlap area larger, so the alignment results obtained by PSO algorithm will be used as the initial positions for fine alignment by ICP algorithm. The purpose of fine alignment is to further reduce the error of point cloud alignment by calculating the coordinate transformation parameters through continuous iteration.

(1) ICP algorithm

ICP algorithm is the most widely used point cloud alignment algorithm. The essence of this algorithm is the optimal matching method based on the least squares method, which searches for the matching relationship between the corresponding points of two point cloud data and the optimal rigid-body transformation through continuous iterative computation, and terminates the iterative process to find the optimal matching between two point cloud data when a convergence accuracy of the correct matching is reached.

Set the two point cloud data to be aligned as $P = \{p_i\}_{i=1}^N$ and $X = \{x_i\}_{i=1}^N$, where the point cloud dataset P is the reference set of points and the point cloud dataset X is the target set of points. For each point p_i in the point set P, the ICP algorithm needs to find the point y_i with the nearest sum of squares of distances between it and the point set X as its corresponding point, and set $Y = \{y_i\}_{i=1}^N$ as the corresponding set of points in the point set P, and c is the operation of finding the corresponding point, which is denoted as Equation (11):

$$Y_k = c(P_k, X) \tag{11}$$

where k denotes the number of iterations, and P_k and Y_k denote the dataset and its corresponding point set after the K th iteration, respectively.

The mean square objective function is shown in equation (12):

$$f(q) = \frac{1}{N_p} \sum_{i=0}^{N_p} \left\| y_i - R(q_R) p_i - T(q_T) \right\|^2 \tag{12}$$

where q denotes the rigid-body transformation vector between two point sets P and Y, q_R denotes the rotation vector, and q_T denotes the translation vector. the ICP algorithm then seeks to minimize this function and defines the operation as $(q, d) = Q(P, Y)$, where d denotes the matching error and Q denotes the minimization operation.

(2) Specific steps of fine alignment

Step 1: For initialization, the number of iterations k is set to 0, the rigid body transformation vector q is set to $[1, 0, 0, 0, 0, 0, 0, 0, 0]$ the translation parameter T is set to

$[0,0,0]$ and the rotation parameter R is set to $R=\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$;

Step 2: Find the point y_i in point set P with the closest distance between it and each point p_i in point set X as its corresponding point, constituting point set $Y=\{y_i\}_{i=1}^{N}$;

The calculation of the distance between two points in the point cloud is shown in Fig. 5, the purple point cloud is the point set P, the blue point cloud is the point set X, take the point p_i as an example, its coordinates are (x_{1i}, y_{1i}, z_{1i}), and find the point with its nearest distance in the point set X, the coordinates of the point in the point set X are (x_{2j}, y_{2j}, z_{2j}), which is calculated as in equation (13):

$$\sum_{i=1}^{N}\sqrt{\left(x_{1i}-x_{2j}\right)^2+\left(y_{1i}-y_{2j}\right)^2+\left(z_{1i}-z_{2j}\right)^2}\ (i,j=1,2,\cdots,N) \tag{13}$$

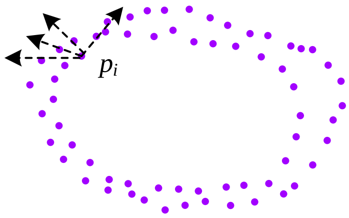


Figure 5: The calculation of the distance between two points in a point cloud

Step 3: Calculate the value of the alignment vector $(q_k, d_k)=Q(P_0, Y_k)$ by quaternion representation. Firstly, the center of mass of the target point set P and the corresponding point set Y are computed as in Eqs. (14)-(15):

$$\bar{u}_P=\frac{1}{N_P}\sum_{i=1}^{N_P}\bar{P}_i \tag{14}$$

$$\bar{u}_Y=\frac{1}{N_Y}\sum_{i=1}^{N_Y}\bar{y}_i \tag{15}$$

The covariance matrix and its antisymmetric matrix are then calculated from the obtained center of gravity as in Eqs. (16)-(17):

$$\sum_{PY}=\frac{1}{N_P}\sum_{i=1}^{N_P}\left[(\bar{p}_i-\bar{u}_P)(\bar{y}_i-\bar{u}_Y)^T\right] \tag{16}$$

$$A_{ij}=\left(\sum_{PY}-\sum_{PY}^{T}\right)_{ij} \tag{17}$$

Construct a fourth order matrix as in equation (18):

$$Q\left(\sum_{PX}\right)=\begin{bmatrix} tr\left(\sum_{PX}\right) & [A_{23}A_{31}A_{12}] \\ [A_{23}A_{31}A_{12}]^T & \sum_{PY}+\sum_{PY}^T-tr\left(\sum_{PX}\right)I_3 \end{bmatrix} \tag{18}$$

where I_3 is a third-order unitary matrix.

The unit eigenvector corresponding to the largest eigenvalue of the fourth-order matrix $Q\left(\sum_{PX}\right)$ is expressed in quaternionic representation, and then the value of the rotation matrix R is computed according to Eq. (9), and the translation transformation vector is computed according to Eq. (19):

$$q_T=\bar{u}_Y-R(q_R)\bar{u}_P \tag{19}$$

The error d is calculated as in equation (20):

$$d_k=\frac{1}{N_P}\sum_{i=1}^{N_P}\left\|\bar{y}_{ik}-\bar{p}_{ik+1}\right\|^2 \tag{20}$$

Step 4: Compute the new position of the point set, $P_{k+1}=R_kP_k+T_k$;

Step 5: Judge the termination condition, when the difference between the errors of the two iterations is less than a given threshold, i.e., $\left|d_k-d_{k+1}\right|<\tau$ (set τ to 0.01), the iteration is terminated; and vice versa to continue the iterative process.

3 "Garden-school linkage" talent cultivation based on aesthetic education and human cultivation

3.1 Higher education level

Agricultural related vocational colleges and universities are essential in the training of talents that will drive the smart agriculture. The following is the list of the main points: (1) the talent training should be considered as one of the essential bases to develop the agricultural science and technology talents combining it with the concept of aesthetic education to establish professional courses on smart agriculture both teaching and practice and cultivate the professionals in smart agriculture; (2) supporting scientific research, agriculture-related vocational colleges and universities possess a high level of agricultural scientific research resources and scientific research strength, which can be realized through mentorship systems to execute agricultural scientific research projects, research, and development of new agricultural technologies; (3) technical guidance and practice, agriculture-related higher vocational colleges and universities in the agricultural production and management have numerous experiences in teaching and learning platform of virtual simulation based on virtual simulation to offer training courses, the teachers guide the students providing smart farm construction technical guidance and services and finally provide intellectual and talent support to the development and transformation and upgrading of regional smart agriculture; (4) demonstration and promotion, through the construction of smart agriculture demonstration bases, to show the latest agricultural scientific and technological achievements to the community, and to promote the construction experience of smart agriculture.

3.2 Enterprise level

Enterprises involved in smart agriculture include businesses in areas such as agricultural science and technology, agricultural machinery and equipment, agricultural pesticides and chemicals, agricultural product processing, agricultural finance, and mobile Internet. It is important to note that agricultural science and technology enterprises specialize in research and development in agricultural science and technology. By integrating with smart agriculture, they help improve agricultural production by providing advanced agricultural equipment, agricultural drones, and precision irrigation techniques. Agricultural machinery and equipment enterprises contribute towards increasing efficiency in production using modern and intelligent machinery. Agricultural product processing enterprises engage in processing and marketing of agricultural products, thus helping obtain information on the quality and yields of the products. On the other hand, agricultural finance enterprises offer more precise financial services that incorporate agriculture loans, agricultural insurance, risk assessments, and loan decisions made after carrying out data analysis and evaluations. Enterprises involved in smart agriculture have close relevance with the field of intelligent agriculture and can provide an abundance of accurate information for the purposes of virtual simulations and training. Through the utilization of simulation platforms, they make it easier to create highly effective practical training environments for higher vocational colleges and universities that specialize in agriculture. Areas like facility agriculture, agricultural big data architecture and modeling, intelligent agriculture, agricultural Internet of Things and sensing technologies, intelligent agricultural equipment, digital service systems, and international agricultural product trade, among others, benefit greatly from theoretical instruction on immersion platforms.

The enterprises will introduce the latest modern core technologies in the sphere of agriculture, but they will cooperate with the agriculture-related higher vocational colleges and universities to develop together and in a comprehensive manner the quality of agricultural production and operation, and their core technologies comprise of modern sensing technology, machine intelligence technology,unmanned aerial vehicles, laser technology,information processing technology, intelligent system integration technology, etc. they can offer big data, Internet of things, artificial intelligence, cloud computing, and so on, and offer everything necessary to advance the development of intelligent agriculture, prompt assistance and support the growth of the technological space of agriculture. With the help of digitization and IT, exact precision in agriculture planting, irrigation, fertilization and plant protection can be done, this is not only useful to reduce the inefficiency and low profitability of conventional agriculture, lower the cost of farming and raise the earnings of farmers, but it also helps to modernize and automate agriculture and achieve its sustainable development.

4 Verification of talent cultivation effect based on virtual simulation

4.1 Sample Selection and Assessment Setting

A total of 240 second-year agricultural students of an agriculture-related higher vocational college were selected as the experimental subjects, which were classified into two groups, the experimental group, and the control group, with 120 students in each group. There were two groups in the experimental group, one the experimental group and the other the control group, each comprising 120 students. The experimental group was founded on the virtual simulation teaching platform to facilitate practical learning and the teaching approach that relied on the idea of aesthetic education whereas the control group was founded on the traditional model of practical learning. Two groups of students are at the same level of learning, they are taught the same curriculum and instructed and evaluated by the same teachers.

The content assessment and satisfaction survey were used to test the practical learning outcomes of the students in different groups. The content assessment mainly consists of a theoretical part and a skill part, with a total score of 100 points. The scores are judged according to the following criteria: [90,100] points are evaluated as excellent, [80,90) points are evaluated as good, [70,80) points are evaluated as medium, [60,70) points are evaluated as qualified, and [0,60) points are evaluated as unqualified. The student satisfaction survey was conducted in the form of a questionnaire from a total of two levels of conscious participation and interest, with the same scores and grades evaluated in the same form as the content assessment.

4.2 Analysis of the results of the applied teaching experiment

4.2.1 Level of agricultural theory

A total of 240 second-year agricultural students of an agriculture-related higher vocational college were selected as the experimental subjects, which were classified into two groups, the experimental group, and the control group, with 120 students in each group. There were two groups in the experimental group, one the experimental group and the other the control group, each comprising 120 students. The experimental group was founded on the virtual simulation teaching platform to facilitate practical learning and the teaching approach that relied on the idea of aesthetic education whereas the control group was founded on the traditional model of practical learning. Two groups of students are at the same level of learning, they are taught the same curriculum and instructed and evaluated by the same teachers.

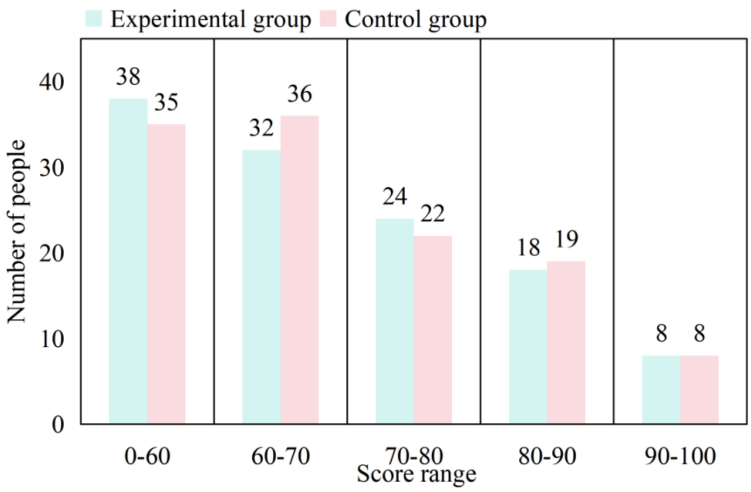


Figure 6: The students' theoretical level in agriculture before the experiment

After a period of experimental teaching, a test on the agricultural theoretical knowledge of the sample students was conducted again. The performance of the two groups of students is shown in Figure 7. Overall, the agricultural theoretical knowledge of both groups of students has improved, but there are differences in specific performance. Among the experimental group, 25 students' agricultural theoretical knowledge was rated as "excellent", 38 students were rated as "good", and only 4 students were rated as "unqualified". In contrast, in the control group, only 13 students' agricultural theoretical knowledge was rated as "excellent", 26 students were rated as "good", and 13 students were rated as "unqualified". That is, the students in the experimental group, assisted by the technology and teaching concepts of this article, achieved more outstanding agricultural theoretical scores compared to the students in the control group.

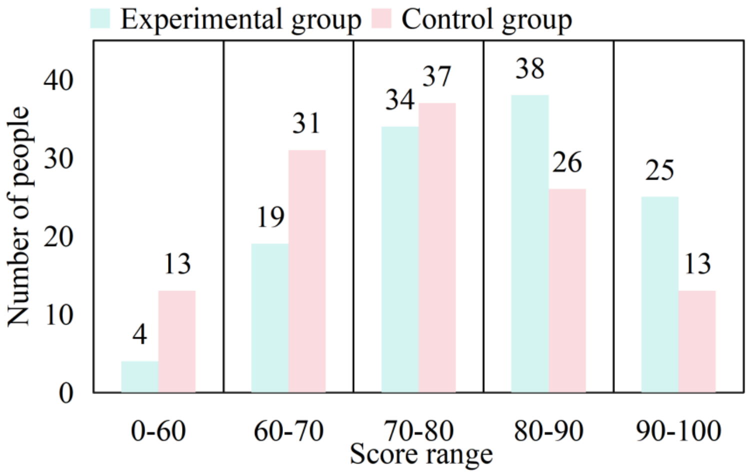
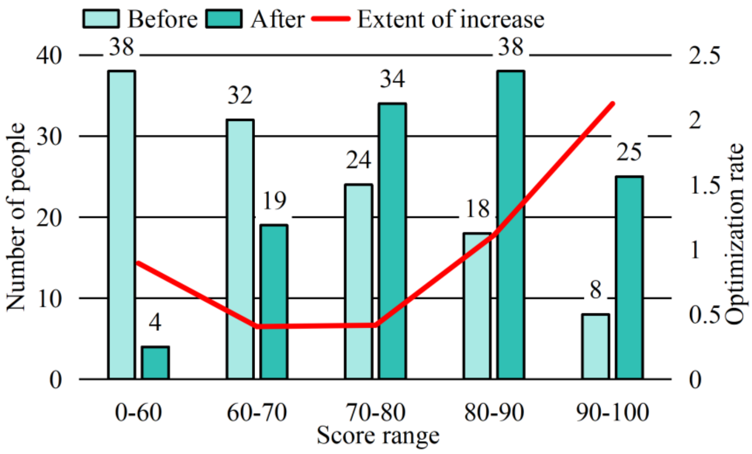
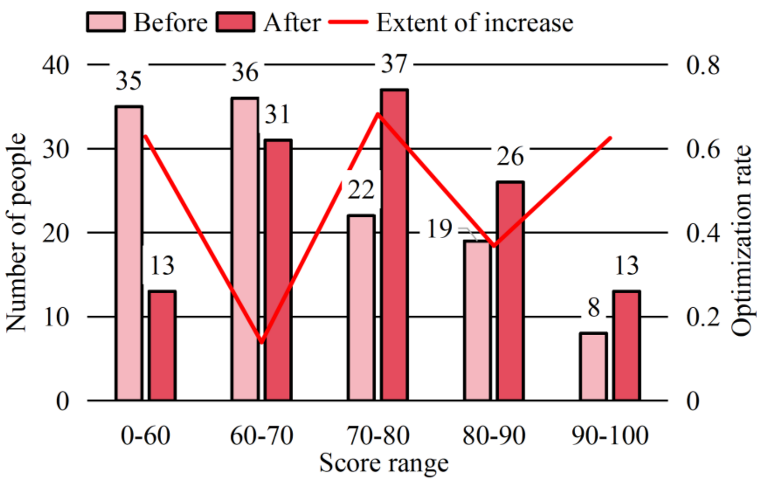


Figure 7: The students' theoretical level in agriculture after the experiment

The changes in the performance of students' agricultural theory level before and after the experiment in the comparative experimental group are shown in Fig. 8(a), and the changes in the performance of students' agricultural theory level before and after the experiment in the control group are shown in Fig. 8(b). The rate of improvement of agricultural theory level of the students in the experimental group in each achievement interval ranged from 0.4063 to 2.125, and there was an exponential increase in the [90,100] interval, with a larger rate of improvement. In the control group, the students' agricultural theory level in each achievement interval improvement rate is between 0.1389~0.6286, not only compared to the lower rate of improvement, and the biggest increase in the achievement interval for [0,60] segments. In contrast, the performance of students' agricultural theory level in the experimental group assisted by the technical methods of this paper is more superior.



(a) Experimental group

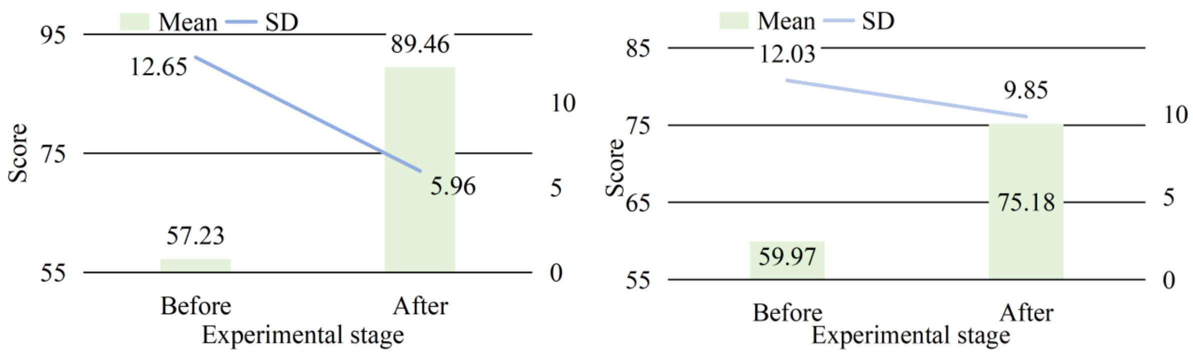


(b) Control group

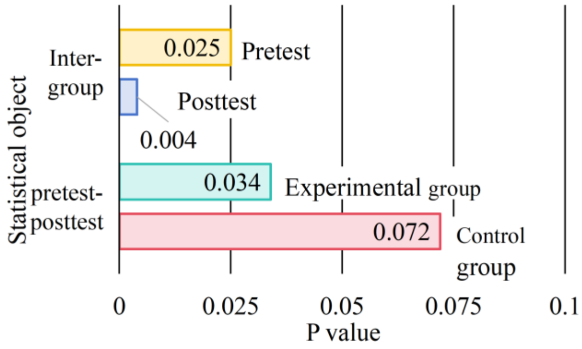
Figure 8: Theoretical scores before and after the intra-group experiment

4.2.2 Level of agricultural practices

Evaluation of the degree to which students are involved in agriculture is mainly based on teachers' assessment. Figure 9(a) represents the degree of agricultural practice among students of the experimental group before and after intervention, Figure 9(b) represents the same measure for the control group while Figure 9(c) presents statistical differences between and within the groups before and after the intervention. Analysis of Figures 9(a) to (c) reveals that the experimental and control groups had the same initial values of agricultural practices with a maximum pre-intervention score difference of 3.00 or less. Also, both groups had very high intra-group variance (SD>12.00). After the intervention, the value of agricultural practices increased for the experimental group to 89.46, showing a statistically significant increase ($p=0.034<0.05$), but with a decrease in intra-group variance (SD=5.96). Conversely, for the control group, the score of agricultural practices rose to 75.18 but with only a 10.0% increase that is statistically insignificant ($p=0.072>0.05$). This implies that students of the experimental group performed better than those of the control group in terms of agricultural practices after the intervention. Moreover, since the statistical significance level for the comparison of the post-intervention scores of agricultural practices between experimental and control groups is $p=0.004<0.05$, there is statistically highly significant difference between them ($p=0.004$).



(a) Experimental group (b) Control group

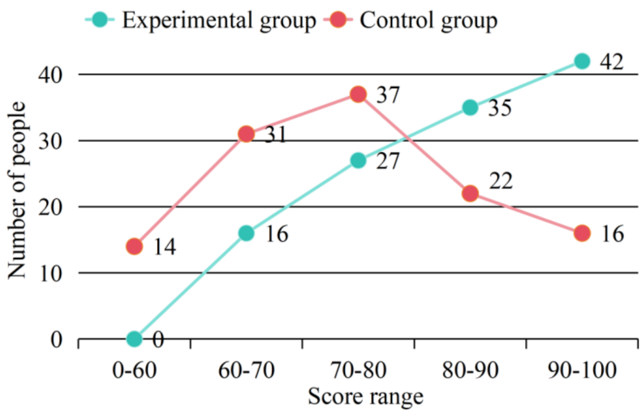


(c) Significance level

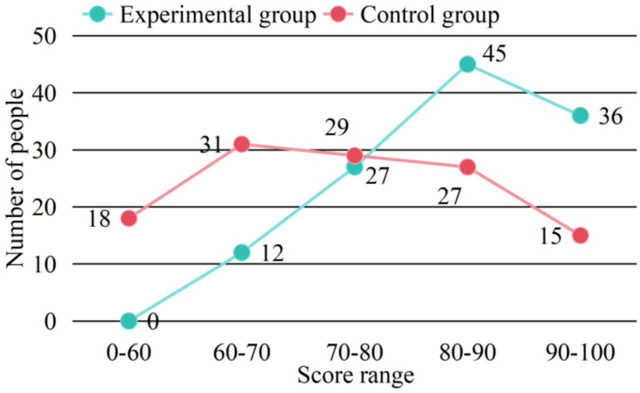
Figure 9: Students' agricultural practice level

4.2.3 Teaching Satisfaction Survey

The questionnaire survey was used to obtain the conscious participation of the sample students in their teaching model after the experiment in Figure 10(a) and the interest level in Figure 10(b). The number of students in the experimental group increased with the increase of scores, and reached the highest point in the [90,100] segment, with a total of 42 students with a high level of participation, more than 1/3 of the number of students in the group, indicating that students in the experimental group are very willing to participate in the practical teaching of agriculture assisted by the technological methods in this paper. In addition, the experimental group of students' satisfaction with the teaching model also increased with the increase of the score, but the difference is that the number of students in the [80,90] subsection of the highest point (45), [90,100] subsection (36) is ranked second. On the whole, the agricultural teaching mode assisted by the technical methods in this paper can greatly stimulate students' interest and willingness to learn, and promote the improvement of agricultural teaching practice. The control group of students for consciously participate in the degree of interest in the choice of [70,80) subsection for the highest point, respectively, the number of 37, 29, and the number of people in each subsection of the difference is relatively small, indicating that the overall interest in the practical teaching of agriculture is not very interested.



(a) Voluntary participation



(b) Interestingness

Figure 10: Student satisfaction situation

5 Conclusion

The current paper is a combination of the features of the intelligent agriculture application demand for talents, as well as a discussion of a talent development way that could integrate the three-dimensional virtual simulation technology and the idea of aesthetic education. The path uses a practical training virtual simulation teaching system with the point cloud alignment and develops a teaching plan under the idea of aesthetic education and human development to implement the course teaching in agriculture-related higher vocational colleges and universities. During the teaching application experiment, the majority of the students in the experimental group were placed in the [80,90) range of agricultural theory and there was an exponential growth in the [90,100] range, and the growth rate of each range was between 0.4063-2.125. The agricultural practice level also improved significantly following the experiment (P=0.034) and overall intra-group difference was minimized (SD=5.96). Over half of the students reported more than 80.00 in teaching satisfaction, conscious participation, interest rating.

Relying on a large amount of real data provided by relevant enterprises, the virtual simulation teaching platform can accurately restore a number of agricultural teaching, production and practice scenarios, and promote the improvement of students' learning effect through the “garden-school linkage” synergy, responding to the talent needs of intelligent agriculture.

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