

The Construction of a First-Class Course of Virtual Simulation Experimental Teaching of New Agricultural and Cultural Integration of Economy and Management in the Context of the Deep Integration of Industry and Education under the Background of Information Technology—The Construction Case Analysis of “Virtual Simulation Experiment of Intelligent Agricultural Operation of Aquaponics”

Shaobao Liu^a, Zhuo Bian^b

^aSchool of Marxism of Suqian University, Suqian, Jiangsu, 223800, China. Email: 29009@squ.edu.cn

^bArt Academy of Northeast Agriculture University, Harbin, Heilongjiang, 150001, China

Abstract. In this paper, a three-dimensional virtual model of an agricultural robot is established by describing and analyzing the position and attitude of the agricultural robot and the workspace, and it is imported into ADAMS software for further model import and design. The agricultural robot operation course incorporates new technologies such as virtual simulation technology, creating a “virtual and real” teaching situation. By arranging comparative teaching experiments and analyzing the experimental data, we assessed the changes in the operation ability, attitude, teaching effect, interest and immersion of the agronomy students. The conclusions showed that the use of virtual robot teaching presented a significant effect ($P < 0.05$) in the development of students’ operation ability and attitude compared with physical robot teaching. In terms of immersion, virtual robot teaching was comparable to physical robot teaching ($P = 0.126$). The pre- and post-test composite assessment scores of the virtual class increased from 70.8 to 88. All of the students’ virtual teaching interest assessments exceeded a score of 4, which is a high interest value. Therefore, the results of this paper play a role in promoting the teaching reform of the agricultural robotics course.

1. Introduction

Modern information technology has become the dominant technology of the century, and modern information technology education is a fundamental area for understanding and mastering modern information technology. There are still a variety of doubts about the understanding of modern information technology,

Corresponding author: Shaobao Liu, mail address: 29009@squ.edu.cn

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and there are also many aspects of the nature of modern information technology education and its developmental laws that need to be clarified, explained and made clear in order to establish a corresponding theoretical structure for guiding teaching and learning practice activities [1–3].

With the rapid development of science and technology, smart agriculture virtual simulation technology has become a powerful tool to promote agricultural education and practice. Constructing a virtual simulation laboratory of smart agriculture that combines virtual and real can not only meet the needs of actual agricultural training, but also give full play to the advantages of virtual simulation software [4, 5]. The first point of building a virtual simulation laboratory for smart agriculture is to adhere to the concept of combining virtual and real. That is, through digital technology to build a virtual environment, and the actual agricultural production is closely integrated, so that students can both conduct simulation experiments in the virtual environment and field internships in actual farms, to achieve a high degree of integration of theory and practice [6, 7]. In order to enhance students' sense of immersion and participation, the laboratory needs to be equipped with hardware devices for multi-sensory interactive experiences. For example, virtual reality head-mounted displays, interactive touchscreens, motion capture systems, etc., which enable students to get a more realistic feeling in the virtual farm and increase the depth of the subject experience [8, 9].

Literature [10] stated that the experimentation of agricultural machinery is limited by the crop production season, if the crop cycle is missed it will prolong the development time, virtual reality can be utilized to complete the initial experimentation, which will reduce the losses caused by these problems. Literature [11] states that the use of IoT and cloud smart plantations is the need of the hour. By measuring a range of parameters such as temperature and humidity, smart plantations are able to detect the health of plants. Literature [12] emphasized the importance of virtual reality technology for experimental teaching. A virtual experiment model was designed, and a transplantation machine and a working scenario were established in a virtual reality environment, which led to the design of a virtual teaching system. The virtual operation is extremely safe, and the learners can also repeat the operation to improve the learning efficiency. Literature [13] shows that the control platform of unmanned farms is important in promoting the supervision of agricultural production with less manpower and the construction of agricultural informatization. It reduces labor as well as management costs. Literature [14] mentions that the approach of simulation and evaluation in virtual environments can provide economically reliable frameworks for experimenting with different sensing and action mechanisms, so that this can validate the performance function of the robot in dynamic scenarios.

In this paper, the kinematic simulation of the overall structure of an agricultural robot was carried out using ADAMS software, and forward motion simulation and inverse motion simulation were performed by importing a simplified model of the robot into ADAMS. Agricultural robot virtual simulation system can be created by creating a combination of virtual and real teaching situations, building a rich variety of teaching scenarios in teaching, teaching to specific scenarios, solving the problems existing in traditional teaching, and realizing efficient classroom. Through into the virtual and real robot teaching with pre and post-test comparison experiments, as well as the collection and analysis of experimental data, the students' programming ability, attitude, immersion, learning effect and attitude and other aspects of the data after learning robotics were counted, analyzed, and relevant conclusions were drawn.

2. Reform of the Teaching of the Virtual Robot Operation Course

2.1. Reform Ideas for Teaching Agricultural Robot Operation Course

Digital transformation of the agricultural industry, agricultural equipment along with the development of science and technology and progress is also imperative. Agricultural robot as a typical intelligent agricultural equipment, not only has the common technology of conventional robots, but also has significant agricultural characteristics, application scenarios are diverse and complex, involving a wide range of technology categories, high intelligence requirements, and also the depth of the combination of agronomic technology. Although China's agricultural robotics research started late, but has achieved good results, has developed a variety of robots such as plowing robots, weeding robots, fertilizer robots, spraying robots,

picking robots, vegetable grafting robots, and so on, part of which has entered the practical stage. The idea of agricultural robot operation course teaching reform is shown in Figure 1.

The high cost, high risk, single scene and other problems existing in the traditional robot operation course teaching limit the course to realize efficient classroom, and it is necessary to introduce virtual simulation and other technologies to reform the design from the teaching method, teaching materials, teachers and other aspects.

1. Create a teaching scenario that combines "virtual and real". In the new teaching process, the creation of a combination of virtual and real environments, integrated into the virtual simulation system of agricultural robots, build a variety of production training scenarios to carry the skill objectives, and organize the students through the virtual scene training, combined with the operation of the physical equipment practice, so as to overcome the difficulties of the traditional robotics course teaching, and to efficiently complete the students' skills-based teaching objectives.
2. Build a "cloud-ground hybrid" teaching platform. In the new teaching environment, we prepare "cloud-ground hybrid" teaching resources suitable for virtual simulation environment, breaking up the systematic and complicated knowledge system and reassembling it to form project-oriented and fragmented resource particles. The resource particles are scattered in various parts of the textbook, and provide the entrance for students to learn in the form of QR code and platform link, thus expanding the teaching space from the classroom to any place where self-learning is possible, and expanding the teaching time from the fixed classroom time up and down to the infinite.
3. Forming a "multi-party integration" teaching environment. In the new teaching atmosphere, the teaching of agricultural robotics courses requires updated teaching concepts, the need for enterprise engineers to participate in teaching, but also the need for teachers, engineers, students and other multi-party communication, thus forming a "multi-party fusion" teaching and communication environment.

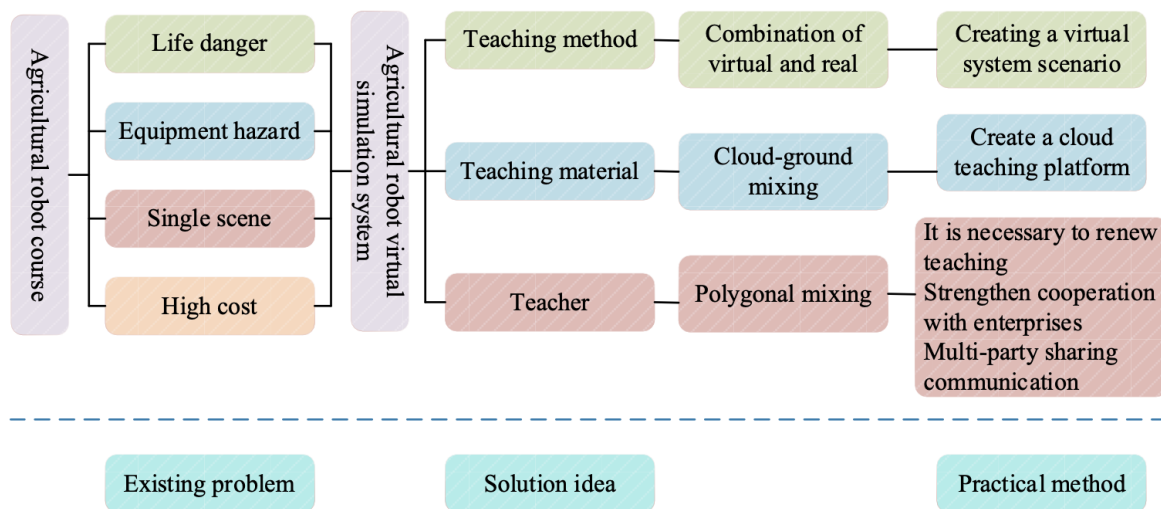


Figure 1: The idea of teaching reform of agricultural machinery operation course

2.2. The Realization of Virtual Simulation Teaching System

This section mainly describes the system development process, introduces the knowledge of the system's teaching module, the composition of each part, the realization method and key technologies, presenting a concise and clear form, easy to understand. As the virtual simulation teaching system contains more elements, the virtual scene within the calculation of a larger amount, so the use of higher configuration of the computer to carry out the development of the system.

2.2.1. Introduction to the Simulation Teaching System

According to the system design program, the basic teaching module consists of three parts, including system introduction, structure cognition, and working principle demonstration. Among them, the system introduction is mainly in the form of text dubbing and pictures to make a brief introduction to the development background, development trend and application areas of KUKA virtual agricultural robot operation.

2.2.2. Virtual Agricultural Robot Operational Structure Awareness Module

The structural cognition module contains the structural components of the virtual agricultural robot operation. The system adds the function of free disassembly and display, and combines the highlighting of the text of parts and components, text introduction, voice pictures and other multimedia effects to display comprehensively. The system adds the rotation animation of each axis, clicking on the corresponding X, Y, Z axis buttons in the lower right corner can realize the rotation of the corresponding axis as well as the clamping and relaxation of the fixture.

1. The realization of free splitting of the operating structure of the virtual agricultural robot. In order to make the experimenter observe the structure composition of the virtual agricultural robot operation more clearly and intuitively, the script code is mounted on the operation model parts of the virtual agricultural robot, which converts the world coordinates of the target model in Unity to the spatial coordinates of the two-dimensional screen and stores them, stores the screen spatial coordinates of the left mouse button when the left mouse button is pressed and moved and increases the offset, and then converts the screen spatial coordinates to the world coordinates of the model at last.
2. Virtual agricultural robot operation joints animation display. The rotation animation of each axis of the virtual agricultural robot operation model is divided into frames and mounted on the model, and the model animation is directly called by clicking the Button buttons of X-, X+, Y-, Y+, Z-, Z+, clamping, relaxing and so on.

2.2.3. Self-test Assessment Module

The self-test assessment module assesses the students' mastery level of theoretical knowledge of virtual agricultural robot operation in the form of selective judgment. Experimenters can continuously apply the theoretical knowledge in the experimental process to prove and strengthen the correctness of the theory by practice, so as to realize the teaching goal of integrating theory and practice.

3. Research and Simulation Analysis of Agricultural Robots

3.1. Overview of Robot Kinematics and Related Definitions

A robot is a mechanism that moves in space with multiple degrees of freedom. First of all, some definitions related to robot kinematics: description of a point in space: any point in space can be expressed by a column vector of 3×1 . For example, a point G in space, the position of G in space can be expressed as: $o = [G_x, G_y, G_z]$, where O represents the origin of the reference coordinate system, and G_x, G_y, G_z represents the displacement in the X, Y, Z direction.

The chi-square coordinates of a point can be represented by any 4 numbers that are not simultaneously 0. It is related to the column vector of any point above.

Chi-Square Coordinate Transformation: one coordinate system can be rejoined with another coordinate system by translations or rotations. Let there be two coordinate systems M and N and a point in space S . The position of the point S in the M coordinate system is mS . The attitude of the origin of the M coordinate system with respect to the position of the N coordinate system can be represented by the translation matrix nP_m and the rotation matrix nR_m . The position of the point S with respect to the N coordinate system is then

$$S = {}^mS {}^nP_m {}^nR_m \quad (1)$$

Establishment of coordinate system for connecting rods: in order to express the mathematical relationship between adjacent connecting rods, it is necessary to establish a coordinate system for each connecting rod, usually the establishment of the coordinate system method has D-H method and five-parameter method and matrix transformation method. The principle of this method is to express the relationship between neighboring connecting rods through two connecting rod coordinate systems, through the translation matrix and rotation matrix to make the two connecting rod coordinate systems coincide, and use the chi-square transformation matrix to express the relationship between the connecting rods to make the coordinate systems coincide. After many transformations, the chi-square transformation matrix of the coordinate system of the end-effector with respect to the base coordinate system can be obtained, and the position of the end-effector in the space of the base coordinate system is also obtained.

The chi-square transformation matrix that expresses the relationship between neighboring links n and $n - 1$ is denoted as the A -matrix, which expresses the chi-square transformation matrix in which the coordinate system of link n reaches a complete coincidence with the coordinate system of link $n - 1$ through a series of translations and rotations. If A_1 represents the position of the first robot arm with respect to the base coordinate system, and A_2 represents the position and attitude of the second robot arm with respect to the coordinate system of the first robot arm, then the position and attitude of the second robot arm with respect to the base coordinate system can be shown by the following matrix:

$${}^0_2T = A_1A_2 \quad (2)$$

The chi-square transformation matrix is created with all of the connecting rods in a defined coordinate system; it is possible to take one connecting rod coordinate system and make it coincide with the neighboring rod coordinate systems by means of transformations such as translations and rotations. Let's take i -rod and $i - 1$ -rod as an example of transformation. There are four parameters in total, and the specific meanings of these four parameters are:

1. a_i : the length of the connecting rod. The distance measured along x_i , from z_i to z_{i+1} , is also the shortest distance between the two jointed axes.
2. α_i : the angle of twist of the connecting rod. From z_i to z_{i+1} , along the angle measured by x_i , move either axis of the same connecting rod in the other direction so that the two intersect, then these two axes will determine the plane, which is perpendicular to the length of the connecting rod, and the angle of intersection of the planes determined by these two lines will be α_i .
3. d_i : the offset of the connecting rod. The distance measured from x_{i-1} to x_i along z_i is the distance between connecting rod $i - 1$ and connecting rod i along the axis of joint $i - 1$.
4. θ_i : the variable angle of the joints of the connecting rods. The angle measured from x_{i-1} to x_i along z_{i-1} , when the connecting rod joint is a rotary joint, represents the angle at which one connecting rod is turned along the z -axis relative to the other.

After establishing each linkage coordinate system, the transformation relationship between coordinate system $i - 1$ and coordinate system i can be realized by translation and rotation of the coordinate system. The transformation from the $i - 1$ coordinate system to the i coordinate system can be realized by first rotating the $i - 1$ coordinate system around the Z_{i-1} axis by θ_i angles, then translating it along the Z_{i-1} axis by d_i , then translating it along the X_i axis by a_i , and finally rotating it around the X_i axis by α_i angles. A transformation matrix A_i is used to synthesize the above four transformations. It should be noted that the coordinate system changes after each rotation or translation, and the latter transformations are performed relative to the moving coordinate system, and therefore should be right-multiplied in the operations. The transformation of coordinate system i with respect to $i - 1$ can be regarded as the product of the following four sub-transformations, and the expression is as follows:

$$A_i = \text{Rot}(z, \theta_i) \text{Trans}(0, 0, d_i) \text{Trans}(a_i, 0, 0) \text{Rot}(x, \alpha_i) \quad (3)$$

By multiplying four different translation and rotation matrices, we can obtain the matrix A . Based on the variables and parameters of each joint of the robot that we have obtained, we bring them into the translation

matrix $\text{Trans}(p_x, p_y, p_z)$ and the rotation matrix $\text{Rot}(\kappa, \theta)$. The expression for the chi-square transformation matrix A can be obtained as follows:

$$\text{Rot}(x, \alpha) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos \theta & -\sin \theta & 0 \\ 0 & \sin \theta & \cos \theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad \text{Rot}(z, \theta) = \begin{bmatrix} \cos \theta & -\sin \theta & 0 & 0 \\ \sin \theta & \cos \theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (4)$$

$$\text{Trans}(0, 0, d) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad \text{Trans}(a, 0, 0) = \begin{bmatrix} 1 & 0 & 0 & a \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (5)$$

Bringing the results of the translation and rotation matrices into the previous expression, we obtain an expression for the chi-square transformation matrix A_i :

$$A_i = \begin{bmatrix} \cos \theta_i & -\sin \theta_i \cos \alpha_i & \sin \theta_i \sin \alpha_i & a_i \cos \theta_i \\ \sin \theta_i & \cos \theta_i \cos \alpha_i & -\cos \theta_i \sin \alpha_i & a_i \sin \theta_i \\ 0 & \sin \alpha_i & \cos \alpha_i & d_n \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (6)$$

This gives us the chi-square transformation matrix of one link relative to the other between neighboring links.

3.2. Determination of the Angle Range of Robot Joints

When the robot is running, the base is fixed on the platform, and the movement of the robot's big arm and small arm should not allow the robot's end-effector to touch the platform, which requires a certain range of angles for joints two and three. Since the large and small arms of this robot are of equal length:

$$1000 \sin\left(\theta_2 + \frac{\theta_3}{2}\right) \cos \frac{\theta_3}{2} \leq 500 \quad (7)$$

Where θ_2 is the corner of the shoulder joint 2 and θ_3 is the corner of the elbow joint.

During the operation of the robot due to the different sizes and shapes between the individual rods, it is necessary to avoid the interference phenomenon of the individual rods. Joins to view the rods as cylindrical rods to satisfy the following conditions, where D represents the shortest distance between each group of rods, and d represents the diameter of the connecting rod.

After analyzing the structure of this robot we have determined the angle range of the three groups of individual joints as:

- Group I: $0 \leq \theta_1 \leq 180, 0 \leq \theta_2 \leq 180, -90 \leq \theta_3 \leq 90$.
- Group II: $-90 \leq \theta_1 \leq 90, -45 \leq \theta_2 \leq 135, 45 \leq \theta_3 \leq 90$.
- Group III: $-60 \leq \theta_1 \leq 60, 45 \leq \theta_2 \leq 135, -90 \leq \theta_3 \leq 90$.

Since the end-effector of this robot is a nozzle, it does not need degrees of freedom to determine the hand attitude, so we only need to make a set of positional joints, and the following are the steps to solve the workspace:

1. The position vector of the end-effector in space is obtained using the robot kinematics obtained as described above, and used as a reference coordinate system:

$$\begin{bmatrix} p_x \\ p_y \\ p_z \end{bmatrix} = \begin{bmatrix} 500c_1(c_{23} + c_2) \\ 500s_1(c_{23} + c_2) \\ 500(s_{23} + s_2 + 1) \end{bmatrix} \quad (8)$$

2. Firstly, the random function $rand_i()$ ($i = 1, 2, 3, \dots, n$) is used to generate N random values between 0 and 1, and then the corner range ($\theta_i^{min} \sim \theta_i^{max}$) of each axis is multiplied, so that we get N random values in the corner range. The random values for the corner of the robot are:

$$\theta_i = \theta_i^{min} + (\theta_i^{max} - \theta_i^{min}) \times rand_i() \quad (9)$$

In the above equation θ_i is the equation representing the angle of the joint, where $\theta_i^{max} - \theta_i^{min}$ represents the range of variation of the joint variable, θ_i^{min} is the minimum value of the joint angle, the maximum value of the joint angle θ_i^{max} is a random number between 0 and 1 given by $rand_i()$.

3.3. Modeling Robot Simulation

The motion simulation process performed by the agricultural robot is shown in Figure 2.

1. **Import the agricultural robot model from UG into ADAMS.** You must first change the format of the model in UG, save the model in UG to Parasolid format, and then import it into ADAMS.
2. **ADAMS model setting.** After importing the agricultural robot into ADAMS, you can assign different colors to the master and slave arms and the static and dynamic platforms of the robot for easy observation and differentiation.
3. **Applying simulation constraints.** According to the structure of the agricultural robot, the constraints are created in ADAMS to match its structure. Firstly, the fixed vice Fixed is created between the static platform and the ground with the purpose of fixing the static platform to the ground. Then create the rotation vice R between the active arm and the static platform, and finally create 2 spherical vice S between the active arm and the slave arm, and also need to create 2 spherical vice S between the slave arm and the moving platform.
4. **Add drive.** In the forward kinematics simulation analysis, through the Rotational Joint Motion command in the main toolbox to add the driving function for the three active arms, respectively, can also be given directly to the angular velocity, the other has a different angular velocity. In the reverse kinematics simulation analysis, a three-dimensional point driving function is set in the center of the moving platform.
5. **Simulation and result output.** After the simulation needs to use post-processing Postprocessor module, can see the relevant curves, but also can be extracted. The simulation results can also be integrated, derivatives and other operations. The above can help agricultural robots to analyze the kinematics and get to the data, curve class.

4. Experimental Research on the Teaching of New Professional Farmers

4.1. Comparative Study of Virtual and Physical Teaching and Learning

This study attempts to compare and contrast the teaching of virtual agricultural robot operation and physical robot operation in terms of (1) what is the difference between the teaching of virtual agricultural robot operation and physical agricultural robot operation in terms of operation ability, (2) what is the difference between the teaching of virtual agricultural robot operation and physical agricultural robot operation in terms of attitude, and (3) what is the difference between virtual agricultural robot operation and physical agricultural robot in terms of immersion. The experimental subjects of this study were selected from two classes of farmers in the training course for new vocational farmers, each with 35 students.

4.1.1. Analysis of Teaching Content

The content analysis is shown in Table 1, and the teaching experiment was conducted simultaneously in two classes, both of which used the same teaching methodology and teaching cases, with the difference that: when class A was taught using virtual agricultural robot operation, class B was taught using physical robot operation. The formal experimental process was divided into two phases (each phase lasted approximately 1 semester and 9 weeks).

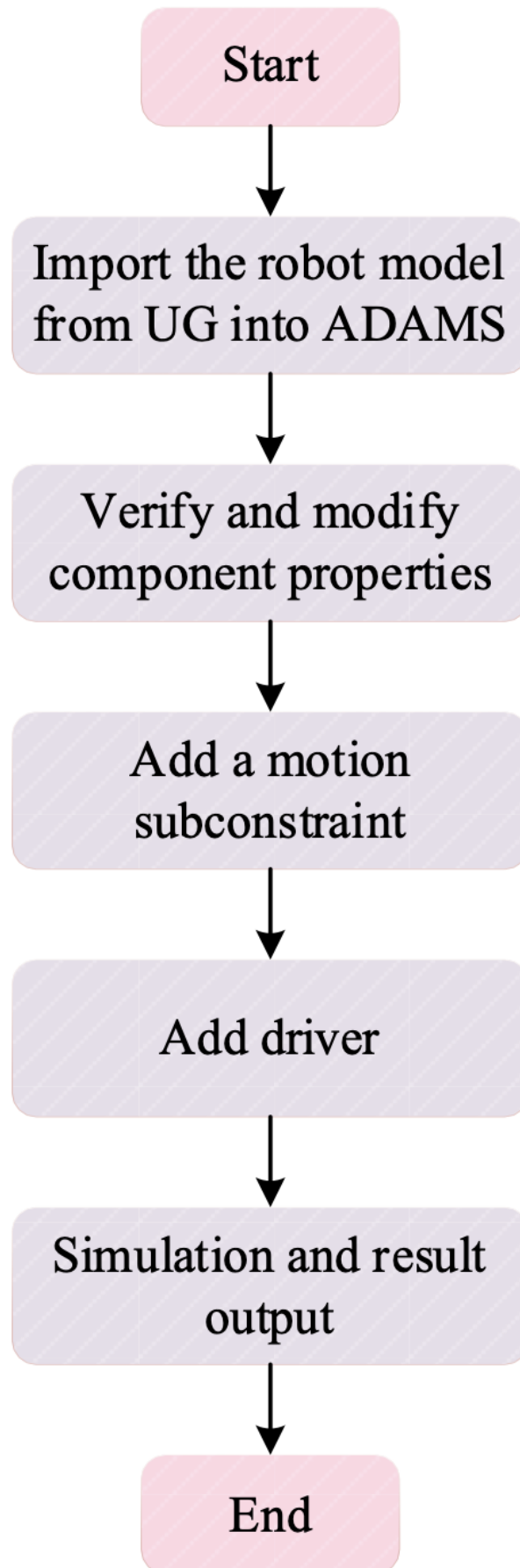


Figure 2: The motion simulation process of agricultural robot

Table 1: Basic knowledge of teaching

Title	Agricultural machinery content		Week
First lesson	Mysterious robot	Introduction of agricultural machinery	4
Second lesson	Agricultural machinery engineering design	The cognitive structure of the assembly body	3
Third lesson	The car is our bank	Intelligent rotary cultivator	5
Fourth lesson	Mechanical assembly	Hydraulic drive	3
Fifth lesson	Maintenance of agricultural machinery	Engine, transmission system, steering system	3

4.1.2. Analysis of Attitudinal Differences

A total of 140 questionnaires were distributed before and after the experiment: 35 pre-tests and 35 post-tests for the physical teaching class and 35 pre-tests and 35 post-tests for the virtual teaching class. In order to get the changes in the attitude of the two classes before and after the experiment, this study used SPSS to analyze the experimental data, the data are shown in Figure 3, the overall significance of the virtual class on the pretest and posttest is 0.029, which is less than 0.05, which indicates that the attitude of the students of the virtual class to learn robotics before and after the study is a significant difference, which is mainly reflected in the aspect of self-confidence. The reason for this result may be that primary school students have almost no contact with virtual robots and are not very fluent in computer operation, but after a period of time, students find 3D virtual robots easy to learn and operate, and also feel the powerful functions of 3D virtual robots.

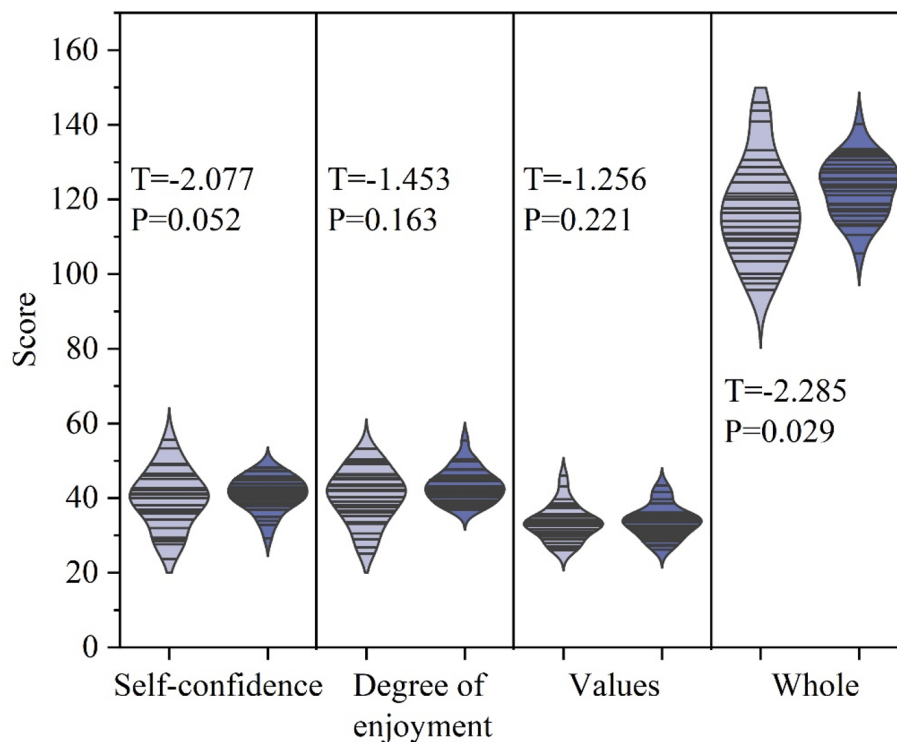


Figure 3: Attitude analysis (virtual class)

The results of the analysis of differences in the attitudes of the physical class are shown in Figure 4, the overall significance of the attitudes of the students in the physical class before and after learning robotics is 0.252, which is greater than 0.05, indicating that the attitudes of the students in the physical class towards

robotics did not change significantly after the students received instruction in physical robotics for a period of time. From the data in the table, it is clear that the students in the physical class have good attitudes before and after learning robotics.

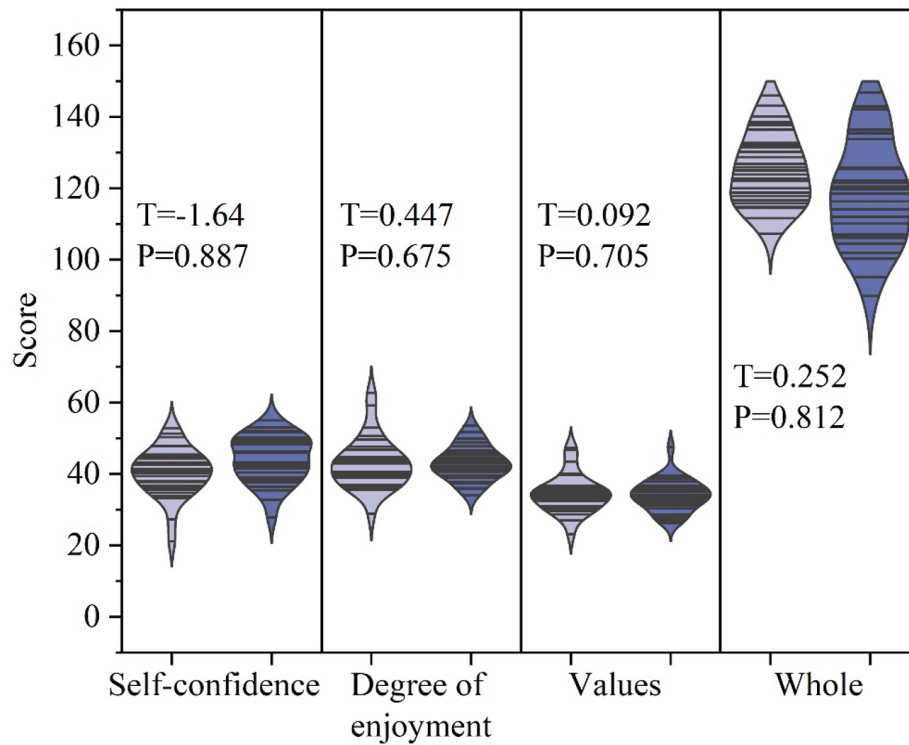


Figure 4: Attitude analysis (entity class)

4.1.3. Analysis of Differences in Immersion

The immersion difference analysis is shown in Table 2, where the overall significance of the physical and virtual classes in the posttest is 0.126, indicating that there is not a significant difference in the immersion level of the students in the physical and virtual classes in learning robotics after one stage of instruction. This result suggests that virtual robotics instruction is not comparable to physical robotics instruction in terms of immersion. The reason for this phenomenon may be that the simulation scenarios can quickly attract students and be more immersive, while students can concentrate on building 3D virtual robots and can quickly realize the robots they want to build. Therefore, we can draw a preliminary conclusion: in terms of immersion, the choice of virtual robot teaching can achieve teaching effects similar to those of physical robots.

4.1.4. Analysis of Operational Capacity

The comparative analysis of the operation ability of the two stages of new vocational farmers is shown in Figure 5, and we processed the operation ability scores of new vocational farmers of the virtual class and the entity class separately in SPSS. The hollow circles in the figure represent the operational achievements of the trained students, the horizontal coordinates are the achievements of the new vocational farmers in the physical class, and the vertical coordinates are the achievements of the new vocational farmers in the virtual class, and most of the achievements of the trained students in the figure are distributed on the top of the Y-X line of the coordinate system. By comparing the horizontal and vertical coordinates of each circle, it can be concluded that the operation ability of the virtual class is better than that of the entity.

Table 2: Immersion analysis

Dimension	Class	M	SD	T	P
Behavior	Aftertest	21.42	3.526	1.594	0.120
	Pretest	20.23	3.262		
Affections	Aftertest	22.84	3.536	0.886	0.396
	Pretest	20.13	2.546		
Cognition	Aftertest	13.36	2.285	1.214	0.247
	Pretest	12.78	1.895		
Whole	Aftertest	57.49	8.63	1.584	0.126
	Pretest	54.93	4.47		

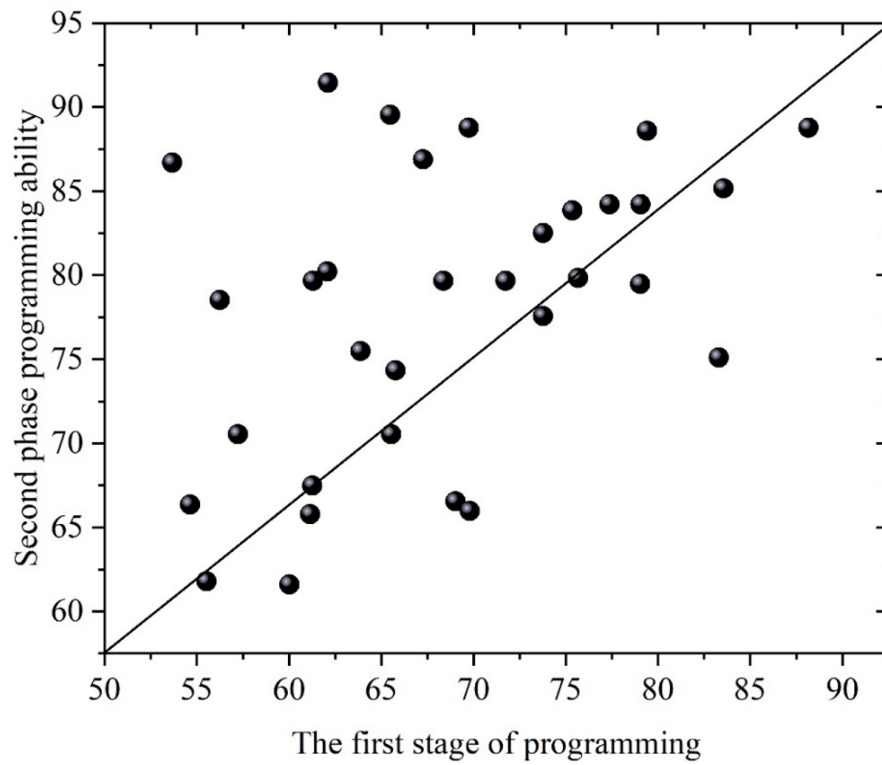


Figure 5: Programming migration ability analysis

4.2. Pre- and Post-Test Comparison of Virtual Teaching Effectiveness

Learning Effectiveness Testing identifies and improves problems in user experience through user feedback and observation of user behavior. Utilize automated testing tools or scripts to automate testing of various system functions to improve testing efficiency and coverage. Check the user documentation and technical documentation of the system to ensure its accuracy and completeness for users and developers to understand and operate the system. After testing the platform with 35 students in the virtual class, the test results show that all the functions of the virtual lab platform can be successfully implemented. As shown in Table 3, this paper in the 30 students randomly selected the results of 5 students, through the system background test results show that the comprehensive assessment of new professional farmers significantly improved by the average score of the pre-test 70.8, increased to 88 points. New vocational farmers need to more accurately master the operation and maintenance skills of agricultural robots, so the combination of virtual reality technology and robot equipment structure teaching, through the design of simulated real experimental environment, show the rotating mechanism, actuators and other related robot parts, the role of the robot equipment assembly process, so as to make the teaching content more vivid and intuitive. Such a teaching strategy can not only improve the interest and enthusiasm of new vocational farmers in experimentation, but also effectively enhance the learning effect, and then improve the proficiency of experimental operation.

Table 3: Comparison table of learning effects before and after

Student number	Test content	Pretest	Aftertest
1	Method testing for rotary cultivator	66	84
2	Assembly sequence test	72	90
3	The rotary cultivator fault description test	67	87
4	The assembly model position test	73	90
5	File format and structure selection	76	89

4.3. Interest Assessment

The hydraulic transmission course is difficult, and the hydraulic transmission course combined with virtual reality technology can help new professional farmers understand the course to a certain extent, and improve the learning interest of new professional farmers. A questionnaire survey was organized to assess the learning interest of new professional farmers. The responses ranged from 1 to 5 (1-strongly disagree, 2-disagree, 3-neutral, 4-agree and 5-strongly agree). The 6 questions were: the teaching experiment system was interesting, helped me to understand the difficult points of the knowledge, allowed to construct the circuit according to my own understanding, improved the efficiency of learning, promoted more participation and satisfied me. The average scores of the new professional farmers on the six questions are shown in Figure 6. The average score for each question was above 4, indicating the recognized role of this virtual agricultural robot manipulation instruction in farmers' learning. The highest mean ratings were found on the questions of how satisfied the new professional farmers are with this teaching system and how this teaching system promotes more participation of the new professional farmers, which reached 4.47 and 4.73, respectively.

5. Conclusion

This paper combines virtual reality technology to realize virtual agricultural robot operation teaching by modeling, simulating the use, maintenance and assembly of real agricultural robots and other training contents. Students majoring in agriculture can experience the training course of agricultural robot operation in an immersive way through the virtual laboratory, so that they can optimize the agricultural technology plan faster in order to improve the digital literacy and information skills of new professional farmers. By comparing the teaching effects of virtual and physical robots, the use of virtual agricultural robots in

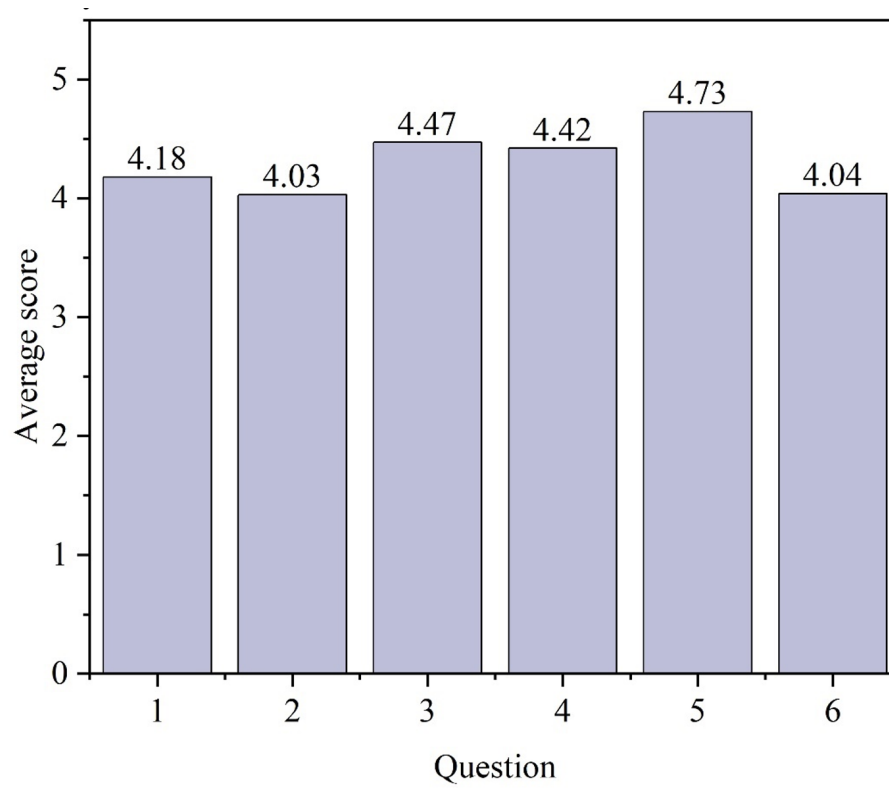


Figure 6: Average score for each problem

teaching can guarantee the teaching effect of robots, cultivate students' operation ability and effectively promote students' attitudes towards learning robots. In the pre- and post-test comparative analysis of the virtual agricultural robot, the assessment scores were significantly increased by 17.2 points. The students' interest in teaching the virtual agricultural robot was above 4 points.

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