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Design of vehicle steering system testing training in augmented reality environment

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Abstract: *In order to improve steering system detection technology, with the help of Solidworks software and Unity3D platform. Using dynamic simulation and VR technology, a design project of automotive steering system in augmented reality environment was studied, an interactive steering system testing platform was implemented. Experiences include import modules, interaction modules, and UI interface modules through models. Through experiments with more than 100 students, it has been analyzed that under friendly human-computer interaction, this platform can not only achieve interpretation of the vehicle detection process, but also enable testers to become more familiar with and master the detection process, improving detection efficiency. It is also possible to integrate the testing process into the classroom through three-dimensional display, providing students with a novel and vivid, people-centered teaching experience, and achieving good practical results. The project initially explores the application of virtual simulation in intelligent direction and interactive control of vehicle testing, providing beneficial assistance for vehicle testing training and engineering applications.*

Keywords: *Virtual Interactive; Steering System; Detection*

1. Introduction

Since the Ministry of Industry and Information Technology of the People's Republic of China issued the Integrated Development Plan for Informatization and Industrialization (2016-2020). China has gradually begun to support technological breakthroughs and innovations in virtual reality in the field of technology. At the end of 2018, China issued the first policy document with the title of "virtual reality", which shows the importance our government attaches to the development and application of the virtual reality industry. In 2020-2021, China also issued a number of relevant policies on the virtual reality industry, mainly focusing on the in-depth application and industrial integration of virtual reality. In combination with the Guiding Opinions on Accelerating the Development of the Virtual Reality Industry issued in 2018 and the relevant policies on virtual reality issued in 2021. The overall plan for the development of the virtual reality industry in China during the "Fourteenth Five-Year Plan" period was summarized.

At present, China's mechanical products in the design and development and related training in more and more augmented and reality technology combined. Formed a new product development and training model. For example, the design of the virtual disassembly system of the automobile rear axle in the augmented reality environment is [1]. Using augmented reality technology to improve the fault diagnosis and maintenance efficiency of railway transportation equipment [2]. Building a secondary development platform using Pro / Toolkit, Realize the product disassembly and remanufacturing process simulation. Interactive virtual disassembly system developed by using the force feedback device. Research on the construction of sustainable development system of virtual simulation experiment teaching [3]. Application of augmented reality technology in preoperative planning of aortic dissection [4]. Based on the augmented reality technology of low-voltage line barge connection power emergency training [5]. PZ1740E Design of virtual assembly system of offset printing machine [6]. Development of Intelligent Inspection Terminal for Power Plants Based on Augmented Reality (AR) Technology [7].In addition, there are some human-computer interaction motion simulation using Unity3D software. Such as loader motion control simulation based on Unity3D, for virtual assembly teaching system based on Unity3D [8]. For virtual assembly experiment system based on Unity3D [9]. For dam inspection training system based on Unity3D [10]. With the advancement of the intelligent process of China's manufacturing industry, the application prospect of augmented reality technology in the manufacturing industry is broad. And it has good application practices in industrial design, manufacturing and assembly, assembly inspection, equipment maintenance, staff training and other links.

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In order to improve the steering system positioning detection technology, the project studied the enhanced and realistic environment car steering system positioning detection training system design. The project with Solidworks [11]software and Unity3D [12]engine platform. The car steering system positioning detection instrument structure, assembly process and car steering system positioning detection process dynamic simulation and VR. Realize interactive car steering system positioning detection system platform.The platform can not only realize the interpretation of automobile detection process and teaching production practice of three-dimensional display. And through virtual interaction means, make testing personnel further familiar with and master the detection process, so as to get better experience effect.

Through friendly human-computer interaction to trainees novel vivid teaching experience. Preliminary exploration virtual simulation in car detection intelligent direction and interaction control. For design,car testing training and engineering application to provide useful help.

With the rapid development of the virtual reality industry in recent years and the further maturity of related technologies. VR / AR [13] technology is being applied more and more frequently in many fields. At the beginning, AR technology was applied in military, medical and other high-end fields. And the public could not feel it personally, it was not so easy to understand. However, now VR / AR, as a new technology, has entered the stage of accelerated growth after five years of precipitation. AR headset experience improvement, cost-effective products have been launched. Game content enrichment, global technology companies continue to invest. On the one hand, VR / AR shipments increased significantly, on the other hand, the application ecology was gradually improved, and more application scenarios were implemented. Driving the explosive growth of VR / AR industry chain. Facebook In the recent F8 Refresh online event, AR features based on video calls: Multipeer API, Using this tool, developers can add a variety of interesting and immersive AR effects for multiperson video calls. At the same time, the world's largest "tree of life AR Park" in Hangzhou HUB. A wonderful journey of "reality + virtual". Make the artistic conception of "people in the middle of the painting" can be truly touched truly. Ford's directors of design engineering and technical operations each log in to the virtual studio on the HTV Vive AR headset and they can check the vehicle's design progress here. The UK Drivers and Vehicle Standards Agency (DVSA) is using virtual reality (VR) technology to study driver behavior. The agency is working with digital platform and solution company Kainos to simulate drivers' responses to dangerous conditions to improve road safety.

As an important part of automobile testing, automobile steering system positioning is an important maintenance training project for maintenance enterprises and universities, which can effectively improve the driving stability, fuel economy and comfort of vehicles.

2. Scheme demonstration

The AR-based vehicle steering system positioning detection training system takes the Unity3D engine as the development platform. As shown in Fig1.Uses the Solidworks 3D modeling software, and accesses the XML file [14] after the development of the modeling software to realize parametric modeling through XML data management. Take SolidWorks and Unity3D software as an example, and combine the virtual scene with the real environment. Use C # language to program, develop relevant controls and design system UI interface.

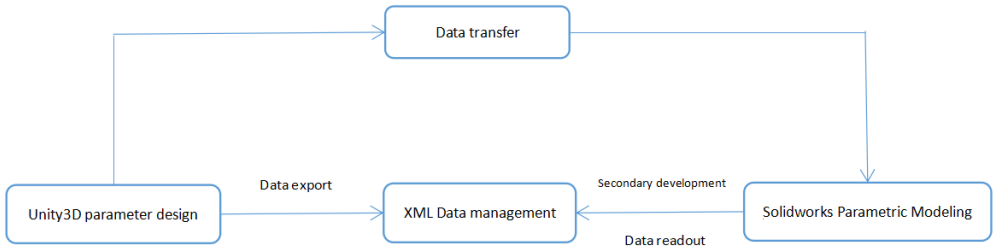

Figure 1: Structure diagram of automobile steering system positioning detection training system.

As a new media information technology, AR technology has not been used for a long time in the field of education and training in China. It can promote effective training through its advantages and specialties, and achieve better training results with as little time, energy and material investment as possible.As a new media information technology, AR technology has not been used for a long time in the field of

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education and training in China. It can promote effective training through its advantages and specialties, and achieve better training results with as little time, energy and material investment as possible.

3. Modular analysis

3.1. Model establishment

The main need to construct three models required for the steering system position detection training system. Which can be built through Soliodworks 3D. In that process, four rotation-positioning instruments, transfer-to-manoeuvre, transfer-transfer, transfer-to-mobile organisations have been established and a model of the model has also been used. A large number of preparatory work has been performed, consult information, measurement and consultation of professionals from the car laboratory. Field measurements and data analysis.

First integration of models into unity3D and then enter procedures in forming modelling and transforming the requirements of Unity3D software into false equipment systems developed through XML data management in the Unity3D engine as shown in Fig2. A parameterization model can be achieved after the second development of the module of the XML document.

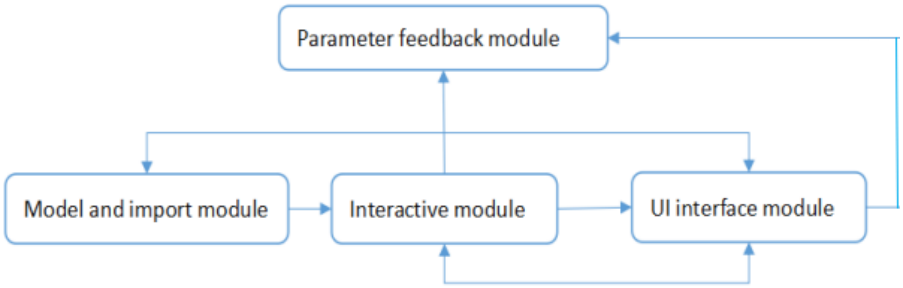

Figure 2: Data transfer flow chart

3.2. Interactive modules

You must first register in the vuforia.

The aim to develop the selection of Target Manger, ADD Database on the right-hand side of the pointer, created a database for entry into the name.

Selection of Device, then create, emphasize only the construction base, emphasize ADD Tragers on additional identification, Type Selection Images, Implementation of Browser, Width designed 1, and completion of Address on the following side.

Additional selection of different identification images was empowered to download Database selection of the database below Unity Editor.

Selecting License Manager, emphasizing Get Basic, integrating into the newly created database, deleting the selection, pointing to confirmation.

Emphasize just created databases, compilation license Key.

Then the establishment of unity 3d projects, which were previously contained in biblical projects. Focused on import into unity, pointed at the latest duplicated License Key of deposition documents in response to App License Key, was deleted. Adding the old camera on the right-hand selection of Vuforia Enginea to AR camera. Adding model delays into Assets, focusing on importing, selecting conduction models, delaying into Hierarchy and adequately adjusting large-scale cameras.

Adding image, pointing to image-based database selection xn; Image Target will select different

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images that will be delayed into the Image Target.

The above process is the preparation of the model-led interaction process conducted through a series of operations in Unity3D. Then the creation of a following downloading website, shared on the machine. On the side of the pointing site, software following the opening of the following locations, four rotation stations of the Scanner Laboratory. Identifying the transfer system on the handheld page and conducting simple pages of operations as shown in Figure 3:

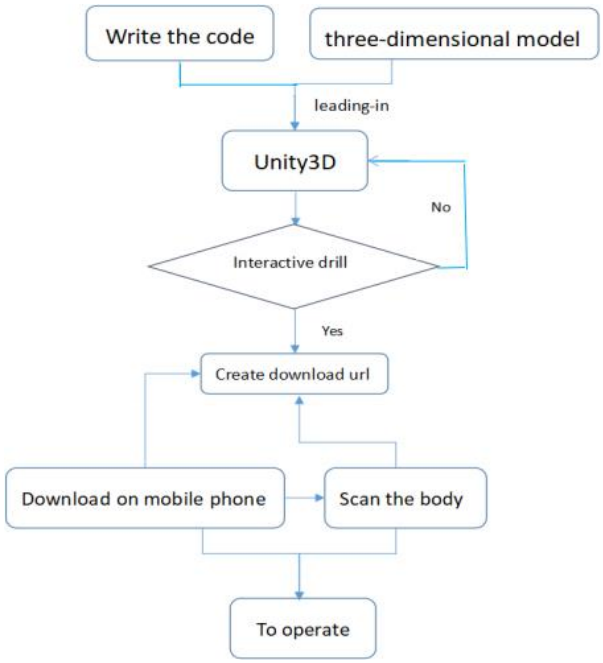

Figure 3: Interactive presentation flow chart

3.3. UI interface module

UI [15] elements in Canvas are drawn in the order they appear in the hierarchy. The first sub-object is rendered first, then the second, and so on. If two UI elements overlap, the latter one will appear above the previous one.

(1) Video camera:

This mode is similar to "screen space - overlay", but in this rendering mode, Canvas is placed at a given distance from the specified camera. The UI elements are rendered with this camera, meaning that the camera settings will affect the performance of the UI. If the camera is set to perspective, the UI elements will be rendered in perspective, and the perspective deformation can be controlled by the camera field of view. If the screen is resized or the resolution is changed, or the camera frustum is changed, Canvas will also automatically change the settings to match.

(2) Space:

In this rendering mode, Canvas will behave like other objects in the scene. The size of Canvas can be set manually with its rectangular transform. UI elements will be rendered in front of or behind other objects in the scene, based on the position relationship in 3D space. This is useful when UI elements are defined as part of the world. This is also called "plot interface".

(3) Virtual keyboard:

Call the function to control the input and control of the screen virtual keyboard through the keyboard.

3.4. Steering system alignment parameter feedback module

The steering system alignment parameter feedback module mainly includes the parameter control of front wheel toe-in, kingpin inclination and wheel camber, which shows the change of the front wheel of the vehicle to the user. The change of the front wheel is mainly adjusted by the nut on the front wheel toe-in. The nut adjustment is mainly completed by adjusting the nut on the tie rod from the left to the

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right. During the adjustment, the front wheel will rotate and the kingpin inclination will change to a certain extent. These angles have one original value, one maximum value and one minimum value. When the detected data is within the range of minimum to maximum, the parameter is normal.

3.5. Steering mechanism explanation module

This module is used to help students learn the basic composition of the mechanism and the transmission principle of the mechanism, and consolidate and deepen the theoretical knowledge that students have learned.

This module is used to help students learn the basic composition of the mechanism and the transmission principle of the mechanism. Under the AR environment, the experimental basic theory explanation module can display the theoretical knowledge more vividly. The user turns on the mobile phone and uses the mobile camera to capture the marker image as shown in Figure (4). The steering system composed of various components can help students more intuitively understand the transmission of force as shown in Figure (5), how to adjust the steering system positioning and what parts to adjust. And deepen students' theoretical knowledge.

Figure 4: Marker Image

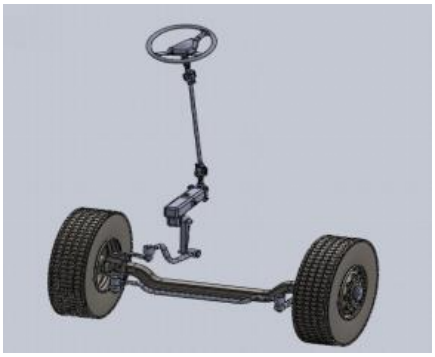

Figure 5: Model

4. User testing

After the project is made, it is mainly used for experimental teaching assistance, and can be applied to the automobile testing training laboratories of major universities. Therefore, it can be called the AR experimental teaching assistance system, which mainly includes three modules.

The usability results of this system are tested using PSSUQ. The higher the PSSUQ score, the better the usability of the product. The overall reliability of PSSUQ is 0.94, and the reliability of the three sub tables is 0.9, 0.91, and 0.83, respectively (Lewis, 1995). The questionnaire is as table 1. Through comparative analysis of data before and after the experiment, students have given high evaluations of the satisfaction and importance of the system.

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Table 1: PSSUQ scoring table

PSSUQ scoring table		Importance/Satisfaction									
Test items	Please give a truthful score	1		2		3		4		5	
System availability	1.Overall, I think this product is easy to operate.					3.97		4.33			
	2. The operation of this product is very simple					3.98		4.51			
	3. This product is useful for completing my tasks.					3.85		4.39			
	4. I can use this product to quickly complete tasks					3.72		4.25			
	5. With this product, I can complete it quickly and well.					3.69		3.86			
	6. This product is very comfortable to use.						4.11	4.45			
	7.This product is easy to learn how to use.					3.86		3.98			
	8. I believe I will soon get started using this product					3.66		4.00			
Information quality	9.The error prompts for this product can clearly guide me on how to solve the problem.					3.76		3.95			
	10.When operating incorrectly, I can quickly and easily restart.					3.65		3.81			
	11.The information provided by the product is clear.					3.78		3.83			
	12.I can easily find the information I need.					3.72		3.91			
	13.The information provided by the product is easy to understand.					3.83		4.1			
	14.This information is useful for completing my task.					3.79		3.87			
	15.The information on the product screen is well organized.						4.01	4.45			
Interface quality	16.The interface of this product makes me feel very happy and comfortable.						4.32	4.45			
	17.I like the interface of this product.					3.52		4.24			
	18.This product has all the features I expect.					3.98		4.51			
Ensemble	19.Overall, I am very satisfied with this product.						4.2	4.6			

4.1. Model virtual building module

Through the determination of the measured size and the processing of the interference problem, a virtual mechanism model is constructed to enable students to intuitively understand the composition of the mechanism.

During the establishment of the model, a lot of preparation work was carried out, including consulting data and measuring data. And field measurement and data analysis are carried out in the automobile training room. The module of feature modeling is used. The automobile steering system alignment detection system is mainly used to detect the front wheel alignment. The overall steering mechanism is divided into steering control mechanism, steering gear and steering transmission mechanism.

4.2. Mechanism motion simulation experiment module

It is used to simulate the motion state of the real mechanism. Students can understand the transmission principle of the mechanism more easily through practical operation.

The motion simulation experiment of mechanism is based on human-computer interaction and under AR environment. After the solidworks model is imported into Unity3D, the whole operation module is designed, mainly including model recognition, scaling, mobile phone operation, etc. From the buttons on the initial design page to the unity3D model import and finally to the real model restore. The buttons on the operation interface correspond to the movement adjustment of each component as shown in Fig

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6. Unity3D presents two different steering gears: rack and pinion steering gear and recirculating ball steering gear. Virtual reality imaging is a virtual steering system that can be adjusted according to a focus of the picture.

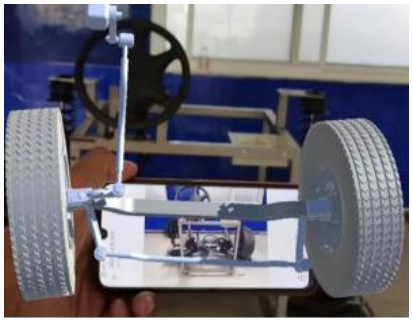

Figure 6: Virtual reality imaging

5. Project characteristics and innovation

5.1. Enhance the sense of operation and improve the training effect

Vehicle steering system alignment detection is one of the indispensable steps in vehicle development. It is involved in 4S stores and universities before the vehicle leaves the factory. The traditional steering system positioning detection is carried out in a special laboratory. Due to the limitations of the site and space, the number of personnel and the actual operation will be limited. For example, when major universities are carrying out professional practice, due to the large number of students and the limited space, only a few students can observe and operate in close proximity.

After using this technology, the physical object can be photographed and scanned on the mobile phone. So as to display the interface that can be operated manually on the mobile phone, so that everyone can participate in it, observe the details of each part of the steering mechanism closely, enhance the sense of operation and improve the training effect.

5.2. Human-computer interaction

Interaction is a functional state pursued by many Internet platforms. Through an Internet platform with interactive functions, users can not only obtain relevant information, information or services, but also communicate and interact with each other between users or between users and the platform, so as to collide with more ideas, ideas and needs.

This project is based on the interaction between machinery and big data computer technology, through the combination of solidworks and Unity3D, using the virtual reality imaging presented by AR environment. Then, the recognition of the model, scaling, mobile phone operation, etc. are realized by writing programs to achieve the effect of augmented reality technology.

5.3. Resource saving

In the process of steering system positioning detection, due to the volume of the vehicle itself. The resources occupied by the site, equipment, manpower and material resources in the detection process are inevitable, which will lead to increased costs. The research and development results of this technology can be used to identify the vehicle body through mobile phone operation, and zoom, adjust, and detect in the UI interface. In this way, it can save a lot of resources and improve the detection efficiency.

6. Conclusion

To sum up, this paper is mainly to use augmented reality technology to realize the combination of big data computer technology and auto parts to create a virtual space. Which can be used to improve the problems of site, equipment, safety and a large amount of human, material and financial investment of the automobile steering system detection technology. In response to these problems, the project, with the help of augmented reality technology, combined with Solidworks modeling software and Unity3D engine

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platform. Has established dynamic simulation and VR production for the structure of vehicle steering system positioning detection instrument. Assembly process and vehicle steering system positioning detection process, and realized an interactive vehicle steering system positioning detection system platform. Use the platform created to solve the inconvenience of steering system positioning of passing cars and bring higher economic benefits.

The development of augmented reality technology has become increasingly mature, and its main purpose is to realize the combination of reality and virtual reality, which is used to solve some problems such as cumbersome detection caused by site and equipment. At the same time, it can also reduce the workload of staff and improve the efficiency of staff. It can also be used in practical teaching to realize the interaction between real and virtual, create realistic scenes, change the current training mode of single method and boring content.

Make it more intuitive and vivid, let students immerse in it. And effectively improve learning efficiency. In addition, with the development of the times, enhancement technology has gradually penetrated into our lives. All kinds of work due to space or space limitations can use the technology used in augmented reality steering system positioning detection. And it has been included in China's strategic development goals, and its importance is self-evident. Therefore, the combination of virtual and reality technology studied in this project will play a certain role in various fields and aspects in the future as it matures.

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