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Design of Intelligent Vehicle Virtual Reality Integration based on Unity3D

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Abstract

Aiming at the problems of high operation risk and lack of interest in the intelligent vehicle control experiment, a set of practical training equipment system is constructed by using the design based on Unity 3D and STM 32 to realize the combination of virtual and real to control the movement of the intelligent vehicle. By simulating the real application of intelligent vehicles, building virtual scenes, according to the experimental data, writing the corresponding processing code, combining the virtual and real, real-time feedback of some parameters in the operation of the intelligent vehicle information situation, to provide users with a safe and reliable operating platform, effectively reduce the risk of operation at the same time to enhance the user's interactivity and interest in the learning process. This innovation not only greatly improves the safety and reliability of the intelligent vehicle in the experimental process, but also lays a solid theoretical and technological foundation for the application of virtual reality technology, simulation testing and other areas of development, and promotes the further innovation and development of the combination of virtual and real technology.

Keywords

Unity 3D; STM 32; Intelligent Vehicles; Virtual Reality.

1. Introduction

Unity3D virtual reality technology has demonstrated the potential for a wide range of applications in many fields, for example, through the mixed reality and Unity3D fusion to realize the interactive display simulation of virtual venues, providing users with immersive experience and effectively avoiding collision with obstacles[1]; the rehabilitation training system developed using Unity3D combines the human-computer interaction function, which improves the patient's active participation and the rehabilitation effect[2]; the panoramic filming technology realizes the 360º immersive visual experience without dead angle with the help of Unity3D platform, which enhances the interactivity and the application field. It enhances the interactivity and the breadth of application areas[3]; in addition, Unity3D is also applied in 3D image scene reconstruction, which realizes high-quality scene reconstruction by acquiring depth information and point cloud data processing[4]. Intelligent vehicle technology has a wide range of application prospects in the fields of autonomous driving and intelligent transportation. In order to design, test and verify intelligent vehicle systems more efficiently, virtual simulation platforms have become an important tool[5].

In the experimental process in the traditional mode, there are some drawbacks in the control experiment of intelligent vehicles. There are uncertainties in the experimental process, such as bad

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weather will affect the performance of sensors, causing sensing errors or even failures, reducing the safety and reliability of intelligent vehicle driving. Secondly, the cost incurred by the equipment required in the design and application of intelligent vehicles is also a major problem, including the subsequent testing and research need to be supported by the cost.

Therefore, this design is based on STM 32 and Unity3D to realize the combination of virtual and real to control the movement of the intelligent vehicle, and design a set of virtual and real training system to combine the virtual and real to realize the interaction between the physical intelligent vehicle and the virtual scene. By constructing a virtual environment for simulation testing, we realize the experimental teaching and motion control of the intelligent vehicle in the simulation scene, and solve the safety hazard problem and cost problem in the experimental process.

2. Overall System Framework

This design can be divided into two parts: virtual and real, which consists of smart car and joystick to form the hardware part. In the virtual part, Maya software is used to create a 3D model of the smart car and import it into Unity 3D platform to realize the control function. When the user controls the joystick, STM 32 will regulate the motor and servo according to the signals received from the joystick to complete the control of the smart car. At the same time, the joystick also receives feedback signals from the wireless module of the smart car and sends them together with control commands to Unity 3D, which receives and parses the commands through the pre-set communication protocols, and displays the changes of parameters such as temperature, voltage, rotational speed, speed, rotation and steering in real time on the user interface (UI), so as to realize the synchronized control of the virtual smart car under the virtual scene. The overall block diagram of the system is shown in Fig. 1.

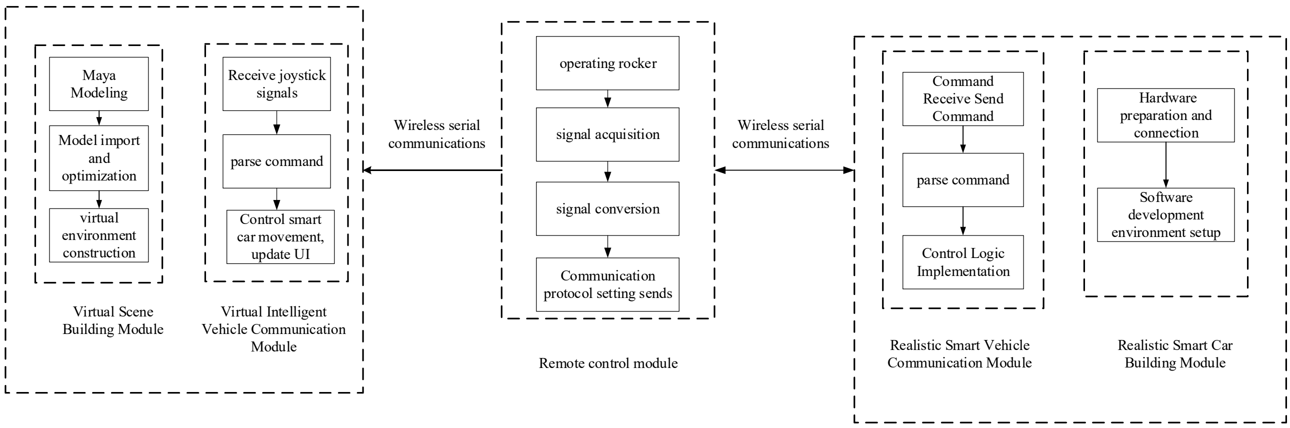

Fig. 1 System overall framework diagram

3. Entity Control Design

3.1 Physical Intelligent Vehicle Design

The schematic block diagram of the combination of real and virtual control intelligent vehicle mobile system is shown in Fig. 2, and the main components of the system include STM 32 main control chip, power supply module, sensor module, servo drive module, motor drive module and wireless communication module.

STM 32 main control chip as the core, complete the acquisition of sensor data, algorithm judgment and control command output. The power supply module ensures a stable power supply for the whole system and maintains the normal operation of the intelligent vehicle. The sensor module provides real-time feedback information for the control system by detecting the environment around the intelligent vehicle. The servo drive module controls the steering operation of the intelligent vehicle and controls the direction change of the intelligent vehicle. The motor drive module is responsible for regulating the speed of the intelligent vehicle so that it can travel smoothly. The wireless

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communication module is mainly responsible for realizing the data transmission and communication between the intelligent vehicle and the joystick, and realizing the interaction between the intelligent vehicle and external devices. The modules work together to form an efficient intelligent control system. The physical diagram of the intelligent vehicle is shown in Fig. 3.

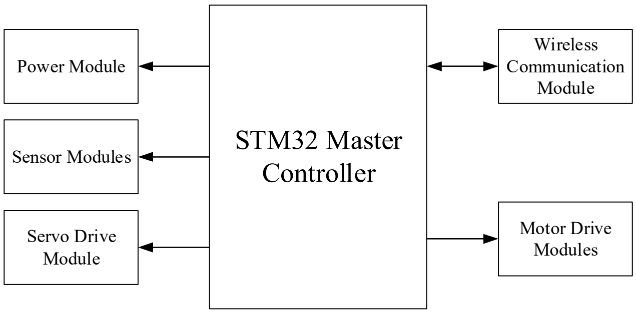

Fig. 2 System Block Diagram

Fig. 3 Intelligent Vehicle Physical Drawing

3.1.1 Master Module

There are various ways for microcontroller to control the trolley, which mainly include using input and output ports to control the motor to make the trolley move forward, backward, and steering[6]; acceleration, deceleration, and accurate control of the motor is realized through pulse width modulation (PWM)[7]; communication with external devices through serial ports and receiving commands to realize remote control[8]; and with the feedback from the sensors Combined with the feedback information from the sensor, closed-loop control is carried out[9]; PID algorithm is used to accurately control the speed and position of the motor[10].

The STM32F103C8T6 minimum system board is selected as the main control module of the system, and the STM 32 uses pulse width modulation (PWM) technology to accelerate, decelerate and accurately control the motor. Specifically, the internal timer of STM 32 generates PWM signals to regulate the average voltage of the motor through the change of duty cycle to realize the control of motor speed. The higher the duty cycle, the higher the voltage obtained by the motor and the faster the speed; the lower the duty cycle, the lower the voltage obtained by the motor and the slower the speed. By dynamically adjusting the duty cycle, the motor can be accelerated and decelerated smoothly and the speed can be precisely controlled. For example, by increasing or decreasing the PWM duty cycle using stepping, the motor can be accelerated and decelerated step by step, thus ensuring a smooth and precise motor[11]. In this design, the STM 32 also communicates with the joystick through the wireless serial port to control the movement of the intelligent vehicle and ensure that the system can operate in a coordinated manner. The diagram of the main control module is shown in Fig. 4.

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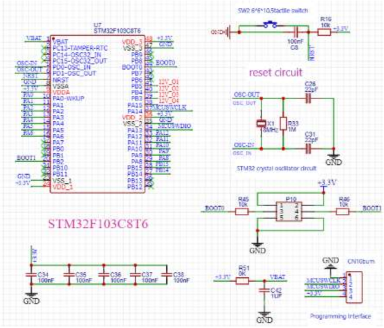

Fig. 4 Master Control Module Diagram

3.1.2 Sensor Modules

In the smart car design system, the sensor module has a fast, reliable and efficient transmission rate, and is able to collect real-time data such as temperature and voltage from the smart car. With the built-in ADC (analog-to-digital converter), the sensor is able to convert the analog voltage signal generated by the thermistor as it changes with temperature into a digital signal and accurately converts it into the actual temperature value using a pre-stored look-up table. For voltage monitoring, the voltage levels at specific circuit nodes are measured directly through the ADC, and median filtering algorithms are applied to improve data accuracy and ensure the accuracy of the measurement results.

This digitized temperature and voltage information is then uploaded to the STM 32 master controller chip, which is responsible for receiving and processing the data to perform calculations and analysis. Subsequently, STM 32 transmits the processed information to the remote control module through the serial communication interface, enabling the smart car to respond in time according to the environmental changes and its own state to ensure the real-time and reliability of the system.

3.2 Remote Control Module Design

The remote control module sends commands to both the virtual scene smart car and the physical scene smart car. When the joystick is manipulated, the change of joystick state will change the resistance of the internal potentiometer, which will lead to the change of voltage. STM 32 reads the change of voltage through the analog-to-digital converter and converts the analog signal into digital signal. The STM 32 reads the voltage change through an analog-to-digital converter and converts the analog signal into a digital signal. The motor and servo are then controlled according to the joystick signal to adjust the angle and direction, thus realizing the movement control of the intelligent vehicle. In addition, the joystick also receives signals from the wireless module of the smart car and sends them together with control commands to Unity 3D, which controls the operation of the virtual smart car by receiving and judging the data. The diagram of the remote control module is shown in Fig. 5 below.

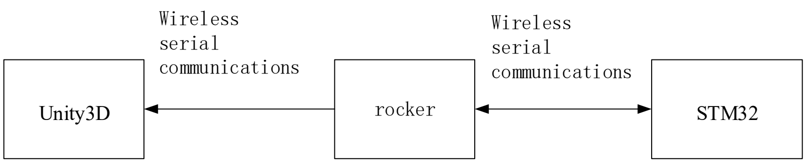

Fig. 5 Remote Control Module Diagram

4. Virtual Simulation Design

4.1 Modeling Preparation

In the process of modeling the smart car using Maya software, firstly, you need to prepare the pictures of the smart car from various angles in advance, such as top view, side view, front view, rear view and other multi-angle pictures. Secondly, you can then measure the main components of the car and record the proportions, which will help to divide the model parts in the modeling process and make the model more detailed.

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4.2 Selection and Application of Modeling Techniques

This design chooses to use polygonal modeling technique, which is a 3D modeling technique based on vertices, edges and faces. Polygonal modeling technology includes the creation of polygonal geometry, editing, and processing of its function, the application is more widely used, can achieve the model details control[12].

Import the picture of the smart car into Maya, add a square body as the base model, and get the desired model size by enlarging the picture. Adjust the size and proportion of the body and then by translating, rotating and stretching the plane to make it match the size of the picture to get the general outline of the body. Compare with the reference picture to see if the edges or fixed points are protruding or have obvious deviation, and move the edges and vertices with deviation. For the edges and vertices that cannot be solved even by moving them, you can adjust them by adding more edges. Cylinder is chosen as the base for the wheel, and the size and height of the wheel are adjusted according to the reference picture. First get the general shape of the wheel modeling, second model the pattern on the wheel to add more details to the wheel model. Finally, smooth the wheel to make it more realistic and natural looking. The above operation is repeated for the rest of the car body, and the resulting modeling is shown in Fig. 6.

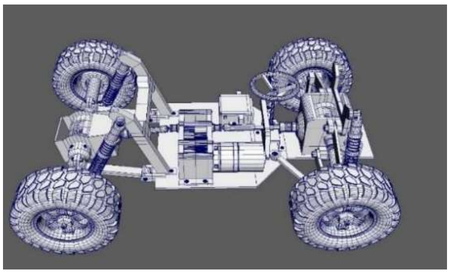

Fig. 6 Maya Smart Car Modeling Diagram

4.3 Modeling and Mapping

In the modeling process in order to make the model more suitable for the smart car, usually the modeling will be mapping processing, mapping can increase the color and texture of the device, as a way to enhance the model's visual effect and sense of reality. Here we choose Arnold Renderer (Arnold Renderer), which has good drawing effect, supports cross-platform, fast drawing, easy to get started, and can produce real materials and light to adapt to different complex drawing needs, and facilitate the mapping work. First of all, through Arnold's shading program to add materials to the model, followed by adjusting the properties to achieve the desired effect. Finally the rendering is started and the model obtained is shown in Fig. 7 below[13].

Fig. 7 Maya Smart Car Virtual Simulation Diagram

5. Virtual Control Design

5.1 Communications Protocol

There are many ways to control the movement of a car in Unity 3D. One can use compiled software to control the movement of the car by writing scripts and using a code language to interact the smart

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car with the scene in an immersive way[14]. Secondly, the physics engine of Unity can be used to add some rigid body and collider components to the smart car to realize the basic control logic[15]. Alternatively, input devices such as keyboards and joysticks can be used to receive user commands and translate the commands into movement operations of the smart vehicle[16].

This design defines a communication protocol that is divided into: revelation flag, control byte, and termination flag. The revelation flag and termination flag are used to ensure the correct transmission of data, while the control byte is used to control the movement of the intelligent vehicle, steering, and displaying parameter information such as revolution, speed, temperature and voltage on the UI. After receiving the data from the serial port, the virtual intelligent vehicle determines whether it can be executed and what kind of operation it will perform; if the execution succeeds, it will clear the cache and receive new data for the next operation; if the execution fails, the intelligent vehicle will keep the status quo until it successfully reads the next instruction. The uplink communication is shown in Table 1 and the downlink communication is shown in Table 2.

Table 1. uplink communication

Transducers-STM 32	starting mark	control byte1, 2	control byte3, 4	control byte5, 6	stop sign
usage	mark the beginning of	Ensure that the receiving equipment is able to correctly recognize and process the received data	Transmission of control-related integer data	Accurate transmission of temperature measurements	End of flag

Table 2. downlink communication

STM 32—Unity 3D	starting mark	control byte1	control byte2	control byte3,4	control byte5,6	stop sign
usage	mark the beginning of	Controls movement and updates the display	Control steering and update display	Update temperature display	Update Voltage Display	End of flag

5.2 Communications Realization

The communication implementation is done through a C# script in the Unity 3D engine that establishes a serial connection with an external device. The first step is to initialize the serial port parameters in the CarControl class and open the specified serial port for receiving data. Once the serial port is successfully opened, the program continuously listens for incoming data via the ReceiveDataCoroutine thread. When new data is detected, it reads the data and accumulates them as a hexadecimal string, and then processes the received data. During processing, the data is checked for validity and parsed for control commands, such as steering, rotation, temperature, voltage, etc. The information is then used to control the virtual miniature. Based on the parsed information, the virtual vehicle is controlled to run while updating the text display of the UI to ensure that the virtual vehicle can respond to the commands sent by external devices in the virtual scene. In addition, in order to accurately reflect the rotational state of the smart car, the angle change relative to the initial position is calculated and updated so that the whole system can better simulate real-world interactions in the Unity 3D environment.

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6. Experimental Results

In order to visualize the driving of the virtual intelligent vehicle in the running scene, we choose to add a Canvas through the UI, and create Text and image under the Canvas for displaying some information of the intelligent vehicle during the running process in the virtual scene.

Unity 3D receives and analyzes the code data, controls the virtual smart car to run in the scene, and displays the parameter changes of the virtual smart car in the process of running the scene through the UI. For example, after receiving the signal from the host computer, the motor and servo of the smart car change, and the steering, rotation, speed, temperature and voltage also change with the received information and are displayed on the UI. In addition, a dial is added to show the angle of rotation of the body of the virtual smart car. The operation diagram is shown in Fig. 8.

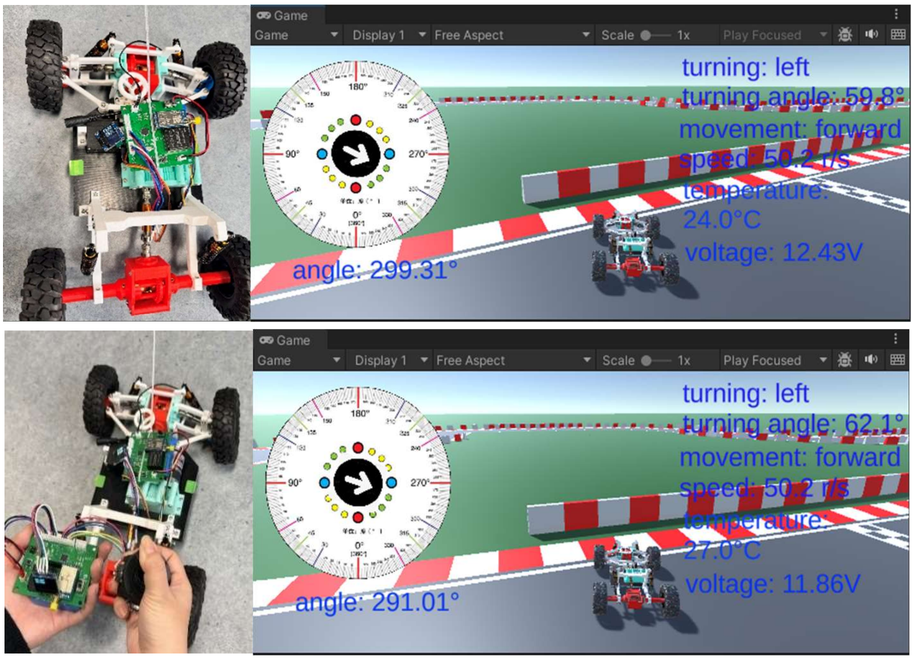

Fig. 8 Scene diagram when data is received from the host computer

7. Summary

This design uses STM 32 and Unity 3D to control the smart car by researching and analyzing the characteristics of virtual reality technology and designing the combination of reality and virtual reality. When the user controls the joystick, STM 32 will regulate the motor and servo according to the received joystick signal, and then control the operation of the smart car. At the same time, the joystick sends code commands to Unity 3D, which receives and parses the commands through the communication protocol, realizing that the joystick controls the operation of the smart car while Unity 3D controls the virtual smart car to perform the same operation. In this design, we show the possibility of integrating microcontroller and 3D technology, and design a safe and reliable practical training system to improve the interest and initiative of students' learning, and lay the foundation for future learning.

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