Construction Technology of E-sports Racing Simulation Track Scenarios

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Abstract: The construction of track simulation scene is one of the key links of racing electric racing driving platform. The effect of construction technology directly affects the authenticity and usability of racing simulation driving platform. In this paper, the characteristics of high-precision racing circuit simulation and the existing technical means of simulation scene construction are analyzed, and the sensor scanning technology of racing circuit simulation scene is studied. According to the simulation characteristics of racing circuit scene, when modeling is proposed, the completed game building scene is referenced, and the scene construction is enhanced and generated by real scanning sampling data High precision simulation track scene. Based on the above modeling concept, the real 3D scanning sensor is used in combination with multiple platforms to measure and obtain the discrete 3D point set data with certain density, record the terrain, height of ground objects and their interrelations, etc. the resource base is established through the combination of the track simulation scene model subsystem, and finally the example of the electric race track scene is realized to solve the track simulation efficiency and simulation scene Low authenticity and poor operability.

Introduction

With the increasing number of electronic racing games, especially racing esports, there have been large-scale professional events of the world, and the most discussed among racing esports players, in addition to various racing models, driving simulators and techniques, is the track simulation scene. Racing games have great innate advantages in the field of simulation. For example, Live for speed (LFS), which is excellent in clutch simulation, has a very good tuning system and tires and suspension system. DIRT series, GRID series, rFactor series are very outstanding racing simulation game, as well as the excellent work, Assetto Corsa, selected by the China Electric Race Car Championship (CREC). Players can use these immersive games to feel the engine vibration, practice start, oil separation, follow-up driving and other driving techniques. For esports players, it is not enough to pursue real operation in racing e-sports. They also expect for the real scene. The biggest charm of the racing simulator is the high level of simulation of the car operation. The hand block, the throttle, the clutch, the brake and the steering wheel are all real car grades. The dynamics generated by the racing seat drag the player from the virtual world into the real competition.

1. The Content of the Simulation of The Simulation of the Racing Circuit

The content of the simulation scenario construction refers to the virtual static scene content for the race vehicle test, usually including the track (center line, lane line, road material, etc.), traffic elements (competition lights, racing signs), participation racing (race car, race guide car) and elements around the track (including indicator lights, referee stations, speed bumps, green belts, buildings, etc.). The low-end game uses a common simulation track, while the racing esports uses a high-precision simulation track, which outperforms in the both accuracy and details. The racing simulation track simulation scene usually contains the following elements:

- Element type. For example, the description of the maintenance area, track layout, speed bump and other elements.

- Element geometry expression. Taking the lane boundary as an example, a coordinate sequence is used to describe the boundary shape.
- The attribute description of the element. For example, the referee attribute description.
- The description of the relationship between elements. For example, the relationship between the departure area and the signal light.

Some literature studies have shown that the high-precision simulation track has accurate vehicle position information and rich track element data information, which plays a role in constructing the overall memory and cognition of the human brain for space and helps the driver to predict the complex information of the road surface, such as slope, curvature, heading, etc., resulting in a better performance.

2. Features of High-Precision Racing Esport Simulation Track

High-precision racing esport simulation tracks usually include the following four features:

- The simulation track is a device that serves people and people's vision and understanding.
- The scale of the high-precision simulation track is constant. In different scenarios(weather), the accuracy requirements of different racing cars for the map are constant.
- The high-precision simulation field track is static and multi-dimensional. When the track is used to serve a racing simulator, the accuracy and content requirements of the data are constant. The terrain and environment around the sports car are moving according to different spaces. Multidimensional means that if each piece of content information (such as the slope of the track, the degree of congestion of the car, the degree of weather, etc.) is superimposed on the two-dimensional track as a dimension, the vector dimension of the vehicle changes during the movement.
- High-precision simulation of non-field racing tracks is non-measurable. The high-precision simulation track actually provides a model for the race driver's driving environment. If the car wants to successfully carry out the driving competition, it must construct the surrounding environment, including the mobile racing, competition accidents, referee flag control, rain and snow, etc. The bottom-level static high-precision simulation track also includes lane models, road components, road properties, and other racing layers.

3. Technical Means for Constructing Simulation Scenarios

The technical means for constructing the simulation scenario usually includes constructing a scenario based on the modeling software, building a scenario based on the completed game, constructing the scenario based on the augmented reality method, and generating a scenario based on the high-precision simulation track.

3.1 Based on Modeling Software

Depending on the requirements, the simulation model can be built using 3D modeling software, or the ready-made model provided in the model library. The prepared simulation model can be integrated to construct the expected simulation scenario.

3.2 Based on the Completed Game

Relying on the completed game scene features, such as the complexity of the GTA scene, the researchers can render realism and high randomness, using this large open world scene to test the e-sports racing simulation.

3.3 Based on Augmented Reality Technology

Enhance real-world images by simulating traffic flow, creating realistic simulation images and rendering. More specifically, use Lidar and camera to scan streetscapes. Based on the obtained trajectory data, a plausible traffic flow is generated for the car and synthesized into the background. Composite images can also be resynthesized based on different viewing angles and sensor models (camera or laser, etc.). The resulting realistic image adds a complete annotation that can be used for training and testing of the racing esports driver's driving system from perception to planning.

3.4 Based on High-Precision Simulation Track

Combine and structure various real unstructured surveying and mapping data from, surveying vector, satellite image, etc., and call virtual resources to generate virtual scenes, so that drivers can understand the track scene deeply. The specific implementation process is to collect real unstructured surveying and mapping data such as point cloud, panorama, surveying vector, satellite image, etc., to structure the real surveying data. Based on data, and call different virtual resources for scene generation according to different semantics. Compared with the traditional modeling software of scene building, this is more effective and less expensive.

4. Sensor Scanning Technology for Racing Simulation Track Simulation Scene

At present, with the wide application of real-time 3D geographic information data, depending on the platform, the discrete three-dimensional points with a certain density are measured by airborne, vehicle-mounted, ground-based, portable scanning sensors. They are used to collect data, and record the terrain, the height of the features, and the relationship. Since the scanning mode of each scanning sensor has certain applicable conditions, as the application continues to deepen, multiple platforms are often used together in practice.

4.1 3D Lidar Sensor Simulation Scan Sampling

The idea of 3D lidar simulation is to simulate the emission of each real radar ray with reference to the real laser radar scanning method, and to intersect with all objects in the scene. At present, the more common ground 3D laser scanning technology mainly includes mobile laser scanning system and fixed laser scanning system. The application of these two types of laser scanning systems varies, and the adaptability also has obvious differences.

From the point of view of the specific application process, the fixed laser scanning system can realize the series acquisition of three-dimensional coordinates. The corresponding information acquisition is more comprehensive and detailed, and the scope is also wide. The acquired data information is also ideally expressed in terms of accuracy. The mobile laser scanning system is realized by means of a mobile carrier, and can also exhibit greater application benefits. For example, there is a radar with a fixed line, a high horizontal resolution and a moderate maximum detection distance. Each frame of the radar emits a geometric strip ray to intersect with all objects in the scene, and the intersection obtained within the maximum detection distance is the effective point. The scene resource adds enough fine scan data that is exactly the same as the original model to ensure the accuracy of the intersection result. The intensity of the lidar reflection is related to the reflectivity of the near-infrared light used by the lidar by different physical materials. The reflection intensity is affected by the obstacle distance, the laser reflection angle and the physical material of the obstacle itself. It is necessary to set the appropriate physical materials for the scene resources during the simulation, including various tracks, departure zones, lane lines, signs, semaphores, racing cars, etc. The laser reflectivity of each physical material is different. The laser reflectivity of each physical material can be measured in advance.

4.2 Camera Sensor Simulation Scan Sampling

The idea of camera sensor simulation scanning sampling is based on the geometric spatial information of the environment object to construct the 3D model of the object. The real material and texture of the source object such as color and optical properties are added to the 3D model by computer graphics. The physics-based rendering engine Unreal Engine is generally used. The camera simulation transforms the points in the three-dimensional space on the image through the perspective transformation method, and simulates the internal data acquisition process of the structure and optical characteristics of the camera lens. For example, focal length, depth of field, color space, brightness adjustment, gamma adjustment, white balance adjustment, distortion, high dynamic range (HDR) tone adjustment, etc., camera simulation scan sampling generally needs to be able to change to the camera external parameters, internal parameters and distortion parameters, including the camera installation angle, position, resolution, operating frequency, field of view, focal length, etc. These parameters are internally converted into a projection matrix, the coordinate system is correctly converted throughout the process, and the image that is consistent with the real image pixel effect is output. RGB or YUV can be used to represent the raw data of each frame of the camera simulation.

4.3 Millimeter-Wave Radar Sensor Simulation Scan Sampling

Millimeter wave radar simulation scan sampling generally emits a series of continuous frequency-modulated millimeter waves in different directions according to the configured resolution and field of view information, and receives the reflected signal of the target. Different radar echo intensities can be calculated using the energy radiation micro-surface model calculation method. Multiple frequency modulated continuous waves will detect the same track fixture. The target-level simulation of millimeter-wave radar is to cluster the points of the same track fixture according to the distance resolution, radial distance and angular resolution of the obstacle and obtain the final simulation result.

Physical-level simulation scan sampling of millimeter-wave radars requires high-precision hardware sensor support. The radar sensor needs to first detect the radar's transmitted probe wave through the receiving probe, and then process it, and add the track fixture information to the required echo to monitor the received echo. The relatively complicated system is that the radar launch and reception are very fast. Millimeter wave radar signal level simulation skips the millimeter wave radar signal transceiver module using real radar echo signals, directly input the PC signal processing program or FPGA/DSP signal processing module. The general procedure is to modulate the main sidelobe pattern of the transmitting signal antenna, select the target radar cross section model, calculate the target Doppler shift and time shift to generate the target echo, and generate the final radar signal.

Millimeter wave radar simulation scanning sampling generally needs to determine the millimeter wave radar installation position, detection distance, detection angle, distance resolution, noise parameters and so on. For some millimeter-wave radars with long-range and mid-range detection functions, it is necessary to support both parameter settings. The millimeter wave radar is installed by default on the front end of the vehicle, and the returned target-level track fixtures are sampled and detected as values in the spherical coordinate system, relative distance, vertical azimuth, horizontal azimuth, and radial distance.

4.4 Other Sensor Simulation Scan Sampling

IMU sensor simulation scan sampling: It is necessary to debug the acceleration and angular velocity of the on-board sensor. The IMU also needs to modify the cumulative error of the speed and heading of the on-board sensor when the track position is deviated.

Ultrasonic radar sensor simulation scanning sampling: Ultrasonic radar is widely used in simulation scenarios. Generally, it is necessary to set the position and angle of the ultrasonic radar installation, and return the V2X sensor of the track fixture in real time. The simulation scene with God's perspective is naturally suitable for V2X target level simulation. Generally, a sensor V2X device summer information network will be established, and each frame will obtain the current V2X device data in real time, and the LTE-V-DSRC communication delay or packet loss is realized by the real-time system.

5. Conception of the Construction of Dynamic Scene of Electric Racing Competition Track

The simulation construction of the racing e-sports dynamic track scene is mainly based on non-field events such as the car rally. The dynamic data generated by such scene simulation is large, and various types of change factors are more.

5.1 Racing Electric Tracks Dynamic Scene Simulation Construction Path

- Based on real case data of real track competitions. Dynamic information is collected by various sensors and processed into the track simulation scene.
- Based on generization of the real case. Reasonably change some of the data characteristics of the real case, generalizing to generate a new track fixture scene.
- Based on the micro-competition referee simulation system. The micro-simulation system is used to generate dynamic elements such as racing and control to form a simulated dynamic scene. Real data is used in the process, such as training simulation models based on real case data, using real game semaphore signals and racing competition scenes as simulation conditions.

5.2 Track Dynamic Scene Construction Needs to be Solved

5.2.1 The Statistical Significance of Real Scene Data Lacks in-Depth Research

The realistic racing competition does not explicitly state the statistical significance of the dynamic scene outside the track. The problem should be solved is that the statistical relationship between the real world and the simulation scene is not determined. The theoretical research breakthrough in this aspect can optimize the test case library design and dynamic scene collection work, and provide the basis for simulation test effectiveness.

5.2.2 The Real Scene Lacks Interaction with the Racing Car in the Test

During the simulation test, the vehicle in the real scene travels according to the measured trajectory and cannot interact with other racing vehicles. As a result, the behavior of the car around the main car is actually “unreal”, which will adversely affect the test results. Combining real cases with simulation models may be one of the directions to solve this problem.

5.2.3 Lack of in-depth Study of Generalization Methods for Real Scenes

There are two problems in the generalization of real scenes. One is whether the direction of generalization meets the requirements of scanning test and statistical significance, and the other is the loss of real data in the generalization process. Combining the generalization of actual competition cases with the vehicle behavior model may be one of the ideal solutions.

5.2.4 Micro-simulation Model Realism Needs to be Improved

In the dynamic scene built on the racing electric racing track simulation model, the surrounding vehicles should be able to interact with the main vehicle, providing more reasonable test conditions. The authenticity of this kind of test environment mainly depends on the realism of the simulation model and simulation method of the racing electric race track. The existing micro-simulation solution still has a shortcomings in terms of racing dynamics behavior, multi-vehicle interaction and complex decision-making. To improve the accuracy and authenticity of the model, it should simultaneously improve the effectiveness of the simulation test of the electric racing track and the generalization ability of the case.

References

[1] Overview of Virtual Reality Enhancement Technology [J]. Zhou Zhong, Zhou Wei, Xiao Jiangjian. *Chinese Science: Information Science*. 2015(02)

[2] The application of ground 3D laser scanning technology in engineering measurement [J]. Huo Wenqiang. *Technology horizon*, 2018 (30): 228-229+237.

[3] Current status, policies and implications of virtual reality technology in the United States [J]. Wang Jian, Zhang Xu, Wang Yong, Zhao Yunhua. *Science and Technology Management Research*. 2010(14)

[4] Overview of Virtual Reality Technology [J]. Li Min, Han Feng. *Software Guide*. 2010(06)

[5] Application of virtual reality technology in practical training[J]. Zhang Jianwu, Kong Hongju. *Research on Audio-Visual Education*. 2010(04)

[6] 3D Scene Design and Motion Control of Vehicle Driving Simulation Platform [D]. Xia Huan. *Southwest Jiaotong University* 2015

[7] Overview of Virtual Reality Technology [J]. Zhang Zhanlong, Luo Xyong, He Wei. *Computer Simulation*. 2005(03)

[8] Research on real-time force simulation of steering simulator steering wheel [D]. Zhang Weiwei. Zhejiang University 2012

[9] Research on 3D Graphics Modeling Method in Virtual Reality [J]. Wang Yichuan, Zhang Dengyin, Xin Chenxi. *Computer Aided Engineering*. 2000(04)