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A Design and Implementation of VR Cycling Fitness System in the Context of National Fitness

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Abstract: ***This article introduces a cycling fitness system based on virtual reality technology. The system uses a combination of VR helmets and bicycles to simulate different cycling scenes through a virtual environment, providing users with an immersive cycling experience. Users can choose different scenes and modes to monitor fitness data such as heart rate in real time. with the assistance of AI, a real experience can be achieved. Through the introduction of VR technology, the system can not only improve the user's cycling experience, but also effectively stimulate the user's interest in exercise and promote the development of the fitness industry.***

1. Introduction

With the improvement of economic living standards, people are under great social pressure. More and more people will stay up late due to work pressure, lack of exercise for a long time and other unhealthy lifestyles, which will lead to the body being in a sub-healthy state all year round. Some cardiovascular diseases are no longer limited to the elderly, but gradually begin to become younger. In order to meet the people's growing fitness and health needs, improve the health quality of the whole people, and promote the development of national fitness, the State Council has promulgated a series of policies and plans to enable more people to realize the importance of fitness, improve their physical fitness and mental health, and slow down their fast pace of life. Fitness also plays a positive role in promoting the overall development and stability of society; due to the inertia formed by people's long-term life pressure and rhythm, or because of the unpredictable and bad weather environment, indoor sports have gradually become a common way of exercise in people's lives, and fitness cycling is one of the popular indoor activities. According to the feedback from the survey of people who do fitness exercises, 35% of the people think that the process of cycling is very boring, and 45% of the people think that it is because of improper riding posture or inaccurate time control, which leads to joint ligament strain, physical fatigue, and even arrhythmia and other negative effects.

With the continuous advancement of science and technology, Virtual Reality (VR) technology, as a new interactive experience, has brought innovative possibilities to the fitness field, while Artificial Intelligence (AI) technology has emerged in recent years. With the support of these two technologies, the traditional way of fitness cycling has been broken, creating unlimited possibilities for the fitness field. The main purpose of this paper is to design and implement a cycling fitness system based on VR + AI technology, aiming to explore the potential value and application prospects of the system in the context of national fitness. Its conclusions will provide useful references and inspiration for the promotion of national fitness policies and the application of VR and AI technologies in the field of fitness.

2. National Fitness Policy and VR Cycling Sports

2.1 National Fitness Policy

The National Fitness Policy is a social policy promoted by the government to promote health and fitness activities throughout the society. The goal of the National Fitness Policy is to enable everyone to participate in sports that are suitable for them, thereby improving the health level of the whole people, strengthening their physical fitness, and promoting social stability and development. By promoting fitness activities, the policy aims to solve the problems of sedentary living, lack of exercise and unhealthy lifestyles that are prevalent in modern society, so as to improve the physical and mental health of the public. At the same time, the National Fitness Policy allows more people to enjoy the fun and benefits of fitness. The government will also strengthen the promotion of fitness education and guidance and encourage people to establish a healthy life concept and develop good exercise habits.

The implementation of the national fitness policy promotes the development of national fitness. Only through the joint efforts of the whole society can the national fitness policy achieve better results and allow more people to benefit from the beauty of healthy life. In this context, this article introduces a newly designed VR+AI cycling system, which allows the whole people to exercise healthily and happily in this system.

2.2 Introduction to VR Cycling

VR cycling is a form of exercise that combines virtual reality technology and indoor cycling training. By using a VR helmet and an indoor bicycle, participants can perform cycling training in a simulated virtual environment. Zwift has developed a smart training bike that runs on a headset developed by Holodia. The system is transferred to the Meta headset through a USB adapter, allowing users to enjoy beautiful scenery during exercise, making users more motivated during exercise.

In the context of the national fitness policy, VR cycling can not only improve physical fitness and health, but also enjoy the beauty of nature and relax. People can meet more like-minded partners through the social system and share the fun and experience of cycling. The cycling system introduced in this article allows users to experience the thrill of competition while enjoying the beautiful scenery and can increase the safety of exercise and scientific fitness.

3. Overview of Key Technologies of VR Riding System

3.1 Virtual Reality Technology

Virtual reality technology is a technology that uses computer technology to simulate a simulated environment, allowing users to interact with this virtual environment and experience immersion. Through virtual reality technology, users can enter a virtual environment, such as an alien environment that cannot be reached, by wearing or using specific equipment, such as a head-mounted display (such as HTC-VIVE), a handle, etc., and people can interact with creatures in the virtual environment. Currently, Virzoom has applied this technology to sports such as skipping and running, attracting more fitness enthusiasts and allowing users to exercise happily and without pressure.

In the context of national fitness, virtual reality technology has brought new possibilities to the field of fitness. By combining virtual reality technology with cycling, users can ride in a virtual environment, and they can choose to challenge various training programs of different difficulty levels in the virtual environment, such as high-intensity interval training, intelligent heart rate monitoring, etc., thereby improving the effect and fun of exercise.

3.2 5G Technology

5G technology is the fifth generation of mobile communication technology. It is an upgrade and expansion of the current 4G technology. It has higher data transmission speeds, lower latency, larger capacity and more reliable connections. It solves the visual dizziness effect during riding in the riding system, allowing users to experience riding more easily.

5G technology also has greater network capacity and the ability to connect more devices. It uses more efficient wireless access technology and network architecture and can connect more devices at the same time in multi-person online mode, providing more users with a stable online riding environment in this mode.

In the context of national fitness, 5G technology is of great significance in supporting innovative applications in the field of fitness. And through the high speed and low latency of 5G technology, fitness equipment and fitness applications can achieve faster data transmission and real-time feedback, helping users better monitor and manage fitness data.

3.3 AI Technology

Artificial intelligence technology is an intelligent technology that simulates human thinking, learning and decision-making capabilities through computer systems. The key features of artificial intelligence are intelligence and interactivity. Intelligence lies in the ability to imitate human behavior and talk to people. The AI developed by OpenAI with text interaction and voice interaction functions is currently the most complete. It not only solves the problems in people's lives and studies, but also realizes some intelligent functions, allowing people to experience and interact more immersively.

In the context of national fitness, artificial intelligence technology has a driving significance for the fitness field. The cycling system introduced in this article can evaluate the user's physical health through artificial intelligence technology and develop a safe fitness plan for the user by detecting and analyzing the user's real-time exercise status and various body data. The user can also get personalized training guidance, correct the user's incorrect posture during cycling, and adjust the user's healthy exercise time to ensure that the user can exercise reasonably and scientifically and avoid injuries due to incorrect posture. In addition, the user can communicate with AI through text interaction and voice interaction, allowing the user to enjoy a more immersive fitness experience and increase fun.

Our VR cycling system uses virtual reality technology as a bridge to communicate the real world and the virtual world and uses the low latency characteristics of 5G technology to solve the problem of dizziness when users experience the virtual world; with the assistance of AI technology, users can enjoy fitness cycling more safely and immersively.

4. Design of VR Cycling Fitness System

4.1 VR Riding System Design

The VR riding system is produced through a game development platform. Its production content includes character modeling, scene construction, environment rendering, script writing, game special effects, etc. This system consists of four modules: level-breaking mode, multiplayer online, AI guidance, and autonomous training.

The challenge mode consists of several different scenes. The difficulty of each scene is different, and the difficulty increases level by level through the resistance of the scene ; the three modules of multiplayer, AI guidance, and autonomous training can be selected according to the user's own preferences; the multiplayer module is to compete with friends online through 5G technology; AI guidance and autonomous training use AI technology for fitness cycling. AI guidance can detect and guide users throughout the process, so that users can exercise in the correct way; and autonomous training is that users train according to the plan and time made by the AI system. During the training process, the AI system will monitor the user's physical health status in real time and remind the user whether to overtrain.

VR riding system design diagram:

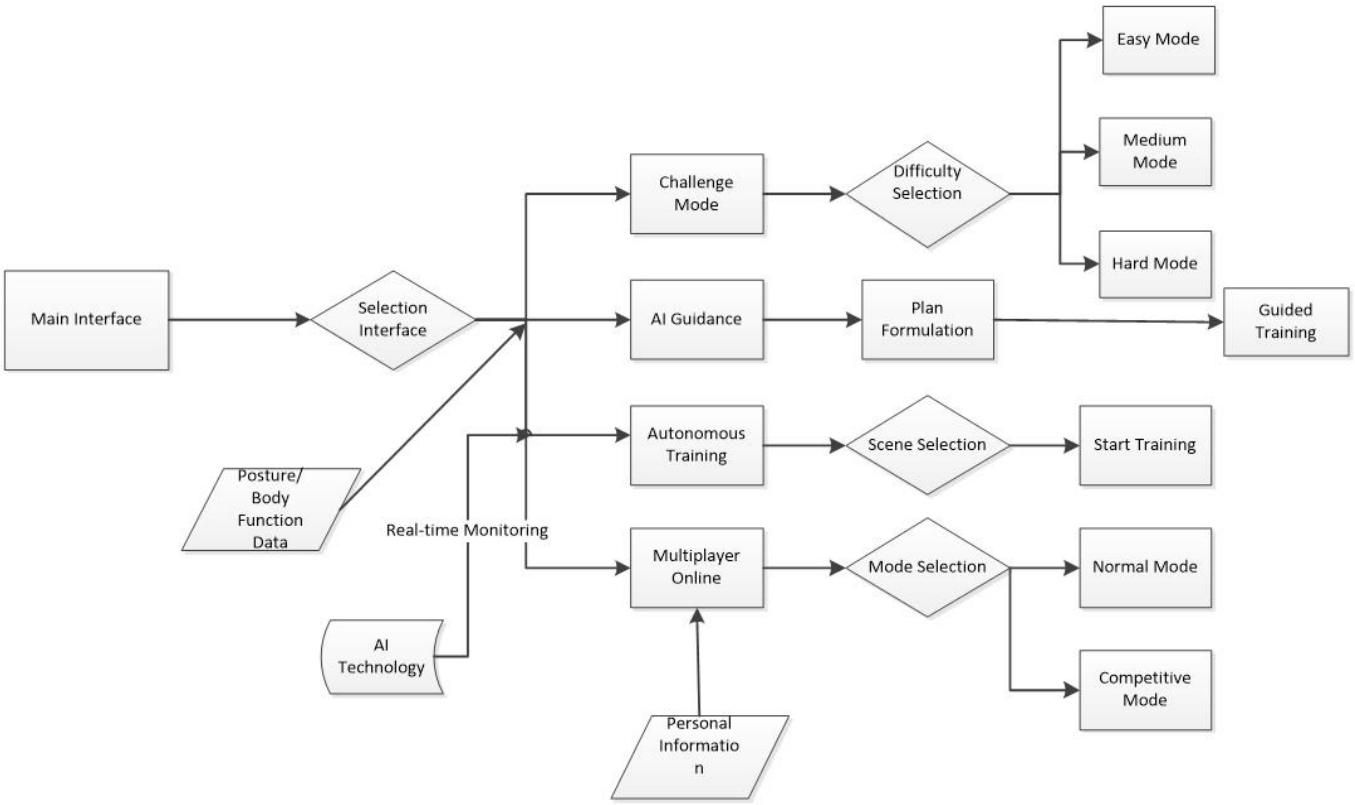

Figure 1: VR Riding System Design

4.2 VR Riding Overall Design

The VR riding system's body detection, speed, body posture and other data are transmitted to the riding system's database through pedaling speed sensors, heart rate monitors and cameras. After AI data processing, the data is returned to the user using a VR headset, providing the user with safe training and interesting competitive experience.

VR riding overall design diagram:

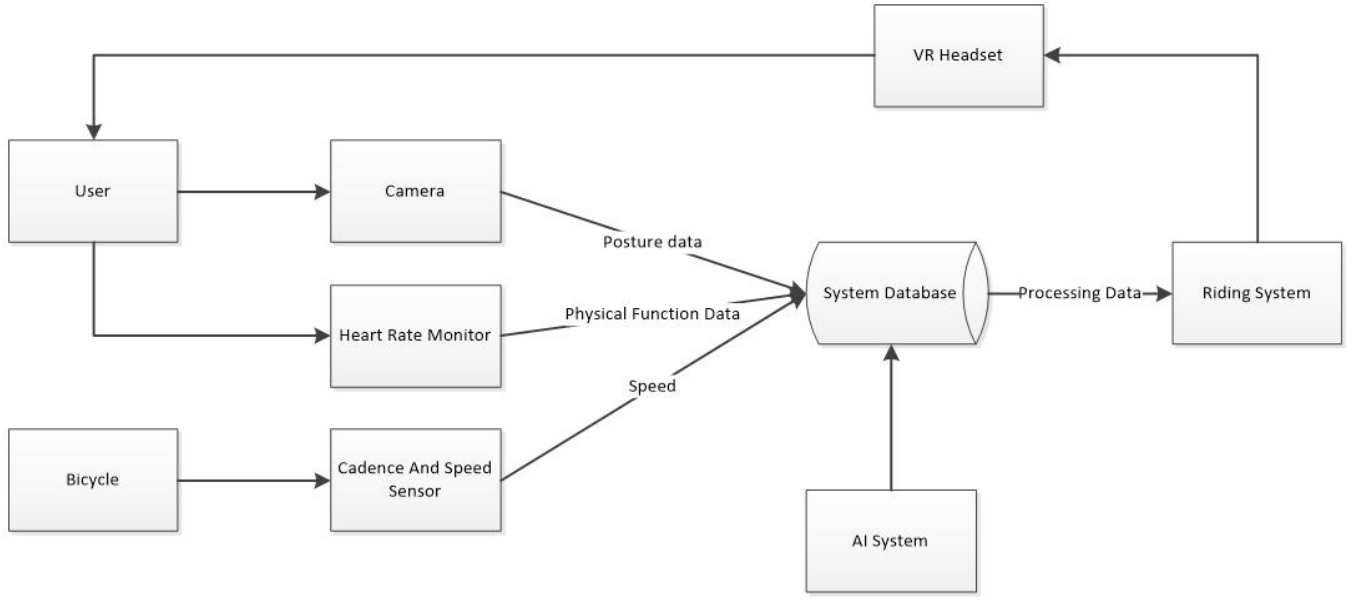

Figure 2: Overall Design of VR Riding System

5. Development and Implementation of VR Cycling Fitness System

5.1 Introduction to Development Tools

Introduction to character modeling and UI design platform:

The main modeling tool of this system is 3DMAX, which is a professional 3D modeling, animation and rendering software developed by Autodesk; and the software can be converted into different formats for use on different platforms. This system uses this platform to model the bicycle, helmet, and

body of the cyclist, and connects the joints of the virtual character's body through skeleton lines, making the virtual character's movements more flexible.

Introduction to the development platform:

The development platform of this system is mainly the Unity3D engine. Unity3D is a cross-platform game engine developed by Unity Technologies. It has powerful graphics rendering capabilities, physics engines and animation systems, enabling developers to easily create high-quality games and interactive applications. The riding system introduced in this article is developed on this platform, integrating character models, scene models, and UI interfaces. Through code scripts such as animation control, collision box algorithms, and mobile control, these three modules are integrated into a complete riding system. The riding system can be deployed to VR devices through this platform and the scripts connected by the interface, allowing users to interact immersively in the riding system through VR devices.

5.2 Scene Construction

The scene construction is composed of environment renderer, terrain model, skybox, etc. In the cycling system, in order to distinguish the four scenes of mountain, countryside, city and snow, we distinguish the visual effects of each scene by adjusting the light of the cycling track part of these four scenes, including adjusting the position of sunlight and shadows to project the player's cycling movements. In the snow scene, we set the particle effects of white snow crystals and the appropriate sound effects of snowing to trigger the user's vision and hearing, so that the user can truly experience the feeling of being in the scene.

5.3 Terrain Generation and Construction

The terrain of this system is drawn and generated by the Gaia plug-in. First download the plug-in, configure the area of the required scene in the inspector panel (the scene area required by this cycling system is uniformly 10*10 in size), and then use the built-in Stamp function of the Gaia plug-in to paste the appearance of mountains, cities, villages, and snowfields, add Mesh Rigibody components to these four scenes respectively, and uniformly set the size ratio to 1:1:1. Finally, click Play, and the plug-in can generate the four scenes required by this cycling system.

5.4 UI Interface Settings

The UI interface is the login interface of the cycling system. The UI setting components include Canva, Button, Toggle, Image, TextPro and other tools. First, click GameObject, select Canva component under the UI menu, click Panel, create a main plane, set its position to 0, 0, 0; the size ratio is 1:1:1; insert a bicycle-themed competitive picture as the background, and then insert four panels as selection cards, insert pictures of snow, tunnels, villages, and mountains respectively; and set the ratio to 0.5, 0.5, 0.5, and put in the script code for jumping to the scene, so that the function of jumping into the scene can be realized. Similarly, add Button, Toggle and other components, set the size and position in the same way, put in the jump script, and you can realize the function of clicking to jump to the next interface.

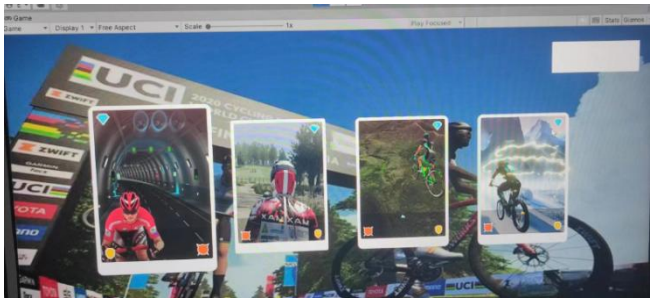

Figure 3: The UI Design

5.5 Camera Settings

The camera is one of the most important and difficult components in the entire system. It is a bridge between human vision and the virtual world. Adjusting the camera usually involves properties such as position, rotation, and field of view. If the field of view is to be a third-person perspective, the camera must be 4 meters away from the cyclist. Write a script to follow the character, and you can follow the character from a third-person perspective. If the field of view is to be a first-person perspective, put the camera component in the neck position of the cyclist in the Hierarchy panel, put the camera component in the component of the cyclist in the inspector panel, adjust the relative position of the camera and the character in the Scene panel, and then adjust the focal length of the camera to 0.3, so that the camera's field of view presents a first-person perspective.

Figure 4: First-person Camera View

5.6 Artificial Intelligence Design

As a part of the cycling system, artificial intelligence is tasked with ensuring the safety of users during cycling, detecting and correcting their postures, and analyzing their body data in order to develop a safe training plan for them. This article introduces the design of text interaction, voice interaction, and real-time detection.

5.6.1 Text Interaction Design

This system uses the Dialog System plug-in to implement text interaction. First, download the plug-in from the Asset Store. Set the font size and the text box for the dialogue. Second, put in the NPC character and set the size and position of the character. Fourth, build a background database and corresponding dialogue scripts, put the measured data into the database, and the NPC will calculate the data and feed it back to the user through the headset. Fifth, put in the written trigger and detection script code and run the system detection.

When AI sorts and calculates the data in the database, it is transmitted to the user's headset through the system dialog box. The user can complete the text dialogue interaction by

clicking the controller.

5.6.2 Voice Interaction Design

The voice interaction function of this system is artificial intelligence based on the open-source platform of Convai. The first step is to set the basic parameters of the AI character, such as personality, voice, and image on the Convai platform. The second step is to import the set character into the Unity3D scene through the interface provided by the Convai plug-in downloaded from the Asset Store and set the character animation script logic and trigger conditions. The fourth step is to hang up the database calculation script. The virtual character can interact with the user through voice comparison of data, allowing users to have a truly immersive experience.

5.6.3 Design of Posture Correction

This system is based on the posture correction technology built on OpenCV technology and is performed through mathematical calculations using resource libraries such as Mediapipe and OpenCV. First, the system calculates the angles of various parts of the body based on the movement posture captured by the camera; secondly, the data is analyzed and stored in the form of a list; finally, the data is transmitted to the Unity3D platform through the Socket communication protocol, and the current posture is reminded through voice or text interaction whether it is correct.

This cycling fitness system is implemented through a system composed of hardware and software, combined with AI technology and 5G technology; the level-breaking mode and training mode are single-player modes, while the multiplayer online module uses 5G technology to send the user's operation information to the server or other players' host through data transmission. The server or host then distributes it to other users ' clients, which also avoids the disadvantage of low latency; during the cycling process, artificial intelligence will use cameras and heart rate monitors to capture postures and monitor physical conditions throughout the process, helping users have a safe and effective cycling experience.

5.7 System Implementation

5.7.1 Start screen

This interface is mainly a dynamic interface. When the system is connected to the bicycle, head display and handle, this is the first interface displayed. Click the button on the handle, the bicycle character in the interface will be ejected, and then enter the next interface.

5.7.2 Selection interface

When the start interface is displayed, the next one is the selection interface, which is the scene selection interface; press the front button of the handle, and four scenes will pop up. Move the handle to select the scene you want. Press the back button of the handle, and the selected scene card will pop up. Click the next button to enter the selected scene.

5.7.3 Multiplayer

When entering multiplayer mode, select a city scene and a countdown sign will appear. After the countdown ends, the system bicycle character will start riding according to the bicycle pedal speed and number of times while pedaling. Of course, friends who are online with the user will also compete online in the scene like the user.

5.7.4 Level-up Mode

When the level-breaking mode is selected, taking this scene as an example, after entering the scene and completing the specified distance, you can enter the next level. The difficulty of the level can be controlled by the user. If the user does not select the level difficulty, the system defaults to starting from the lowest difficulty, and the level difficulty increases from easy to difficult, level by level.

5.7.5 Artificial Intelligence Model

Text interaction

During riding, the heart rate monitor will automatically measure the pulse and transmit the data to the system. The AI coach will make substantive suggestions to the rider based on the data, and the user can use the handlebars to have text conversations with the AI coach.

Voice Interaction

AI detects a series of body posture data; users can also communicate with AI through voice. The AI system will process and respond in real time to achieve real-time communication and give users a better experience.

Figure 5: A Screenshot of the System Implementation

6. Conclusion

6.1 Summary

In the context of national fitness, the design and implementation of the VR cycling fitness system is to combine virtual reality technology and fitness exercises, so that users can reduce the boredom of fitness, reduce the risk of injury during fitness, and provide users with a more interesting, real and effective fitness experience. In the process of design and implementation, this system designs scenes according to needs : design various virtual cycling scenes, such as mountains, cities, etc., to provide a variety of experience options ; the third step is software development: determine the development of user interfaces and exercise methods, and ensure data monitoring and analysis functions to ensure that the system is easy to operate and stable. The fourth step is to select appropriate head-mounted display devices and body sensing devices to ensure the normal operation of the system and accurate monitoring of various user data.

In general, the design and implementation of VR cycling fitness system needs to combine various technical and service requirements, so that users can get a more personalized, interesting and effective fitness experience, solve the unnecessary troubles brought by traditional fitness, reduce the risk of fitness injuries, and achieve fitness effects, and effectively promote social interaction, enhance user participation and social interaction, which is conducive to promoting the development of national fitness.

6.2 Further Grounds

In the context of national fitness, the future VR fitness system may incorporate more sports methods, allowing users to fully experience the fun of various sports in the virtual world and meet the fitness needs of different users. Combined with the continuous improvement of artificial intelligence and big data analysis technology, the VR fitness system will be able to provide more intelligent and personalized fitness guidance and training plans based on the user's health status, exercise data and preferences, allowing users to exercise more scientifically. With the continuous development of technology, the future VR cycling fitness system may integrate more health management functions, such as sleep monitoring, dietary recommendations, etc., to pay full attention to the user's health status while exercising and provide users with a full range of health management services.

In general, looking forward to the future, VR cycling fitness system will serve users in a smarter, more personalized and more diversified way, promote the development of national fitness, drive more people to join fitness, promote social interaction and improve overall health level. I believe that with the continuous advancement and innovation of technology, VR fitness system will present a more colorful development prospect in the future.

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