Preliminary Research on VR Technology Application to Inspect the Physical Evidence of Vehicle Body Trace at the Road Traffic Accident Scene

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Abstract. This thesis discusses a VR-based system designed for the policing at the grass-root level at the road traffic accident scenes. Basing on theoretical studies and technical comparisons, a VR-assisted simulation system for investigating the road traffic accident scenes is created on the aspects of system architecture performance, databases, back-stage management modules. The VR-based system plays a favorable role in assisting the scene investigators and instructors. This system can improve the efficiency of scene investigators and increase the effects of related teaching and simulative training remarkably.

1. VR Technology Profile
VR (Virtual Reality) means virtual simulation. It is a computer simulation system that can create and experience the virtual world. Through the utilization of the computer graphics system and various display and control interface devices, it provides immersive feelings in the interactive three-dimensional environment generated on the computer. [1]

Based on core technologies such as dynamic environment modeling, stereoscopic display, system development tool application, and real-time three-dimensional image generation, VR technology aims to solve the accuracy of indicating the virtual environment, the interactive naturalness between man and the virtual environment, and the real-time display intelligence technology, etc. With conception, immersion, and real-time interaction as its three characteristics, it enables users to sense the virtual environment personally so that they can explore and cognize objective things. [2]

2. The Combination between VR and the Physical Evidence Inspection of Vehicle Body Trace at the Road Traffic Accident Scene
Road traffic accident refers to the events of casualty or property loss caused by vehicle faults or accidents on the road. [3] The physical evidence inspection of vehicle body trace at the road traffic accident scene refers to an investigation activity that checks, understands, and examines the traces left on the vehicle body or those related to the accident (such as collision traces, scratch traces, and roller compaction traces) as well as discovers and fixes the physical evidence of traces related to an accident after its occurrence.

Due to the collisions and scratches of vehicles in every road traffic accident, it is essential to form corresponding vehicle body traces under the function of interactive forces. People can inspect vehicle body traces. Combined with ground traces, tire traces, and human body traces, the contact parts, direction, and the stress of vehicles can be preliminarily determined, the accident vehicle can be affirmed, and the accident process can be restored. All of them will provide strong evidence for
determining the accountability of the traffic accident.[4]

By integrating VR technology into the physical evidence inspection of the vehicle body trace at the scene of the road traffic accident, some road traffic accidents that inspectors fail to arrive at the scene in time can be inspected timely in a long distance. They only need to use peripheral devices (such as VR head-mounted display) to witness the restored traffic accident scene through the handling of certain technical means and conduct their inspection work further. The system can also be set to inspect local vehicle body traces so as to determine the object as well as the magnitude and direction of the force leading to these traces. Besides, it can be used to estimate where these traces stem from. Consequently, it is conducive to initially analyzing the cause of the accident, saving human and material resources, and enhancing the efficiency of case handling.

3. System Design

3.1. Overall Scheme Design

The virtual simulation system for inspection at the scene of the road traffic accident based on VR technology is practical, efficient, intelligent, extensible, and highly reductive. It consists of the system, hardware, the server, and VR devices, etc.

The system can be used to take the panoramic images at the scene of the road traffic accident, collect image materials regarding the overview and details of the accident scene, or record videos that are involved in the scene of the road traffic accident through a special device. Then by transforming from 2D to 3D in terms of technical means, it can build a model to restore the accident scene. This enables users (e.g. grass-roots on-site inspection policemen) to realize remote inspection by virtue of VR peripheral devices through the Internet and the system platform. Each inspection step is withdrawale. The system records all inspection steps and uploads the data to the system server in real-time for independent storage.

According to the tips of the system, inspectors scan the whole and details (such as collision parts) at the scene of the road traffic accident with a special handheld device. Then the scanned data is uploaded to the server in real-time through the network. The server automatically analyzes and processes the data, conducts 3D modeling to restore the scene, and sets hotspots for key parts.

With the web version as its main form, the system can match the PC terminal. Its special device can scan and upload the data, and the server builds a model and restores the scene based on the data.

3.2. Programming Language

The programming language C# used in making 3D panorama is excerpted as follows:

```csharp
if (tempPanrama == null)
{
    tempPanrama = new RenderTexture(cubemapSize, cubemapSize, 24);
    tempPanrama.dimension = UnityEngine.Rendering.TextureDimension.Cube;
    tempPanrama.useMipMap = false;
    tempPanrama.autoGenerateMips = false;
    tempPanrama.antiAliasing = 1;
    tempPanrama.wrapMode = TextureWrapMode.Clamp;
    tempPanrama.filterMode = FilterMode.Bilinear;
    tempPanrama.Create();
}
if (panrama == null)
{
    panrama = new RenderTexture(length, width, 24);
    panrama.antiAliasing = 1;
    panrama.wrapMode = TextureWrapMode.Clamp;
    panrama.filterMode = FilterMode.Bilinear;
```

panrama.hideFlags = HideFlags.HideAndDontSave;
panrama.Create();
}
if (texture2D == null)
{
texture2D = new Texture2D(length, width, TextureFormat.RGB24, false);
texture2D.hideFlags = HideFlags.HideAndDontSave;
texture2D.wrapMode = TextureWrapMode.Clamp;
texture2D.filterMode = FilterMode.Trilinear;
texture2D.hideFlags = HideFlags.HideAndDontSave;
texture2D.anisoLevel = 0;
}
tempCamera.transform.localPosition = Vector3.zero;
tempCamera.transform.localRotation = new Quaternion(0f, 0f, 0f, 0f);
tempCamera.Render();
tempCamera.RenderToCubemap(tempPanrama);

Graphics.Blit(tempPanrama, panrama, m);//The bitmap is transferred here have to go through this particular material——shader.
To transfer bitmaps here, it is essential to go through this specific material- shader.
    RenderTexture.active = panrama;
texture2D.ReadPixels(new Rect(0, 0, length, width), 0, 0, false);
texture2D.Apply();
    RenderTexture.active = null;
byte[] bytes = texture2D.EncodeToJPG();
    string fileName = path + "/" + System.DateTime.Now.ToString("yyyy-MM-dd-HH-mm-ss")
    + ".jpg";
    System.IO.File.WriteAllBytes(fileName, bytes);

3.3. Effect Image

Image 1. Trace extraction of Simulated Road Traffic Accident Based on VR Technology
4. Vision
In the following on-site inspection of the public security unit, the notice will be automatically issued to relevant units through the overall analysis of police information under the aid of AI. After the police arrive at the scene, they will select the type of road traffic accident and determine its severity as per the actual situation as well as place the on-site inspection device. According to the given information, the device formulates the scanning scheme and plans the scanning route. The scanned data is transmitted to “the virtual simulation system for inspection at the scene of the road traffic accident” in real-time through the 5G network. The system server automatically carries out 3D modeling to restore the outline of the road traffic accident according to the collected data information as well as automatically identifies key parts and sets hotspots. On-site inspectors can also take photographs on key parts, which will be voluntarily uploaded to the server, with the vector graph as the type of these photographs.

On-site inspectors can log in to this system with the special account password or the police “Key” on their terminal device and wear the VR peripheral device to inspect the scene of the formed virtual road traffic accident. While inspecting key parts, if they cast their eyes on the set hotspots for seconds, they are able to see the 3D model set up by the system according to the accessed information of the special device.

In the process of inspection, inspectors can apply inspection tools (such as scale, protractor, and scale, etc.) that the system offers as the supplement. At the end of the inspection, they can write the inspection report and the traffic accident confirmation online. The system records and backs up the information from the scanning personnel and inspectors at the scene of the road traffic accident as future reference. Meanwhile, this information will be uploaded to the road traffic accident scene inspection platform and the OA system. When inspectors wrap up all inspection work, they can submit the data and information to specific objects (leaders). As system administrators, they can check and consult the relevant data on the inspection of any road traffic accident within their scope of authority.

5. Conclusion
The integration of AI and VR can effectively boost the work efficiency of on-site inspectors from the public security unit. However, due to the existing problems such as the lack of industrial ecology, the failure of transmitting tremendous scanning data in real-time, immature image recognition technology, and high demand for hardware, it is still not easy to fulfill these functions. Nevertheless, with the constant development of science and technology in this era, it is just over the horizon to realize them.

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