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Development of fully mechanized coal face safety production application system based on the open GL

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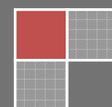
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ABSTRACT

In the study, with VC as a high-level language development platform, 3Dmax as a modeling tool of complex object and OpenGL library for three-dimensional graphics development, fully mechanized coal face safety production application system was developed, which took coal face 607 of Huangling No.1 Mine as an example. It includes red and green stereo display and two-channel stereo display system, coal mine safety production system simulation module, interactive safety technology training module, emergency rescue drills module for safety accident, 3D visualization module of safety production and mobile monitoring. And it realized many functions, such as three-dimensional roaming of the surface-underground parts of the mine, assessment of safety knowledge, safety training to avoid disasters, disaster simulation, emergency rescue, 3D visualization of security shift monitoring. Therefore, it has widespread application value and prospect.

KEYWORDS

Virtual reality; OpenGL; Safety production; Disaster simulation.



INTRODUCTION

Coal mine is a complicated production system. The position of tunnel arrangement is crossing and complex. Underground operation space is narrow and there are variable and hidden dangers and all kinds of emergency during the underground working, which bring some difficulties to the safety education and training of security personnel and miners and the improvement of the supervision and administration functions of the department in charge. The research of virtual reality technology in coal industry is in the initial stage. This study is based on application requirements of virtual reality technology in coal mine production safety and emergency rescue drills for safety accidents. With VC as a high-level language development platform, 3Dmax as a modeling tool of complex object and OpenGL library for three-dimensional graphics development, fully mechanized coal face safety production application system was developed. And it realized the functions, such as three-dimensional roaming of the surface- underground parts of the mine, assessment of safety knowledge, safety training to avoid disasters, disaster simulation, emergency rescue, 3D visualization of security shift monitoring remotely. It is not only significant for the promotion of traditional patterns of teaching, learning and scientific research, but also can meet the demands of safety education and training about coal mine and provide effective prevention and control measures for prevention and reduction of mine disasters when the system developed realizes distributed network sharing and concurrency control at the same time^[1].

THE STRUCTION AND COMPOSITION OF APPLICATION SYSTEM

Hardware system is divided into true 3D volumetric display system and interactive control devices. True 3D volumetric display system is mainly composed of red and green 3D display system and multi-channel annulus of 3D display system. According to different degrees of immersive, users can use red and green 3D glasses and polarized light to experience virtual scene, and use mouse, keyboard and directionkeys to realize the interactive control of 3Dscene. Software system is divided into four main modules^[2]. They are fully mechanized working face production system simulation module, interactive miners' safety training module, emergency rescue drills module for safety accident and 3D visualization module of safety production and mobile monitoring. The overall structure and function modules of fully mechanized coal face safety production application system are shown in Figure 1 below.

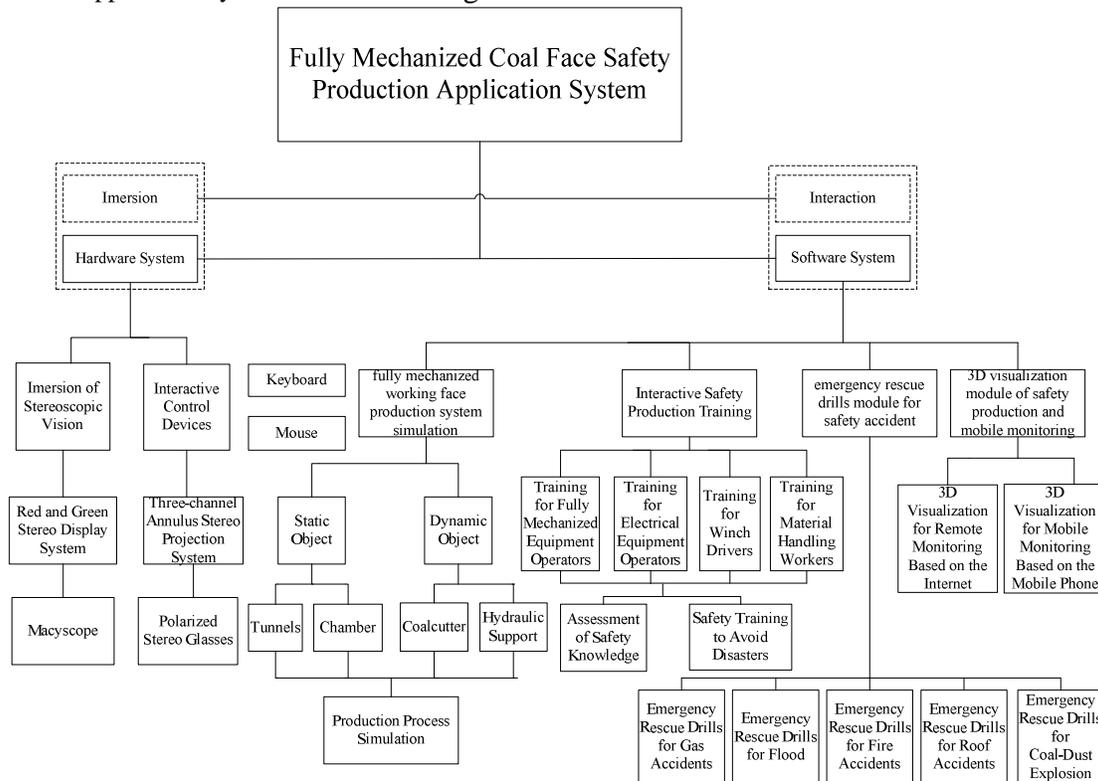


Figure 1 : The structure of fully mechanized coal face safety production application system

KEY TECHNOLOGY

Implement method of 3D display system

This stereo projection system adopts the three-channel stereo projection system, using two projectors, one projecting for the left eye image and the other projecting for the right eye image. The polarized light is installed in front of the projector lens, changing the light projected into polarized light. And the lens of 3D glasses worn by users is polaroid, of which the polarization directions of the polaroids in the right and left eyes are same with that of the projector mentioned above projecting images for the left eye, so that the users can see stereo images. Xi'an University of Science and Technology has established 120 degrees of three-channel large annulus display system with virtual reality lab of geological disasters of Chang'an University. Projection screen of the display system is a 120-degree arc surface with 3 meters radius and splits two images^[3]. Each image is the superposition projection of two projectors and passive stereo effect is generated by polaroid. As shown in Figure 2.



Figure 2 : Realistic picture of dual channel annulus display system

D modeling and simulation of full mechanized coal mining production system

For regular objects, such as the ground industrial square, underground tunnels and chambers, according to their topological structure relationships, we use OpenGL graphics library and surface-underground contrast plan and real-world photos of the mining area provided by coal mine to create the 3D models for the objects. For the shearer, scraper conveyor and other complex mechanical equipment in the production, we firstly build entity models in the 3Dmax software, then call the OpenGL library to read and drive 3DS data, which not only ensures the flexibility of system development, but also greatly reduces the workload of 3D modeling. Specific modeling steps are as follows: collection of the CAD Figures of model, CAD data pretreatment, modeling with 3Dmax software, model modification, model transformation, arrange and optimize the model. Through a series of model simplification and display processing, the 3D models will finally be displayed and dealt with in OpenGL^[4]. As shown in Figure 3.



Figure 3 : 3D model of fully mechanized equipment

Interactive safety training module

Interactive safety training adopts the ideas of RPG game design. Level design method is employed to the assessment of skill operations and safety knowledge, which means that virtual miners can have multi-role dialogue with the miners (NPC role). What's more, they can also operate equipment. If the answer and equipment operating are correct, they will pass this level' test and their life value increases^[5]. On the contrary, if the answer or the operation is wrong, they will fail to pass the test. System operation interface as shown in Figure 4.



Figure 4 : Avoiding disasters training for virtual miner

The 3D visualization of safety mobile and monitoring based on mobile internet

Based on the 3D visualization of safety mobile and monitoring of coal mine, the safety mobile and monitoring based on mobile Internet with apple iPhone iOS system as an example is realized. Implementation method is: it takes the database of the real-time monitoring of coal mine safety and data source of application runtime as the real-time monitoring data and 3D scene data. The system reads real-time monitoring data in ADO way, and then through processing and analyzing, diagnoses the current safety data information from each downhole sensor, and according to it, determines the scene performance effect. The system read 3D scene data from the 3D scene data files and makes a dynamic modification for 3D model expressions according to the performance effects required^[6]. When browsing 3D scene, it will show security monitoring and warning information in real-time and intuitively. The safety monitoring client as shown in Figure 5.



Figure 5 : Safety mobile monitor client interface

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CONCLUSIONS

In this study, fully mechanized coal face safety production application system was develop, with VC as a high-level language development platform and OpenGL as a scenario-driven interface. This system is composed of software and hardware. The hardware system is divided into true 3D display system and interactive control equipment. Stereo display system consists of red and green stereo display system and multi-channel annulus stereo display system. According to different immersive degree, users can use red and green 3D glasses and polarized light to experience virtual scene, and realize interactive control of 3D scene with the mouse, keyboard, and directionkeys^[8]. Software system realized simulation of production system of fully mechanized working face, interactive miners' safety training, emergency rescue drills module for safety accident and 3D visualization of security shift monitoring. Therefore, it has widespread application value and prospect.

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