Design of Simulation System for Railway Freight Loading and Strengthening Training Based on VR

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Abstract. Railway freight loading and strengthening is the key link in railway freight transportation, and the quality of its employees has a great impact on the efficiency and safety of loading and strengthening. The improvement of the quality of operators needs a more efficient training technology to assist. In view of many shortcomings of traditional training, this paper presents a design method of railway freight loading and strengthening training simulation system based on VR, and applies it to an example. The design method defines the overall goal of model system design, defines the design principle and model base design structure.

1. Introduction
The virtual reality (VR) technology has four characteristics of multi-sense, Sense of presence, interaction and autonomy, and has been applied in the field of railway transportation to the emergency rescue of the subway train, the operation management of the rail transit, the surge of the rail transit project and the emergency rescue, track vehicle display, etc.[1-4]. New process, new equipment and new technology are continuously used for railway freight loading and strengthening operation. The use of new equipment poses new challenges to the railway freight loading and strengthening workers. The onerous production tasks with high safety requirements makes it impossible for the first-line staff to be drawn to the training for a long time. At the same time, there are some practical problems in the training of loading and strengthening operation, such as the limitation of site and equipment, the high requirement of safety guarantee, lack of virtual immersive training environment, the prominent contradiction between work and study, and the weak pertinence of safety education. Therefore, it is of practical significance to integrate VR technology into the training of railway freight loading and strengthening operation to improve the training efficiency and training safety.

2. Overall goal
Enable trainees to immerse themselves in the virtual environment of railway freight loading and strengthening site to gain visual, auditory and other perception. It interacts with all the elements involved in the railway freight loading and strengthening process in virtual environment.

3. Design Principle
The design principle as follows:
- The color and shape of different types of freight trains and loading and strengthening main devices, auxiliary devices, cargo structure and key accessories are consistent with the material object.
The equipment and facilities in the virtual environment, which are not directly related to the trainees, establish a three-dimensional solid model framework consistent with the real designated field. The railway freight loading and strengthening process is realized in two forms: completed by Non-Player Character, the trainee can observe the whole operation process from many visual angles. By the trainees directly through the railway freight operation of interactive equipment to complete the loading and strengthening of each process.

- Pre-production railway freight loading and strengthening training course.
- The training files of the training personnel are formed.
- Process operation prompt and evaluation system.

4. Model library design
The model library includes model database, environment database and event control database.
- Model database: various types of freight train, loading and strengthening devices, auxiliary devices and different forms of cargo entities in the simulation process.
- Environmental database: scene data of freight station (freight yard), mainly related to loading and unloading lines, different types of cargo platforms, yard depots, rain sheds, weather, day and night and other equipment and scene data.
- Event control database: loading and strengthening operation flow rules, basic principles of process control, etc. Its function is to control the operation of visual simulation. The operation flow rules can be formulated according to the requirements of all kinds of loading and strengthening operation.

5. Design example
Taking the design of VR simulation system for unloading operation of field operators which is one of the processes of the training operation of railway freight loading and strengthening as an example.

This design of VR simulation system includes fine art effect unit and function realization unit.

The fine art effect unit includes five modules as follows:
- model.
- Animation.
- Scene.
- Sound effect.
- User interface (UI).

The function realization unit includes seven modules as follows:
- Server reading and writing.
- Login.
- Basic framework.
- User interface (UI).
- Voice sound effect.
- Task simulation.
- Assessment

The fine art effect unit includes: the model module, animation module, scene module.

The model module includes: train, moisture-proof tarpaulin, bedding, standby items, tools, protective signals, isolating switches, cleaning tools, goods, cameras, freight train signs, waybills, freight bills, staff and other elements.

Animation module includes:
- Character standby animation.
- Character operation animation.
- Other elements.

Scene module includes:
- Train pick-up scene.
The function realization unit includes: the server data reading and writing module, the basic framework module, the voice sound effect module, the operation simulation module and the examination module.

The server data reading and writing module realizes communication with the server and reads and writes student information.

The basic framework module realizes the foundation framework construction, the modularization function splits.

The operation simulation module includes as follow operation processes:

Before unloading operation processes:

- Receiving train and align the location.
- Notify loading and unloading dispatcher to send shift.
- Check vehicle.
- Tarpaulin.
- Cargo loading status inspection.

Unload operation processes:

- Check waybill.
- Cargo ticket.
- Comparison of actual goods with bill goods.
- Supervise unloading operations.
- Supervise the unload vehicle washing operation.

After unloading operation processes:

- Check the vehicle door status.
- Window status.
- Cover status.
- Valve closing status.
- Check the safe distance of the goods.
- Clean the line.
- Check the ancillary operation.
- Register.
- Report the completion time of unloading.

The examination module includes the functions of student achievement record, student error record, experiment report output and so on.

6. Conclusion

In the training of railway freight loading and strengthening, VR technology can make the training process more intuitive, have a stronger sense of experience, and the process is more practical, which can effectively overcome many shortcomings of traditional training. In this paper, a model of railway freight loading and strengthening training simulation system based on VR is put forward, which has strong pertinence and can be applied to the development of all loading and strengthening training simulation systems.

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