Study on Simulation Emergency Exercise System for Rescue Personnel

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Abstract

Background: Emergency events have a huge threat to people's lives and property and social stability. The shortcomings of the traditional emergency exercise have greatly limited the scope and scale of its use. Objective: A virtual system that can simulate the real environment is needed to assist the emergency rescue personnel in training and improve their emergency rescue capability. Method: Using advanced computer virtual reality technology, a virtual simulation emergency exercise system is established. It includes basic information management, exercise scheme management, exercise scenario management, and emergency exercise evaluation. Result and conclusion: The virtual simulation emergency exercise system can create a highly realistic digital virtual environment, simulate the scene of a variety of emergency incidents with small cost, and quickly and repeatedly rebuilt emergency scene. It can further improve the response and disposal capabilities of rescue personnel in the emergency.

1. Introduction

Emergency events refer to natural disasters, accidental disasters, public health incidents and social security incidents that happen suddenly, cause or may cause serious social harm and need emergency measures to deal with them. Under the specific conditions, the emergency rescue personnel should follow up in the first time to achieve the maximum of life preservation and ambulance. This is not only the requirement of saving lives, but also the career mission of first-line emergency rescue personnel. Due to the limitation of various environmental factors and security reasons, it is very hard to adopt the way of on-site exercise and let the rescue personnel in the real environment of emergency. At the same time real environment exercise has the characteristics of high cost and long cycle. Even this real environment cannot be provided at all. However, the traditional desktop deduction has the characteristics of poor performance and training effect. Thus it is a need to have a virtual system that can simulate the real environment to assist emergency rescue personnel in feeling the environment. Emergency simulation exercise can improve emergency response and scientific decision-making ability of the rescue personnel [1-5]. The simulation emergency exercise system using virtual reality technology can create a highly realistic digital virtual environment, simulate the scene of a variety of emergency incidents at a small cost, and quickly and repeatedly recreate emergency scene. This system can save the cost of setting up actual simulation scenarios, and reduce the comprehensive costs of exercise. So it can be used as a normal exercise mode.

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2. Related Work

Emergency exercise is an important application of virtual simulation technology. Emergency rescue is a highly professional work. Experiences at home and abroad show that effective command and management play a very crucial role in giving full play to the emergency response capabilities. Advanced virtual simulation technology can provide emergency rescue personnel with an exercise environment which is very similar to a real disaster scene. On the one hand, this exercise environment is very close to the real scene, so that the trainees can get real experience from visual, auditory and tactile. On the other hand, virtual simulation technology can construct a lot of virtual environments beyond the real world. [1-4]

Based on advanced computer virtual reality technology, through the process of emergency simulation modelling methods and reproduction technology, a virtual environment which is closed to the dangerous reality is created. It lays a solid foundation for the development of event scene scenario editor and 3D scene real-time rendering sub-system in the emergency exercise platform [1, 6]. Using virtual reality technology, the relevant 3D scenes and events in different stages are set up according to the process of emergency plan. At the same time, it proposes the knowledge points at each stage as the emergency rescue personnel should master. So as to deepen the understanding of the plan and improved the ability of emergency disposal. Through the methodology of modelling, simulation and performance integration, it integrates scientific computing visualization, synchronization synthesis of video and audio and decompression of video and audio into one. The trainees are immersed in the relatively real scene of virtual emergency with related equipment. Through the virtual simulation emergency exercise, trainees can experience the emergency response process, manipulate a variety of virtual emergency exercise equipment, and view emergency rescue preparation process, search process, rescue process, evacuation process and other activities. It can confirm whether the actual emergency rescue system has the ability to complete the scheduled emergency rescue task. The defects of the emergency rescue process can be discovered and improved.

3. Functions of Emergency Exercise Simulation System

3.1. Basic Information Management

The basic information management module is responsible for managing and maintaining all data related to the emergency exercise. According to tutorial library, case library and plan library, the corresponding data sets are configured for different types of incidents and regions. The basic data needed for the exercise include the object of emergency action, emergency organization, emergency resources, disposal actions, emergency types, scenario events, weather elements and geographic information, etc. A data set can correspond to multiple incident types. Technical staff can flexibly maintain and manage all kinds of basic information, and establish the interrelationships of all kinds of basic information in the data set. In different data sets, the association of various types of basic information can be different, that can meet the needs of diverse exercise scheme. Those data will be provided to exercise scheme management module and exercise scenario management module. [7]

3.2. Exercise Scheme Management

Based on the data provided by the basic information management module of the emergency exercise, the exercise scheme and the implementation plan are formulated and managed according to the needs of the exercise. Existing scheme can be reused during multiple exercises or can be modified to generate new ones. The steps of formulating the exercise scheme include determine the basic scheme information, configure the information bar, set the weather conditions, determine participating department, and configure the organizational structure. [7]

The basic scheme information includes scheme name, emergency type and data version selection, etc. The information bar is the core content of the exercise scheme. The main contents to be configured for each information bar include the source of the information bar, delivery time, receiving department, disaster-bearing body, scenario events, relevant parameters of the scenario events, and trend display requirements, etc. The configuration of the organizational structure refers to divide the command department into groups and determine the team leader and team members.

The formulation of the implementation plan involve selecting an exercise scheme, configuring the basic information related to the exercise, adding the participating staff, determining their department, and generating the handbook for scheduling staff, participating staff and evaluators [1, 7]. Then the system starts the exercise scheme, pushes the information bar, and monitors the exercise process. According to the actual needs, it adjusts the information bar, controls the exercise process and the time advancement, and sets the time span. Through the simulation scheduling framework and the emergency situation deduction system, this system interacts with scenario settings and situational evolution information.

3.3. Exercise Scenario Management

The exercise scenario is one of the most important functional modules in the emergency exercise system. This module

takes the concept of unified library in the relevant field as the background. Based on the requirement of virtual emergency exercise, the conceptual scenario is modelled combining the data of the natural environment. Through emergency scenario editor combined with the solid model data, the conceptual scenario model is mapped to a runnable simulation scenario model. Finally the simulation system is running, and the simulation results are obtained. Exercise simulation scenario is intended for a certain purpose of the exercise to set space, time and process that the exercise system needed, and set background, conditions, constraints, rules, and simulation resources that the process needed. The simulation resources include model, data, script, triggering mechanism, etc. The scenario editor is a tool for scenario model management and use. Through some kind of specification, it gathers and assembles each relatively independent simulation model into a common environment. Those models are assigned attributes and relationships. They serve for the simulation exercise or deduction. The collected valid simulation data are provided to the exercise evaluation. [1, 2]

The exercise director team members customize the personalized scenario through the scenario editor. In brief, that is like building blocks. The models are selected from the simulation repository to build the scene needed for the exercise. The corresponding triggering event is added to the specific exercise scenario, and the affect scope is set. So that it can be triggered during the exercise.

3.4. Emergency Exercise Evaluation

The emergency exercise evaluation generally includes three basic steps: preparation for evaluation, implementation of evaluation and evaluation summary. [8-10]

In the preparation step, the evaluation team is responsible for designing the exercise evaluation program and writing the exercise evaluation report. It conducts a whole and comprehensive evaluation of each aspect in the exercise such as preparation, organization, implementation and safety. The evaluation team timely puts forward opinions and suggestions to the exercise leading team, the planning department and the security department. The members of evaluation team are generally emergency management experts and have a lot of exercise evaluation experience. The evaluation program is based on the exercise evaluation demand analysis. It comprises determining the purpose, content and procedures of the evaluation, the organization and implementation process of the evaluation, the specific work arrangements of the evaluation, and the related tools required for the evaluation. The exercise evaluation is a summary of the effectiveness and inadequacy of the exercise, through observing, experiencing and recording the activities of the exercise and comparing the difference between the

actual effect and the goal of the exercise. The exercise evaluation should be based on the exercise target. Each exercise target must be designed reasonable methods and standards of the evaluation items. According to the different exercise target, evaluation can use options, subjective ratings, quantitative measurements and other methods. [8]

In the implementation step, according to the arrangements of exercise evaluation program, the evaluators are in place ahead of time to prepare for the exercise evaluation. After the exercise started, the evaluators record and collect information, related data and materials of the exercise. They observe the implementation progress of the exercise and the performance of the trainees. The evaluators promptly record the problems encountered during the exercise. Without affecting the progress of the exercise, the evaluators can conduct on-site questioning and make a record. According to the observation and record, the evaluation items are scored one by one, and the evaluation results are recorded in time.

After the exercise, the evaluators comment on the problems and the achievements during the exercise and summarize the advantages and disadvantages of the exercise. According to the exercise process and evaluation records, evaluators make suggestions, exchange opinions and make records. And then they analyse the relevant information, define the existing problems, and put forward the rectification requirements and measures. After the evaluation of the exercise is over, based on evaluation criteria and related documents, the evaluation team conducts a scientific analysis of the whole exercise process according to the collected information and materials, and writes an exercise evaluation report. The main contents of the evaluation report generally include the implementation of the exercise, the rationality and operability of the plan, the command and coordination capability of the emergency commanders, the disposal capacity of the exercising personnel, the suitability of the equipment used in the exercise, the achievement of the goal of the exercise, the cost benefit analysis of the exercise, and the suggestions for improving plans, etc. The exercise evaluation report should be fed back to all exercising personnel. If there is no objection to the report, exercising unit should formulate rectification plans and measures, and clarify the goal of the rectification. They should track and supervise the implementation of the rectification plan until the problem is solved.

4. Process of Emergency Exercise

Based on the standardized and formal emergency measures summarized in emergency scheme and scenario, the emergency response process was established in accordance

with the emergency exercise task. Before the exercise, the exercise director team members shall design the overall scheme and determine the tasks, purposes and requirements of the emergency exercise. On the one hand the establishment of the overall scheme is the need of guide the exercise process, determination the key points and the main problems to be solved during the exercise and the purpose of the exercise. On the other hand it is also the basis for evaluating the exercise effect of the trainees. The overall scheme is converted to a specific exercise requirement, at the same time it is the input of the exercise scenario module and the evaluation of exercise. According to the requirements of the exercise, with the assistance of the control team members, the exercise scenario module generates the scenario of emergency events and exercise contents. The exercise scenario corresponds to the specific simulation variables control and simulation environment settings. It separately controls the operation of the simulation system, the performance of the virtual environment and the interaction process. The trainees receive the performance of the virtual exercise environment, interact with the virtual environment in real time, and complete the specific task under the exercise subjects. The exercise results will be saved in real time by the recording and playback module. On the one hand, the results will be played back during the review session. On the other hand, they will be delivered to the exercise evaluation module. [1, 2, 8]

According to the pre-set timeline, the script definition of the exercise process, as well as the information and events injected in each stage, the control team poses questions. Based on the injected information, the exercise implementation team uses aided decision-making tools to analyse and dispose the proposed issues within a limited period of time, and then submits the decision. Finally, according to the available information and response measures, they submit a draft of the response policy for the next action to be taken before the end of the analysis phase. The decision opinions submitted in each stage and the response policy draft submitted finally will be automatically forwarded to the exercise evaluation team. Based on the system judgment, self-experience and the evaluation points provided by the system, the exercise evaluation team checks and confirms the decisions and dispositions of each stage automatically transmitted by the system. Combined with the final response policy draft submitted by the exercise implementation team, a comprehensive review will be made after the exercise is over.

5. Conclusion

Virtual simulation emergency exercise is the effective means

to enhance classroom teaching and expand the effectiveness of exercises. Using virtual simulation can solve the theoretical and practical problems in emergency rescue exercise, and achieves the unity of vision, hearing and touch in the rescue exercise. Virtual simulation exercise can simulate a variety of different emergency scene and environment with small cost. And it can repeatedly rebuild the model quickly and Omni-directional records the exercise process. It is basically impossible to exercise in real scene. However, it is feasible for trainees to try different rescue schema in the virtual environment. The virtual reality technology can further improve the level and ability of the emergency rescue personnel. It can save the cost of setting up the scene model, reduce the wear rate of rescue equipment and training comprehensive cost, and ensure the safety of training. The study of virtual simulation emergency rescue exercise technology can provide rescue personnel with relatively real virtual event scenarios, enhance the trainee's on-the-spot feeling, and strengthen the response and disposal capabilities of rescue personnel in the face of emergency.

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