OVERVIEW OF VIRTUAL CAMERA MECHANISMS FOR COLLABORATIVE VIRTUAL ENVIRONMENTS: AN APPLICATION TO THE VRIMOR PROJECT

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ABSTRACT

This article presents a research on the control of automated cameras in dynamic 3D virtual environments, which analyses the different branches that are currently being developed and improved in relation to the placement and movement of the virtual cameras. The aim of this research is to choose a method to design a management system for automatic cameras to be applied in the project VRIMOR. This project allows operators of nuclear power plants to design interventions with the aid of virtual mannequins with humanoid form. The designed intervention will be used for the learning of the operators in collaborative virtual environments. It is at this stage when the automated management of virtual cameras becomes relevant.

KEYWORDS

Virtual cameras, VRIMOR, shot, agents, collaborative virtual environments, cinematography.

1. INTRODUCTION

One of the main problems in virtual environments is to find the appropriate location for the virtual camera, in order to facilitate an optimum vision of the virtual actor when he is moving around the environment. The appearance of multiple actors, like avatars or autonomous agents on the scene, makes the problem even more complicated.

The main objective of this research is the study of the technological advances reached in the field of placement and navigation of virtual cameras and, also, the analysis of their contributions and drawbacks. The purpose is to suggest a management system for automatic cameras which improves the placement of the point of view in the VRIMOR project and allows new strategies of cooperation between the actors on the collaborative virtual environment.

Nowadays, Collaborative Virtual Environments (CVE) represent a very important investigation area, since they promote communication, coordination, cooperation and, in some situations, collaboration between the involved actors in the education and learning processes. [1]. The most spread description about collaborative learning defines it as a situation in which two or more people learn or try to learn something together. [7]

The first step of our work consisted of a revision of several investigations made in this area, emphasizing that most of these investigations are focused on the field of virtual cinematography and virtual narrative. The second one was to identify the most important aspects of each investigation. The third, was to make a general analysis where the achievements of these investigations and the different needs that still persist were explained. Then, a description of the virtual cameras operation in the VRIMOR project is made to highlight the importance of designing a management system for automatic cameras. The issue is to solve the current problems in the VRIMOR project, considering the presence of multiple agents in the scenario. For this design, a hybrid approach, based on constraints and cinematography, will be selected.

2. BODY OF PAPER

2.1 Cinematography Concepts

Shots are the atomic entities of a movie. A shot, be it static or dynamic, represents a specific camera configuration of a certain length, that is not broken by cuts.

A scene is a unit of a film that conveys the sense of a series of events occurring in a continuous space and time. Each scene is composed of one or more shots.

Idioms describe the formulas used for combining shots into sequences [11].

2.2 Collaborative virtual environments

Software systems developed with the purpose of promoting the communication, coordination, cooperation, and in the best case, the collaboration during teamwork are known as Collaborative Virtual Environments [1]. The interaction which is promoted by its usage, has been investigated from very different perspectives, such as: the learning promoted through the environment [7], the activity generated in the shared working places[13]. Collaborative Virtual Environments (CVEs) are computer-enabled, distributed virtual spaces or places in which people can meet and interact with others, with agents and with virtual objects [14].

2.3 Related work

The increasing development of virtual 3D environments emphasizes the necessity of extending the services that the virtual cameras offer us when handling the points of view from which the scenario can be observed. The person-computer interaction should be as realistic as possible within a collaborative learning environment.

The recent approaches to the automated camera control in a 3D virtual environment include: systems based on idioms, systems based on restrictions and systems based on intuitive techniques. The main problems to be solved when using automated virtual cameras are the following: to choose an appropriate camera position, to avoid the obstacles in the field of vision, determining the path from the actual position to other when necessary, to define the camera's movement style, to select the focused target, and deciding the control level for the user of the virtual camera management system.

2.3.1 Cinematographic approaches

The current investigations which are based on virtual 3D cinematography, in order to resolve the problems mentioned above, decide the placement and direction of the virtual cameras, in real time, by means of Idiom-based planners, that generate, via top-down planning, sequences of prototypical shots to film actions such as conversations between virtual agents. [2] [5] [11] [12].

One of the models that use the common cinematographic techniques, based on idioms, to control, in real time, the camera placements in interactive 3D narratives, is the system FILM [2].Other investigations use hierarchic finite automata to codify the rules of the cinematography [5] [11]. t one, [11] makes a constant analysis of the essence of the scene to determine the adjustments of the position and direction of the camera in real and dynamic time, creating effective shots only in those environments that the camera is familiar with. The second investigation [5] proposes a virtual director and a virtual cinematographer, where the director is in charge of selecting the scenes, but cannot interfere in the course of the actors within the scene, due to the performance in real time. The cinematographer processes the information of the director and consults, constantly, location, direction and dimension of different actors, in order to correct immediately the position and direction of the camera if occlusions are detected.

The systems which are based on idioms can only register satisfactory shots for configurations previously defined according to the object of interest (physical object, actors), and sometimes they are not able to produce effective shots when multiple agents move in environments relatively unexpected or when the structures of the world occlude the object of interest.

2.3.2 Approaches based on constraints

On the other hand [2] [3] [4] [8] [10] [12] [13] are constraint-based systems that have the potential to allow their users to directly declare what type of camera shot is needed for a given user task in a virtual 3D environment. Nevertheless, generally, this additional expressive power requires correspondingly more complex methods for specifying all of the desired visual properties required in a shot. The solvers based on constraints for the camera receive as input specifications of how the object of interest must appear in the shot. Once this is received, they analyse the space of the possible values for the parameters of the camera. These solvers succeed in finding effective shots despite occlusions or unexpected configurations of objects. The importance of each constraint depends on criteria set by the user [4] [8].

The types of constraints determine the object vision in the camera shot and are defined to support the optimal range for the elements of the photographic composition. On this optimal stage (the camera position, direction vector towards the objective, and the field of visual angle) the valid regions of the space are built. These regions represent the permissible range of the values of the virtual camera parameters that will satisfy an individual constraint. Then it is determined if the position of the camera must be close up or far from the object of interest, to generate a greater or smaller projection, creating therefore the composition of scene depth. he user who loads manually the virtual scene, chooses the objects of interest and defines the style of the photographic composition to make the shot automatically [4].

Several investigations develop a predictive planner that, together with a virtual director, processes the parameterized constraints of the shot in a coherence frame which starts from the actual state of the camera, and carries out the necessary adjustments to generate the best output. The navigation systems should be optimised frequently when the constraint solver does not. satisfy them completely, in other to make the shot smoother. These investigations also pretend to be able to execute intelligent movements of the camera without taking into account future situations [10].

On the other hand, there are systems whose goal is to locate as soon as possible the object of interest in the environment, through an efficient planning of the movements of the camera, that is to obtain a good trajectory of the vision by moving the camera from its current location[12]. Some others, as well as being based on constraints, incorporate. ynamic lights and emotional effects that can influence the angle from which the camera exhibits the scene, and therefore the movement of the camera and the styles of transition between the shots [13]. uthors are creating immersive experiences in learning systems, evaluating the intentional behaviour of the students in their activities of navigation and manipulations of objects, in order to direct their attention to resolve the problems related to the subject currently being learnt, while the interface plans dynamically the positions and movements of the camera and the directions of the vision [3].

2.3.3 Approaches based on intuitive manipulations

The systems based on intuitive techniques provide the user simple mechanisms for the manipulation of the viewpoints in real time [9]. They propose that the primary viewpoint and the secondary coordinated system should be coupled with user’s natural movements, so that the user, through his gestures, could control, in a virtual environment, an additional viewpoint independently of the primary viewpoint, by means of intuitive manipulation.

2.4 Virtual cameras in vrimor

The project Virtual reality for inspection, maintenance, operation and repair of nuclear power plants (VRIMOR), developed a methodology based on the use of virtual reality, that allowed to minimize the exposure to radiation that receives an operator of a nuclear power plant, as a result of the operations of maintenance and repairing within the plant [6].

As part of this methodology, it was elaborated in the Universidad Politécnica de Madrid (UPM) a tool called HeSPI, which allows the design and simulation of interventions by means of the concatenation of basic subtasks that an operator could be able to perform within the nuclear power plant, understanding by subtasks each of the individual actions made by each operators. The base of this tool uses the virtual human mannequin Jack 2.3. The main difficulty in its design was to obtain an interface that allowed an easy manipulation of the 3D human mannequins (representing workers) by users non-expert in computer applications, and even less in 3D environments.

Thanks to the VRIMOR´s tools, the designer can obtain an estimation of the radiation dose received by each operator in the intervention, and experiment with different alternative solutions.

hese interventions can then be used for the training of the operators who will carry them out, having HeSPI to generate a simulation that allows a good visualization.

One of the most complex design aspects in HeSPI was how to facilitate the manipulation of the point of view over the virtual scene, that is, moving and positioning the camera along the “virtual representation”. Moving the camera required that the user navigated through the virtual space. In Jack this was achieved with a combination of keyboard and mouse. Pressing a key the navigation mode was activated, and then the three buttons of the mouse controlled navigation along the space. We were afraid that this manoeuvre would be difficult to master for the users, and certainly it took a time to get the users dexterous in navigation, but shorter than we expected. We found that it was easier if we transformed the problem of navigating into the problem of moving the environment with respect to the static position of the observer. With a button the user could move the world up-down-left-right, with other button the world could be brought closer-farther, and the third button controlled the rotation of the world.

Once the designer has positioned the world in a suitable way, a special “camera repositioning action” is introduced into the plan. It is as if the camera was a special actor that receives repositioning commands at certain points in time.

We considered as an alternative the design of an automatic camera management system that was able to follow the movements of operators. However, there can be several operators acting at the same time. In that case, a general view would be preferable, but sometimes it might be impossible to view all the operators at the same time. On the other hand, if some operators are doing routine tasks while one operator is performing the critical subtask, the camera should concentrate on it. Moreover, it could happen that the important thing to show in a certain object was hidden if the position of the camera was selected automatically. For these reasons, we decided to leave the responsibility of camera management to the user, even if it added complexity to the interaction.

In order to minimise the interference that this responsibility might provoke with the goal of planning and designing an intervention, camera management is something that can be done and refined once the plan has been completed. With a trial and error procedure, the user can reposition the camera and view the results as many times as it is necessary.

In addition to these benefits, the combination of interaction mechanisms described in this point resulted in a significant reduction in learning time and an increase in work efficiency when compared to existing human modelling and simulation tools.

Given the difficulty which involves this type of interaction for a non-expert user, it is necessary to design an automated virtual camera management system that can follow the movements of the operators and work, at the same time, with multiple agents in the environment.

An automated virtual camera system, coupled with the design environment, will also improve the way in which the collaborative training of the operators is carried out, providing a visualization of the tasks that multiple students and/or agents are executing.

3. CONCLUSIONS

Once the state of the art has been analyzed, it is proposed to create a system for automated management of virtual cameras that resolve the deficiencies described in the VRIMOR project, and improves its application as a collaborative virtual learning environment. he most appropriate approach for this system, would be a hybrid of the systems based on constraints and cinematography, given that the intuitive manipulation systems are oriented towards the control of the viewpoint by the user, in real time. The approaches based on cinematography use predefined idioms for familiar scenes, being it possible to use this solution for the filming of certain types of subtasks (for example, to show how an operator acts with a tool on an object of the scene). However, it is not possible to predict, totally, the form in which the complete scene will be developed, that is why it will also be necessary to resort to a system based on constraints.

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