A Cinematography System
for Virtual Storytelling

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Abstract. In this paper we introduce a complete framework to automatically generate "cinematographic view" of dynamic scenes in real-time. The main goal of such a system is to provide a succession of shots and sequences (of virtual dynamic scenes) that can be related to pure cinema. Our system is based on the use of an image-based control of the camera that allows different levels of visual tasks and a multi-agent system that controls those cameras and selects the type of shot that has to be performed in order to fulfill the constraints of a given cinematographic rule (idiom). This level of adaptation constitutes the major novelty of our system. Moreover, it stands for a convenient tool to describe cinematographic idioms for real-time narrative virtual environments.

1   Introduction

Automatic cinematography can be seen as the ability to choose viewpoints (eventually animated) from which virtual environments are rendered, with narrative constraints. In this sense, a strong parallel with cinema can be drawn; camera shots and motions participate to the emotional commitment a user can get with narrative virtual environments. Since the beginning of the seventh art, film directors have implicitly established a set of rules and conventions that encode proper ways to tell stories in an accurate and explicit mode (see [2] for examples). Though, this set of rules is not sufficiently detailed to define a formal grammar which could be directly used in virtual storytelling applications. Indeed, given a complete three dimensional description of a scene that includes motion of various objects and characters, many possibilities exist to film with respect to the traditional way of filming. Moreover, we can assume that choosing among one of these possibilities depends on many factors (director's intentions, lighting purpose, disposition of the scene, etc.).

In the contrary of cinema, when dealing with interactive environments such as video games or interactive fiction, it is not possible to use storyboards to characterize pre-

cisely the way each shot will be taken. In fact, due to the user interactions, the placement of cameras and actors can not be precomputed and, consequently, shots can not be planned in advance. Though it is always possible to set up offline some camera positions and switch between them at runtime (pre-composed "cut scenes"), this technique has proved to lack of expressiveness and forbids utilization of particular shots like over-the-shoulder shots for instance. This emphasizes the need of an autonomous cinematographic system in order to adapt to the dynamic world.

2   Automatic Cinematography

Many works have been done to automatically generate complete camera specifications, but among those works it is possible to distinguish two different types of approaches, considering or not real-time constraints. Hence, getting the exact flow of actions before they happen allows to run a planning process, which corresponds to the real cinematographic one [8, 4]. But, due to the user interaction, those approaches can not be used in real-time virtual environments as the flow of actions becomes unpredictable. This point constitutes the major difficulty in automatic cinematography, in the sense that the system has to generate a coherent and accurate viewpoint at each frame without knowing anything about the future of the actions. In [7], He *et al.* are the first to explore real-time automatic camera control. In [3], Bares uses a constraint-based approach for shots composition in a 3D interactive fiction. The FILM language[1] has two objectives: characterize the camera behavior of film idioms and adapt dynamically to the specific situation of any given shot. Funge [5] is one of the first to compare the camera system to an agent. Before the animation, a set of rules describing the camera behaviors are established, and during the animation its A.I. engine chooses between all those rules. Tomlinson [11] considered the camera as a creature, ruled by desires and intentions, that can act upon its environment (displacing lights for instance), in order to display the emotional content of the scenes.

3   Overview of the Cinematography System

The main goal of our system is to provide one camera configuration for the $3D$ engine at each iteration of the application. Let us note that provided that the application would propose several view-ports of the virtual environment, the camera manager should give an equivalent number of camera configurations. Choosing the best camera configuration for the camera manager is performed through the use of information provided by other modules devoted to scenario, characters and environment management. This information can also be the result of direct queries. Those aspects will not be discussed in this paper. The camera manager is composed of a multi-agent system which controls several cameras that act, independently and with different goals, in the virtual environment.

3.1   Camera Control

To perform positioning tasks and animation of the different camera, our system uses an image-based animation system, as proposed in [10]. Among other, this approach allows
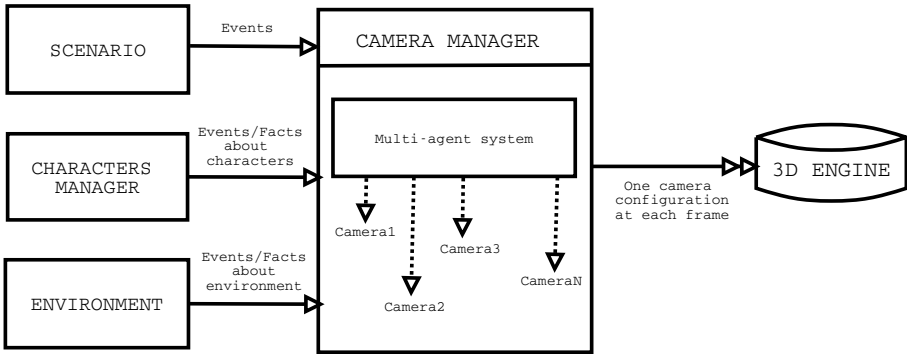
Fig. 1. Architecture of our system regarding to the other parts of the application

definition of multi-level tasks: a main task (or focusing task) that has to be respected at each frame, and some secondary tasks that can be executed providing that the main task is ensured. This feature allows flexibility in the control of the camera. Our camera module provides cinematographic primitives to control the camera. Several solutions may exist at the same time to solve a particular camera positioning task. Choosing between those solutions may depend on the desired effect as well as a particular context. Indeed, while evaluating the quality of a shot, the possible side effects due to the environment, like occlusions or lighting conditions, must be taken into account. Solutions to the detection of occlusions, and to possible strategies to avoid them exist [6, 10] and can be used efficiently in this context. Mainly, given an occlusion detection process, two possibilities are available: one can try to avoid the bad configuration, or if it is impossible (or if it results in a bad shot), the camera behaviors must adapt and choose for instance another shooting sequence. Using a camera control allowing different task levels is quite interesting in this context: while ensuring the nature of the shot (the image-based constraints), remaining degrees of freedom can be used to avoid bad configurations.

3.2   Modeling Idioms and Editing Purposes

The language of film is a common international reference and it can be viewed as a structured style for conveying stories that is familiar to viewers. Even if stories of several movies are different, the related style is so structured that certain situations are almost filmed from the same way. This stereotypical way to capture specific actions into a predetermined sequence of shots is called a film idiom. Idioms are cinematographic rules which represent a codified way of chaining different points of view depending on the nature of the filmed scene. Starting from this assumption, an idiom can be interpreted as an abstract agent chaining shots on different points of interest in the scene. Focusing on those point of interests can be achieved in several manners from different viewpoints. To adapt to the dynamic world, a multi agent system offering good synchronization properties [9] is used. The key concept of this architecture is to exploit redundancy of points of view satisfaction on a given scene in order to automatically

select the best camera in respect with idioms description, knowing that each camera is described as an autonomous agent. The synchronization facilities offered by the multi-agent system are used to ensure consistency during the film, between the concurrent cameras but also between the running idioms.

4   Conclusion

In this paper a cinematographic system adapted to real-time applications such as virtual Storytelling is introduced. The camera control is handled with our image-based constraints framework, and provides a multi-level control of the cameras (through the use of different level of visual tasks at the same time), and is well suited to avoid bad configurations (like occlusions) that are very likely to happen in dynamic environments. Our multi-agent system allows to exploit redundancy that can exist in the different ways of filming scenes, thus performing a trade-over between traditional ways and existing rules of cinematographic productions and dynamic environments constraints. This constitutes one of the major novelty in comparison with prior works. Moreover, this system constitutes a fast and intuitive tool to design cinematographic behaviors (idioms) that conveys narrative information with respect to film language.

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