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Introduction

Since immemorial times, humans have been telling stories. What started out as short stories about hunts and tales of ancestors, soon evolved to myths and legends. Over centuries, stories played an important role in human society and were used to teach, inspire, and entertain. With the advent of new technologies, new forms of storytelling were created. Currently, stories are told through several types of media such as books, movies and games.

Video games were introduced to the general public in the early 1970s and quickly became a form of digital storytelling that added interactivity to the traditional stories, allowing players to be the protagonists in a new form of digital entertainment. With the advancement and popularization of video games, a long discussion about the relationship between games and narratives has taken place (Jensen 1988; Juul 1998; Adams 1999; Costikyan 2000; Jenkins 2003). Meanwhile, a new research topic exploring the combination of storytelling with interactivity emerged (Meehan 1981; Loyall and Bates 1991; Szilas 1999). Soon it became the field of research that today is known as Interactive Storytelling or Interactive Narrative.

The first interactive narratives date back to the 1970s (Klein et al. 1973; Meehan 1977) and important experiments on agent-based storytelling systems took place in early 1990s (Loyall and Bates 1991). In the 2000s we can find the most influential research works on interactive storytelling systems (Cavazza et al. 2002; Mateas 2002). In more recent years, we have been exposed to new demands for richer interactive experiences in storytelling, such as transmedia storytelling (Cheshire and Burton 2010), social interaction between groups (Williams et al. 2011), and interactive TV storytelling (Ursu et al. 2008).

In parallel with the evolution of interactive narratives, cinema has been promoting new forms of immersive experience since the advent of projected motion pictures in the late 19th century. Cinema has evolved from the silent black-and-white film to the high-definition stereoscopic 3D projection. Recently,

films with interactive plots have been proposed as a new experience (Činčera et al. 1967; Pellinen 2000; Ursu et al. 2008; Jung von Matt 2010). However, most of these experiences are based on the concept of branching narrative structures (Samsel and Wimberley 1998), which are known in the area of interactive storytelling as having several limitations, such as the authoring complexity and the lack of story diversity. Research on interactive storytelling has been exploring the generation of interactive narratives since the 1970s and may provide the proper foundation for the creation of a new form of interactive cinema. However, this research area has few works oriented to motion pictures.

The most robust forms of interactive narratives rely on artificial intelligence techniques, such as planning (Ghallab et al. 2004), to dynamically generate the sequence of narrative events rather than following predefined branching points. The techniques that support the dynamic generation of stories are also useful to maintain the coherence of the entire narrative. Moreover, they support the propagation of changes introduced by the users, allowing them to effectively interact and change the unfolding stories. Although artificial intelligence techniques can help to improve the diversity of stories, they face the challenge of generating in real-time a visual representation for a story that is not known beforehand. In branching narratives, all the possible storylines are predefined by the author, and the system is prepared to represent them in the best possible way. On the other hand, in systems based on planning techniques, stories are created by the planning algorithm, guided to some extent by the user interactions, and it is not easy to predict all the possible storylines that can emerge. These unpredictable outcomes require intelligent systems capable of adapting themselves to represent emergent narratives.

Despite the large amount of research works in the field of interactive storytelling, there are still some open issues (Karlsson 2010; Zhao 2012). One of the main challenges, and the focus of this thesis, is the generation of engaging visual representations for interactive narratives. Interactive storytelling systems usually employ 2D or 3D computer graphics to represent the virtual story worlds (Mateas 2002; Cavazza et al. 2002; Ciarlini et al. 2005; Pizzi and Cavazza 2007). This approach provides a visual medium that facilitates the dynamic generation of visual content, providing the freedom to move the characters and cameras to any place in the virtual world, allowing the system to show the story events from any

angle or perspective. Furthermore, virtual characters may have their properties easily changed, such as shape, facial expressions, clothes, and behaviors. However, this freedom usually sacrifices the visual quality of the real-time narrative. Despite the recent progress in graphics rendering and the wide-scale acceptance of 3D animation in films, the visual quality of video is still far superior to that of real-time generated computer graphics.

Although animation is a powerful storytelling medium, live-action films are still attracting more attention from the general public. A promising approach that may be the first step to bring interactive narratives to the big screens is the replacement of 2D/3D virtual characters by video sequences in which real actors perform predetermined actions. This approach, which we propose to call "video-based interactive storytelling", has showed some interesting results in recent years (Ursu et al. 2008; Porteous et al. 2010; Piacenza et al. 2011; Jung von Matt 2010). However, most of those results either are domain-specific applications based on branching narrative structures or do not have the intention of presenting a general approach to handle all problems of a generic video-based interactive story.

The main problem of using videos to dramatize an interactive narrative is the lack of freedom occasioned by immutable prerecorded segments of videos, which reduces interactivity, limits story diversity, and increases production costs. For example, let us suppose a story that includes a kidnap event, where the victim can be kidnapped by the villain in different locations depending on the previous events of the story and user interventions. If only prerecorded scenes are used for dramatization, every possible variation of the kidnap has to be filmed. Consequently, the production costs of the interactive film will be multiplied by the number of storylines that can be generated by the system. Usually, the number of possible stories ends up being limited in order to reduce production costs.

This thesis proposes a new approach to video-based interactive narratives that uses real-time video compositing techniques to dynamically create video sequences representing the story events – rather than proposing a simple method that merely assembles prerecorded scenes. This approach allows the generation of more diversified stories and reduces the production costs. However, it requires the development of fast and intelligent algorithms, capable of applying cinematography techniques to create cinematic visual representations for the story events in real-time.

Advances of interactive storytelling technology towards new media, such as television and cinema, also require the development of new interaction mechanisms that consider the characteristics of the media platform that supports the story. In television, for instance, interaction systems should consider one or few local viewers (in the same room) or thousands of viewers sharing the same story at different places. In movies, the audience is restricted to the theater space, but is still a multi-user environment. Video-based interactive narratives designed either for TV or cinema require new interaction mechanisms that support multi-user interactions. These interaction issues are also addressed by the present thesis.

1.1. Objectives

This thesis aims at the generation of more engaging visual representations for interactive narratives by using video segments with real actors to represent story events. We argue that this approach can generate interactive narratives that resemble traditional movies while keeping the possibilities of user interaction even when the plot generation algorithms produce scenes that were not foreseen during the production stage.

The main objective of this thesis is to propose a general model for video-based interactive storytelling, including the organizational aspects of the production pipeline, the technical aspects of the algorithms responsible for the real-time generation of video-based interactive narratives, and the usability of the user interfaces.

1.2. Contributions

The main contributions of this thesis are summarized below (more details on specific contributions are presented in Chapter 9):

- Proposes a model for video-based interactive storytelling based on cinematography theory;
- Presents new algorithms and techniques for real-time video compositing and editing in video-based interactive narratives;

- Proposes new interaction mechanisms that support multi-user interaction in video-based interactive narratives;
- Reduces the gap between interactive storytelling systems and film directors by proposing a guide and computational tools for the production of video-based interactive narratives.

1.3. Thesis Structure

Chapter 2 presents the main concepts of interactive storytelling and a bibliographic review of the main interactive storytelling systems, emphasizing the methods used by these systems to visually represent interactive stories. It also includes a detailed description of Logtell, which is the interactive storytelling system used as basis for developing the proposed video-based dramatization model.

Chapter 3 reviews some essential concepts of cinematography that are important for the development of a video-based interactive storytelling system. The cinematography theory provides the basic principles and background for the creation of attractive and engaging video-based visual representation of interactive stories.

Chapter 4 presents the proposed architecture of the video-based interactive storytelling system from a software engineering perspective. It also discusses related work and describes the main differences between the proposed system and previous work.

Chapter 5 presents the proposed process of production of interactive narratives, describing how to write and how to film an interactive story. This chapter also describes some tools that were developed to assist the author during the production process.

Chapter 6 describes the technical details about the implementation of the proposed video-based dramatization system, including the proposed algorithms for real-time video compositing and editing.

Chapter 7 describes the technical details about the implementation of the user interaction module of the video-based interactive storytelling system, including the proposed multi-user interaction mechanisms.

Chapter 8 describes the interactive narratives that were produced to validate the proposed system and presents some technical tests to evaluate the algorithms used in the video-based interactive storytelling system.

Chapter 9 presents the conclusions remarks, summarizes the contributions and suggests topics for future research work.