

Developing Virtual Storytellers for the Virtual Alhambra

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Abstract. Thanks to the technological advances in the last ten years, the recreation of 3D virtual worlds is becoming increasingly popular in several application fields. Desktop virtual reality is one of the best ways of reaching a good number of users through this technology. With the aim of improving the development of desktop virtual reality applications and increasing the relevance of the virtual experience, we defined the *Virtual Reality Framework (VRF)*. This framework supports the creation of interactive systems for personalized and group guided tours in virtual worlds. The VRF can incorporate functionalities including context-sensitive information that a virtual guide will tell a user or group of users in a personalized manner. User interaction with the environment and with the intelligent virtual guides will lead to changes in the story told during the tour. In this paper we describe the Virtual Alhambra Project, which was the project that brought the VRF into being.

Keywords: Virtual Reality, Virtual Tourism, Virtual Storyteller, Interactive Storytelling.

1 Introduction

There are many monuments and sites of outstanding beauty on our planet. There is more than one way of experiencing and delighting in the charm of these sites. Visiting the monument in person is evidently the most impressive, but it is not always possible. When this is out of the question, videoed documentaries or photographic reports are a good option if you are looking for realism and an exact representation of the monument. The problem with this second option is that you have no control over what you can or cannot see, and even the order in which the images are viewed is programmed in videos. Additionally, if you have a question about the video you are watching, how do you find an answer? How can you gain access to the extra information? Thanks to technological progress, there has, for some time now, been an alternative way of visiting these beauty spots: virtual recreations of the sites [1].

Virtual recreation has a number of advantages over the use of videos and photos. For example, you can interact with the monument or decide what part of and in what order you would like to visit the site. Also visitor interaction with the environment is improved by giving users real-time access to information about the elements that

prick their curiosity. There are some interesting initiatives, like the Louvre Museum's exhibition rooms [2] or SecondLife [3], a 3D virtual world built and owned entirely by its residents.

To achieve an interactive virtual experience [4], the interactive capability of the environment needs to be used to the full by providing guides, assistants and information points. All these are elements that exist in the real world and that are helpful for visitors for finding out more about the world around them. The primary aim of the virtual recreation system should be to resemble reality as closely as possible. The system should not be confined to simply making the most of the computer's graphical capabilities for representing images (static or dynamic) of reality, but should also be able to reproduce the experiences and impressions that visitors of the real environment take home. To make the experience more life-like, the virtual representations need to be enriched with intelligent virtual guides or virtual storytellers capable of explaining the most important aspects about the place the user is visiting. For example, [5] integrates a system of autonomous dialogue engines with narration to create a multi-modal storytelling environment and let multiple virtual and human participants act in a story.

Since the early descriptions [6], [7], most interactive storytelling systems have integrated artificial intelligence techniques [8], [9], [10], which generate narrative action sequences with 3D graphics and animations, staging these narrative actions to produce the actual interactive story, but some new theoretical approaches [11] focus on computational linguistics (as a form of "computational narratology").

This paper discusses the virtual recreation of the Alhambra in Granada [12] developed by CETTICO¹ and Sema Group, and funded by Legado Digital. The paper is organized as follows. First, we describe the problem leading to the need to build this system and the developed application's features. Then we remark on the technology used to develop the solution, focusing on the Virtual Guides System. This includes an outline of the process of building a storytelling system. We end with some final conclusions.

2 'Virtual Alhambra' Project

2.1 Motivation

Granada's Alhambra is an extremely interesting tourist, artistic and cultural site. It is Spain's most visited monument. There are strict restrictions on admission and on the duration of visits to certain parts of the grounds [13], and visitors are even barred from entering some of the monument's rooms. There are then plenty of reasons stopping people from visiting the monument in person.

Therefore, a number of fundamental aspects (beauty, cultural interest and visiting restrictions) come together to justify a virtual recreation. For this reason, Fundación Telefónica developed a virtual world for La Alhambra in arsVirtual [14]. Although the graphical quality of this recreation is good, it has some limitations: the user's

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range of movements is poor (all the user can do is turn around, and look up and down), there are no visits for groups, and it is more like a sequence of images than an interactive tour. To overcome these limitations, a virtual recreation should include interactive tours with guides and elements in the world from which the user can easily obtain additional information.

To solve the problems described above, we developed a virtual recreation, called the Virtual Alhambra (Fig. 1), with several key objectives:



Fig. 1. *Virtual Alhambra* screenshot

- Give all those people who cannot or do not want to travel to visit the site in person access to the monument, exploiting what is known as virtual tourism.
- Try to reach as many people as possible by setting up a meeting point and an instructive and educational space. This is perfect for use by groups of people from primary and secondary schools and universities.
- Many parts of this age-old monument have suffered the ravages of time. One of the goals of this project is to do the historical groundwork to represent the Alhambra, removing all the damage it has suffered to date from the virtual recreation. This process of historical reconstruction is what is known as virtual archaeology [15].
- Assure the virtual visitor a comprehensive experience, not confined to a realistic visualization. To do this, the environment needs to react to actions that users constantly take in the virtual environment and provide feedback that at least mimics what would happen in the real environment. To improve the relevance of the virtual experience [16], it is necessary to deploy components to increase user interaction capabilities, provide expert assistants in the Alhambra and general- and special-purpose guides, and supply location-dependent information displayed to users according to their preferences and actions. These needs can be met by developing a system to manage virtual guides, also known as virtual storytellers.

2.2 System Features

In development terms, the Virtual Alhambra project is of considerable complexity and size, and has involved a sizeable group of researchers and developers [12]. Therefore, this paper will focus only on the key features of the Virtual Alhambra.

The Virtual Alhambra is a desktop virtual reality application, which can be placed in the virtual tourism slot. Its aim is to offer a virtual world experience within the environment of Granada's Alhambra. To achieve this goal, the system enables the user to relate not only to other users but also to intelligent systems that are in the same virtual space and time inside the monument. This communication will be visual (connected users will be able to see each other, see Fig. 2), through written language via chat (public or private) or speech conversation (public and private).



Fig. 2. Groups of users can visit the same virtual environment in the *Virtual Alhambra*

The user will be able to gather additional information during the virtual visit through the interaction elements there are within the virtual world: on the one hand there are softbots [17] that act as guides or assistants; on the other hand there are interactive information points as happens in reality. These components improve the user's experience of the visit by adding to and extending his or her interaction with the rest of the virtual world. A softbot can be associated with a representation in the virtual world as if it were a user. However, there is no human behind a softbot to manage it, and it behaves autonomously. When the user requests a guided tour (softbot), he/she can communicate with the softbot in different ways:

- Using a *questions menu*: the user is given a list of predefined questions based on his or her location. The visitor can choose the question he or she is interested in. This can help users to learn important information about the places they visit, without having in-depth historical or cultural knowledge.

- Using *natural language* to ask any question (see ‘Virtual Guides System’ section) through the chat.

In both cases, the user receives multimedia information and specific tours in response. The type of multimedia information is very wide ranging, from narrated explanations and explanatory videos to information displayed via web. The subsystems that provide these services are called assistants because they are able to help the user at definite times.

In addition, the user can request a personal or group guide. The guide gives the user a guided virtual tour, taking the user through the virtual world. The user can ask for extra information, as explained above, at any time. There are some differences between personal and group guides:

- *Personal guide*: thanks to the guides system’s artificial intelligence, the features of the tours can be personalized depending on several parameters, like available time, areas of interest, preferred areas, or areas already visited. Each tour is associated with an interactive story where the guide narrates important aspects about each of the visited sections. The user can change the course of this narration either by asking the guide a question or interacting with the elements that there are in the world. When the user interacts with softbots or information points, the system can provide the virtual visitor with extra information about the place. The information is given as web pages, videos, texts, etc.
- *Group guide*: in this case, a group of users shares a virtual guide. If another user interacts with the guide (as described above), the story and the information received by all the group members will be modified as happens in real life.

The system can be run locally or across a network. Of course, guided tours and chat are only available when running the Virtual Alhambra online. Because of how intrinsically related the Internet is to the world of virtuality, the Virtual Alhambra can also take advantage of the potential of the world of the Internet and be used as a meeting place where users are free to act and interact according to their tastes and needs. This feature is applied in many Internet communities [18]. Additionally, each user can come away with a different picture of the Alhambra because different levels of detail are possible. They will depend on the each user’s machine and network capacities. Also, to assure that performance is unaffected, the virtual world has been divided into separate rooms. The geometry and texture of these rooms is not downloaded until they are accessed.

To create the Virtual Alhambra, we defined the Virtual Reality Framework (VRF).

3 Virtual Reality Framework (VRF)

There are several tools for building or helping to build storytelling systems. One of these tools is DraMachina [19]. It is a powerful tool for interactive story editing and interactive story definition. This tool provides the user with an XML file containing all the information needed about the story. This file can be easily imported into a storytelling player system. MuViPlan [20] is an interactive guided tour framework. MuViPlan provides several tools and functionalities, such as editing tools, template definition and group guided tours. To develop the Virtual Alhambra not only did we

need editing tools and group guided tours system capability, we also required a UIMS (User Interface Manager System) and intelligent virtual guides. Such features are helpful in building a better interactive system, including a 2D/3D user interface and personalized tours.

The *Virtual Reality Framework* (VRF) is based on earlier results obtained with a platform that was able to describe user interaction processes: COREUS (User Relations Builder) [21], [22], [23]. COREUS is a platform developed by CETTICO, to create and adapt user interfaces at runtime. COREUS needed to be extended to incorporate the virtual reality medium. This extension allows the construction of any virtual application: virtual tourism systems, demonstration systems, teaching applications, simulations...

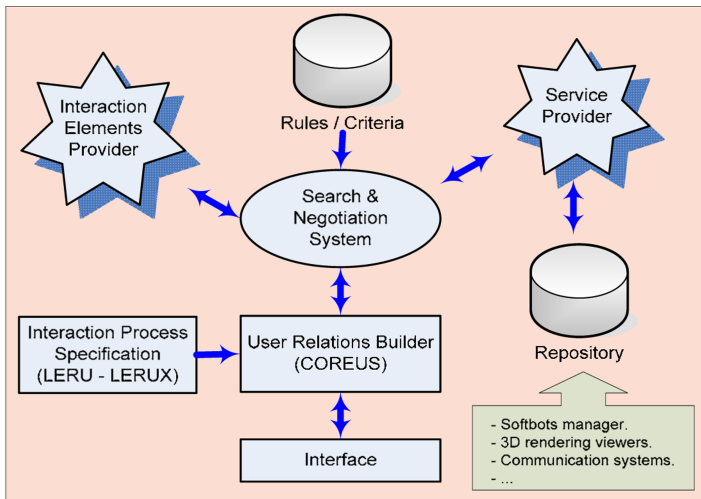


Fig. 3. Diagram of VRF architecture

VRF is a framework for building virtual reality-based systems that are furnished with other additional components, like a softbots manager for guides and tours (Virtual Guides System), multi-user and networking support [12], interface development system integration (COREUS), etc. Fig. 3 shows a high-level diagram of the framework's different parts. VRF's key features are:

- The framework components are independent. Each component is characterized by being able to provide a number of services.
- It uses an interpreted language, as suggested in [24], to represent the interaction process.
- VRF establishes the services and the protocol to integrate interaction elements like softbots into the framework (see 'Virtual Guides System' section). It now provides two types of interaction with virtual guides:
 - The first is based on the principle of closed questions and geographical location.
 - The second is based on the use of natural language and ontologies about the place where the visit is taking place.

- VRF establishes the requirements to be met by a component having 3D rendering capability for use in the framework. This allows the incorporation of different engines with different rendering capabilities depending on the situation at any time and technological advances.

The development of systems based on this framework is based on an interface modelling language and a user interface management system (UIMS) that is responsible for converting the described interface into a runtime. To make the most of the ideas that Puerta suggests in his works [24], we opted to define a flexible and extendible environment, without having to modify the system core. These interfaces are built using the following components:

- User Relations Specification Language (LERU) [22], [23] and its XML version (LERUX) [25]: this is an interface modelling language that can be used to describe the dialogue process, the visual appearance and the space/sound arrangement of the components that are going to participate in the interface. It also specifies the services that the components have to provide. We have defined an open language, whose full definition and interpretation depends on the elements participating in each interface. This requires a distributed and collaborative interpretation by all the components participating in the interface. LERU/LERUX defines the core of the language and the protocol to which both the interaction elements and the service providers should conform to be able to be incorporated into VRF by making the appropriate extensions to the language. This approach allows the incorporation of any new components into the framework.
- User Relations Builder (COREUS): this element implements the LERU/LERUX core interpreter, coordinates the different interface elements, performs the mapping at runtime between the description in the script and the rendering in a specific environment. Along general lines, the steps for generating an interface are:
 1. Prepare the work area in which the interaction is to take place.
 2. Determine the existence of constraints (window size, equipment capacity, existence of Internet connection...).
 3. Perform the search and select the interaction elements. To do this, take into account the results of steps 1 and 2, the objective or purpose of the interaction element and the services to be provided.
 4. Search required services providers (download contents, access databases, p2p communication system, etc.) to make the system operational.
 5. Assemble the interface. This involves locating and assigning the materials that an interaction element should use to generate its *physical representation* within the interface. The materials to be used are determined depending on the purpose of the element and the context in which the interaction takes place. For example, it could be decided that a lower quality version of the model should be used to display a particular room.

As a result, this new platform was later applied to different projects (see conclusion). To do this, it had to be added to and extended with new functionalities. Its use in these projects validated the platform and demonstrated its utility, showing it to be reusable, modular and independent of the application domain.

4 Virtual Guides System

This system is a VRF module that is responsible for managing the tours that the user is given within a world. The tour is accompanied by an interactive story based, in this case, on historical facts related to Granada’s Alhambra. The system will select what to show and tell of this story, creating a personalized interactive story for each user. The story varies depending on the actions the user takes within the world and the natural language question the user puts to the Virtual Guides System.

The Virtual Guides System is characterized by providing all the information required to define the guide’s behaviour by means of a script language. These scripts are interpreted when a guide is activated, establishing the knowledge about the current location, the possible itineraries around the world and the possible decisions to be taken depending on user questions and actions [12]. The scripts that govern the behaviour of the guides (softbots) can be ready built or generated when needed from templates depending on user preferences and information available in the databases.

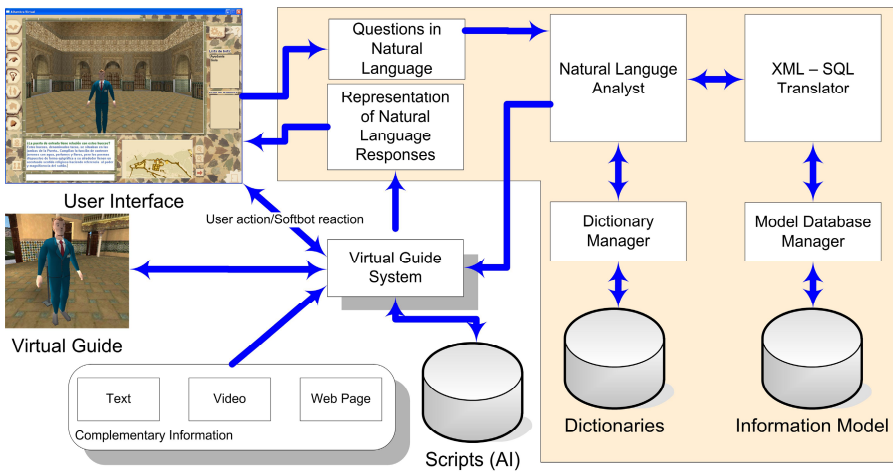


Fig. 4. Virtual Guides System with natural language processor

As already mentioned, the application allows the user to communicate with the virtual guide in natural language through the use of chat (see Fig. 4) driven by the Natural Language Dialogue Module. This component can be described as an improved information retrieval system (IRS) in the sense that it allows the user to ask in natural language about a particular topic (specific domain), in this case Granada’s Alhambra. The technique used for natural language recognition is *shallow parsing* [26]. Our system is also capable of interpreting the actions that the user takes within the world and acting proactively by providing information related to the elements about which the user has shown interest. In both cases, the system responds correctly to the user based on the information that it contains. The user will be given the response directly through the chat system, which may be accompanied by additional information like videos or web pages related to the system response.

5 Building Process

As mentioned previously, VRF provides a set of script languages for story definition. The syntax of these languages is quite simple and they can be used by people with no programming skills. The development team can also use a set of tools (see Fig. 5) to import worlds (3DS Max or Blender 3D formats), specify predefined paths, specify predefined softbot responses (Story Builder) and, when a domain ontology is defined, automatically define new paths. This information will be used to personalize the visitors' tours.

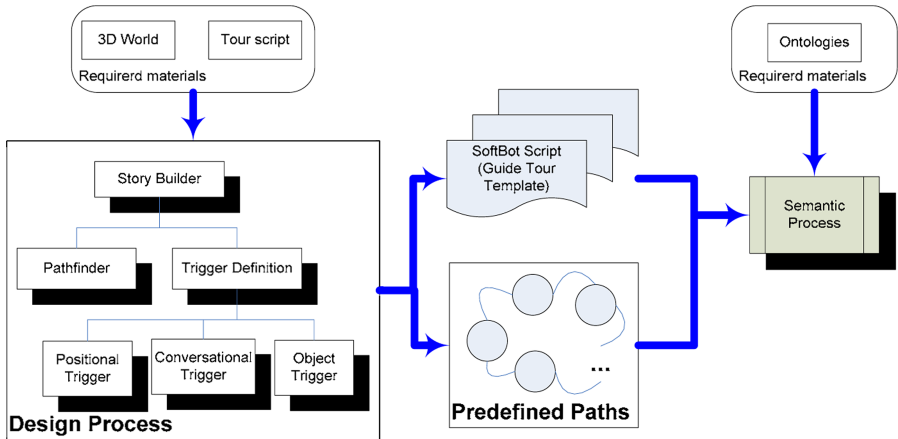


Fig. 5. Building process

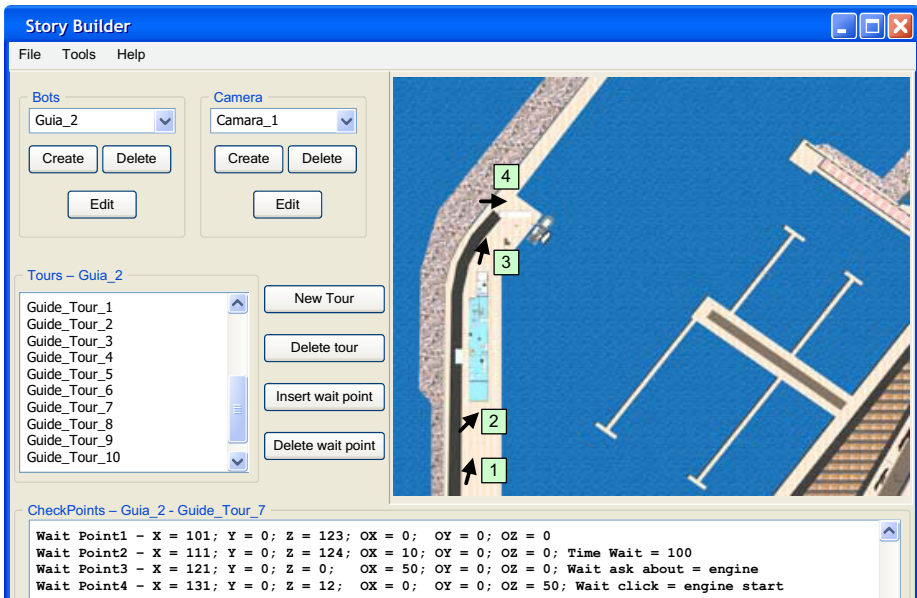


Fig. 6. Story builder used in sea bass breeding and feeding system

Scripts of the available tours and a version of the 3D world with all the rooms and interactive objects are needed before embarking on the building process. Using the Story Builder tool (Fig. 6), the story designer selects the specific points of the world included in the tour, defines camera positions and specifies visitor actions (position, conversation, interaction with objects...) to define each tour. The result will be the predefined paths and the templates for the intelligent bots.

Finally, the semantic process is useful for grouping rooms, defining new tours, new paths or path fragments based on the main subject of the virtual world. Domain ontologies are recommended as they achieve better results in this process.

6 Conclusions

In this paper we introduce the Virtual Reality Framework (VRF). This framework supports the creation of desktop virtual reality systems for personalized and group guided tours. VRF features allow story programmers and components developers to build non-linear stories with a high degree of interactivity between users and elements in the virtual environment. This gives users an intensely interactive, amusing, striking, and informative experience. The system allows the user to meet other visitors and autonomous intelligent systems (*softbots*) that are in the same place of the virtual world at the same time. They can interact by visual communication (movements, gestures and facial expressions), by written language (private and public chat), and by voice dialogue (private and public conversations). Thanks to the modularity of the framework and the use of scripts to create stories, the time and effort it takes to develop this kind of systems have been improved (see Fig. 7).

After developing the Virtual Alhambra, which was the first VRF-based application, many other VRF-based systems have been developed for different application domains. This has demonstrated that framework components are highly reusable and scalable. Worthy of note are a number of scientific disclosure systems, such as mussel culture, sea bass breeding and feeding, gilthead fish breeding and feeding virtual recreations, demonstration systems for the building industry, museum and monument guided tour systems, etc.

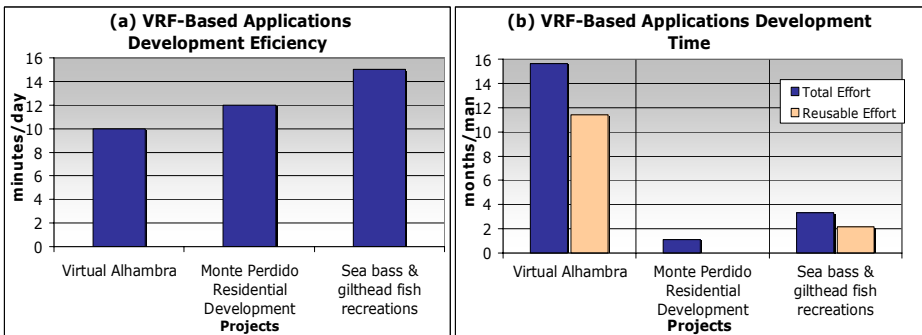


Fig. 7. Development Efficiency (a) and Time (b) using VRF in different projects

Fig. 7a and Fig. 7b. show a measurement of efficiency and the development effort, respectively, for three examples of projects of different complexity in terms of story duration and number of possible story branchings. Fig. 7a represents the measurement of efficiency calculated as the total duration of all the stories a story programmer can build per day using the script system provided by VRF. Fig. 7b shows that most of the development effort can be reused in future applications. Reusable effort consists of components development and component services development.

In conclusion, it can be said that VRF and specifically the Virtual Guides System provide an easy and efficient way of developing virtual guided tours, thanks in part to the reusability of the framework components.

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