3DWikiU - 3D Wiki For Urban Environments

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ABSTRACT

Virtual Reality (VR) systems may be used with great effectiveness in applications such as urban planning, virtual tourism, cultural heritage and education. In fact, the VR systems allow the visualization and interaction with 3D models, which can work as a natural metaphor due to their similarities with the objects that they intend to recreate. This is the perfect scenario for this project which intends to recreate virtual urban environments and complement them with digital services useful for people's everyday tasks.

On the other hand, the implementation and management of a virtual environment is complex and requires a numerous development team with different skills to build it properly. The purpose of this project is to build a collaborative environment where the users have the power to contribute and edit objects in the referred environment, exploring the wiki concept.

This paper presents a collaborative VR system that aims to provide a more natural and intuitive interface to access diversified services on 3D urban environments - 3D Wiki for urban environments. These services shall contemplate citizenship activities, entrepreneurship activities, promotion of the natural and cultural heritage and support of the cooperation and data sharing among citizens.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Computer Graphics]: Virtual Reality, H.5.3 [Group and Organization Interfaces]: Collaborative computing.

1. Introduction

The concept of VR systems can be seen as a way of users to view, interact and manipulate data in computational environments. Thus, VR systems are characterized by three aspects: immersion, interaction and involvement [Mor94]. Immersion is associated with the idea that the user is within the VR system and the perception that he has the power to manipulate and interact with virtual objects. The interaction refers to the computer's ability to detect and process the user input in order to modify the virtual environment on the fly. Involvement is related to the exploration of the virtual environment and the sense of user participation.

Virtual urban environments are an important content to the VR systems used in applications such as urban planning and management, virtual tourism, cultural heritage and education. This kind of virtual environments make available three-dimensional models that mimic the particular urban elements, promoting the attainment of high levels of detail and visual fidelity and thus being a natural metaphor for immersion and interaction.

The "Wiki" concept consists in the notion of collaborative software that allows a collective edition of documents, with the particularity of not requiring approval before publication. The project aims at developing a "3D Wiki": a collaborative environment for managing 3D virtual environments, aiming to be faithful representations of real urban areas. The interface provides immersion in the virtual environment allowing the sharing of diverse types of data such as photographs, texts or events. The users can also contribute with information about the urban environment that is being simulated, in order to improve the level of visual fidelity.

In the next section related work is described, focused on virtual environments and services provided in urban settings. Afterwards the project will be described in more detail, addressing the architecture and functionality of the 3DWikiU system. The last section concludes the paper with the definition of future work planned for the next steps of development of this project.

2. Related work

There are two types of projects that are related with the one presented in this paper. The first ones are to provide services associated with real urban environments such as foursquare [Fou11], Gowalla [Gow11], Brightkite [Bri11] and "A minha rua"[Ama09]. The second type of tools allows the recreation of a world (or part of it) in 3D, introducing edition in a collaborative way. Examples are Google Earth [Goo11a], Second Life [Lin11] or OpenSim [Ope11].

Foursquare [Fou11], Gowalla[Gow11] and Brightkite [Bri11] are all very concept-similar location-based, social network platforms, which allow their users to share their location with others through their mobile devices. For each place that users "check in" (i.e. announcing their arrival at that location), they receive a platform-specific certificate, whose accumulation which can ultimately result in additional rewards, opportunities or deals, depending on the platform. Gowalla, for instance, uses the concept of "virtual passport" to collect "stamps". As a reward, the users can collect some digital souvenirs and, if so, can choose whether to keep, discard or leave another there for the next user that checks in there. The prizes can also be real (discount coupons, movie tickets, etc…)[CG10]. Such services are ideal for users to discover new places to visit (or to avoid) as they allow them to share their experience and leave their feedback about all the aspects of those places.

The project "A minha rua" ("my street" in English), supported by the adherent local authorities, allows the citizens to actively participate in solving possible problems in public areas that are responsibility of the local authorities. These problems can be related with street lighting issues, public parks, monuments, etc. [Ama09]. This service is available in the local authority website and the user just needs to identify the location, write a short resume and, optionally, attach some photos. At any time it is possible for the users to see the reported cases and to check their current situation. This service intends to improve the urban environments management, to give to the community a more active voice and to promote citizenship activities.

Google Earth, Second Life or OpenSim allow to recreate a world (or part of it) in 3D and offers to their users interactivity and, somehow, collaborative work. Google Earth [Goo11a], from Google, intends to be an application that can represent the whole world virtually. It is essentially based on aerial photographs and geographical information, but does provide, for certain areas, 3D representations, which can be extended and improved by any user through tools such as Google SketchUp [Goo11b]. Applications range from academic studies to spontaneous exploration, through their accurate perspectives of certain places. Such features allow a deeper study and perspective of the selected regions bringing up more opportunities in research or urban planning areas. They can also be used for entertainment, by allowing users to discover places or grow their geographical wisdom.

Second Life [Lin11] is a collaborative virtual environment from Linden Lab which intends to be a simulator of the real life with a high degree of interaction. The virtual environment allows the users to perform a total customization of his avatar and profile, as well as their interaction through chat, voice or avatar gestures. It is also possible to build almost every type of objects and apply proper textures and scripts. Programming objects is possible (using LSL – Linden Scripting Language) to perform certain tasks such as follow avatars, send messages, teletransport, etc. Second Life has its own currency, the Linden Dollar, which can be used to buy "virtual goods". Besides this economic side, there is an educational side: some universities are there represented virtually and promote e-learning activities [Sec11]. OpenSim shares many similarities with Second Life but has the advantage to permit users to create their own servers; it also offers more flexibility in the development due to its open-source nature. The users can create a local server to make some experiments or implement a server to be used by anyone [Ope11].

Considering the features of the analyzed tools, the intention is to develop a tool that combines them and offers users a collaborative environment where they can be aware of certain places, how they look like, which services are available and what they can do there. With this combination of services in one single tool, the user has the possibility to access or share geographical information, change building appearance or access services associated to those same places.

3. The 3DWikiU System

The 3DWikiU system intends to provide an interactive and immersive virtual tridimensional environment incorporating a set of digital services. Being available to its users, the services will allow data sharing and collaborative work for further content improvement, this way promoting activities in urban planning, virtual tourism, public services, cultural and natural heritage, education or even commerce.

Concerning urban planning services, the goal is to obtain a reliable 3D replica of the real urban environment, whose base can be built procedurally from geographical data, so the users can navigate on it as they would in the real urban environment. It is intended to offer collaborative edition, so the users can also modify the virtual world to improve visual fidelity (changing textures, adjusting building heights, settings urban furniture locations, etc). More specific purposes could be fulfilled, such as allowing a group of architects to work on a common project remotely and simultaneously, and introducing the possibility for their clients to give feedback directly on the project models. In a similar fashion to "A minha rua", users could report (and propose solutions) situations that need the attention of the local authorities. Regarding the virtual tourism field, the user will be able to discover the place that he plans to visit and have some previous contact with the local culture, so he can plan his trips. He should also be capable of making reservations of the hotel services if they are available.

3.1 Actors

In a similar way to common Wiki platforms, 3 different types of 3DWikiU actors have been identified: users, moderators and administrators.

Users are the most common entities who interact with the system, having access to the basic and widespread features. By registering in the system, users are assigned a profile, which can hold personal information that they may intend to share. General usage statistics are stored as well as logs in order to maintain some track of their activities and therefore be able to provide support or avoid certain abuses. Once logged into the system, users can navigate freely around the virtual environments and interact with the available services. Also, they can contribute with additional

content, such as images, texts, routes or even services and advertising. Regarding the possibility of altering the tridimensional models of the virtual environment, users will be provided intuitive tools for manipulation of the urban elements. Depending on the type of intended contribution, more specific roles may arise and certain titles may be awarded in order to encourage further user collaboration.

Users can be promoted to moderators, being granted a slightly vaster control over the 3DWikiU contents. Similarly to how it is commonly done in standard Wikis, these entities are responsible for supervising the various changes made by the other users, fine-tuning where they see fit and intervening when incorrect data or abuses are detected. Therefore, they are able to undo changes that have been made and to restore previous versions. If suspicions or incorrect behavior from another user is detected, moderators can chose to report that fact.

Finally, there are the administrators, whose contribution is more on a maintenance and general supervision level. They have the power and responsibility to guarantee that the whole system is working, as well as to act directly whenever particular problems with users arise (technical issues, vandalism and bot detection, etc.), acting based on user or moderator reports, as well as logs and statistics. Their interventions are meant to be, unlike moderators, as short and rare as possible since 3DWikiU is supposed to be as autonomous and self-sufficient as possible.

3.2 Architecture

For a better understanding of the various features, processes and links that will compose the whole 3DWikiU system, a general architecture overview is presented in Figure 1. In short, 3DWikiU is structured as a client-server application, while each of the parts may access additional remote databases or web services on the World Wide Web. The previously explained actors have different points of interaction with the system.

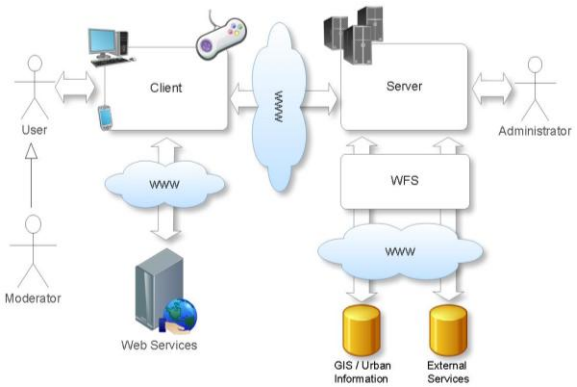

Figure 1: *General 3DWikiU Architecture*

The client application is the main "window" of the system, with which the users and moderators interact. Regarding the target platforms, while in a first step a greater focus will be driven towards more general-based computers, approaches in more dedicated gaming or mobile devices are also considered possible client platforms in the future. The client introduces access to a wide range of features, which are displayed in more detail in Figure 2:

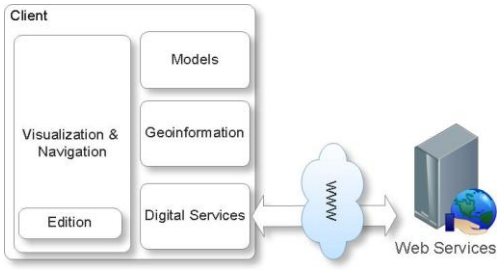

Figure 2: *Client architecture, displayed in modules*

Firstly, the client allows the visualization of the virtual environments and corresponding navigation, which includes the interaction with the many services. Also, user contribution and collaboration is achieved though "Edition" possibilities, which in general allows changes to be executed in the 3DWikiU world.

This first module acts as a frontend to the remaining ones in the client, which are mainly responsible for the internal management of the user inputs and communication with the 3DWikiU server. The virtual environment is loaded by the "Models" unit, which is responsible, on the one hand, for loading the requested virtual environment information from the server and for processing it according to the necessary formats and structures required by the viewer. On the other hand, it acts as the handler for user changes regarding the tridimensional models that represent the various urban elements.

City boundaries, street names and building information are only some examples of data that is managed by the "Geoinformation" component, which requests such information from the server and places it together with the tridimensional geometry of the virtual environments. Further contributions by users in this matter are also sent through this module to the server in order for them to be saved.

Last, but not least, the "Digital Services" unit is responsible for adding and loading the digital services, which, in their turn, are located in remote locations on the World Wide Web. They can be accessed directly through existing Web Services or through the server (see Figure 1).

Acting as a central hub for all incoming client communications is the server (which can be implemented in a distributed manner and in multiple machines), whose internal architecture is described in Figure 3.

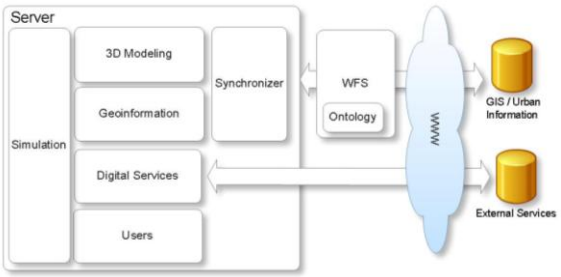

Figure 3: *Server architecture, displayed in modules*

The frontend of the server is the "Simulation" module, which receives and manages all messages and requests from the clients' inner components, mostly forwarding messages to its modules with the same names (compare Figure 2 and 3). In general, it is responsible for updating the many clients with each other's user locations, actions and collaborations when they are navigating within the same area.

The "3D Modeling" component is responsible for the generation and persistence of 3D urban data. It includes procedural techniques that are able to generate the various urban models based on GIS data and on a set of rules, definitions and parameters. Once the data is processed, it can supply the clients' "Models" component. The "Geoinformation" unit loads urban data, sending data through the module with the same name location at the clients. Both these components need to access a set of resources which may be located in a remote server, typically belonging to each city's autarchy or any institutions working in the GIS area. Since all these may have their sources in different formats or data models, there is the need to provide an intermediate component, a Web Feature Service (WFS), which can manage such data and ensure a unified and unique model of information, based on an ontology. This allows both the "3D Modeling" and "Geoinformation" modules to query and obtain information always the same way, from multiple sources, in a transparent way.

In order for the 3DWikiU System to be able to integrate user contributions, each of these modules will have to encompass solutions to persist such data. While this could be done directly by changing the original sources, it might end up saving invalid data before it could be verified by a moderator. Also, to keep multiple versions, each of these modules will be able to save their own data, and only when validated, authorize it to be saved on the original sources (if intended). However, since such sources may be changed by their owning institutions simultaneously, a process of synchronization must occur, which justified the need for an additional component (see Figure 3).

Also important to mention is the "Digital Services" unit which responds to the corresponding clients' module and that acts essentially as an interface for any existing digital service which may not possess a Web Service interface. Finally, the "Users" unit is responsible for storing all user data, including personal data, actions, logs, etc, which, depending on the nature of the information, can be made public to other users or only to the administrative staff.

4. Future work

The project will be developed based on three main tasks: the development of a collaborative virtual environment, the specification of digital services to be provided and, finally, their implementation and integration with the collaborative virtual environment.

In the first task, it is necessary to use a tool that allows the creation of a 3D environment that integrates dynamic features for collaboration. Employing procedural modeling techniques for massive urban modeling constitutes one of the main steps, but cannot reach its full potential without the guarantee of a Web Feature Service which can provide transparent access to a vast set of sources.

In the second task a set of services will be prepared. This set of services should give an added value to the user and also should allow the insertion of new elements as well as amendment or supplement of existing ones.

Lastly, the services will be implemented and integrated in the virtual environment. Most part of them will be associated to 3D models through their georeference, in order to make them an extension of the real objects, providing access to information and related services.

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