Framework for Collaborative 3D Urban Environments

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Abstract. With Virtual Reality (VR) systems it is possible to visualize three-dimensional environments with a high level of detail and visual fidelity. The users can manipulate and interact with those virtual environments in an intuitive way, close to reality. The VR systems enable the access to digital services that can promote, amongst others, collaborative work, data sharing or e-commerce. In this paper, we present a multidisciplinary solution that can offer added value to users through a collaborative environment with an intuitive interface. This environment will use geo-referenced databases to replicate urban environments and represent real world problems in a virtual way, making possible a better and more flexible approach in order to solve them. It is also proposed an architecture and some digital services are illustrated to show its potential.

Keywords: Collaborative work; Virtual urban environments; Digital services.

1 Introduction

There are several areas where the Virtual Reality (VR) systems are currently explored, such as: videogames, remote education, virtual tourism, urban planning or remote education. In this paper we use a VR system to explore applications on citizenship and e-commerce. The objective is to have a collaborative environment that recreates urban areas with high levels of visual fidelity, capable of offering digital services. The collaborative environment should offer an intuitive interface where the user will be able to navigate remotely through an urban area, having access to services like if he was there physically. One of the motivations behind this project is to bring an added value to citizens of the urban areas covered by our VR system, through the supply of pertinent digital services. Those digital services should allow the user to

remotely acquire or access services available in a determined urban place, bringing him a more flexible and comfortable way to enjoy the services or goods that he wants. They also bring an opportunity to people that cannot go to the physical places due to, for example, mobility handicaps.

Other reason that led us to this project is related with collaborative work. Our platform intends to bring a collaborative component so the users can cooperate and enhance their virtual urban environment together. The users will also be capable of proposing or reporting issues that need some attention by the local authorities. These aspects will allow them to create social ties and motivate all the users to the enrichment of their social life, building a strong and united community with civic duty awareness.

The collaborative work can promote the concept of citizenship, which we intend to explore, giving the users a set of digital services in order to accomplish that. Other area that we intend to boost is e-commerce due to the possibility of the user acquire goods or services in a remote way with the advantage, when available, of personalizing their requests.

For this paper we propose a collaborative environment, so it will be explored the "wiki" concept where the users can contribute with information collectively with the particularity of not requiring that the contents are reviewed or approved before publication. Our project also intends to extend this concept to the 3D universe, creating a "3D wiki". The "3D wiki" concept will allow the users to contribute for the visual fidelity of the virtual urban environment as they will be able to contribute with information related with elements that make part of real urban environment recreated. The information can vary from the feedback given on certain digital services to the visual aspects of certain buildings, parks, streets, etc.

In the next section we will explore some tools that are, somehow, related to the platform that we intend to develop. In third section it will be presented the proposed architecture for the collaborative 3D urban environments. The last section is about the conclusions and future work planned.

2 Related work

It is intended to develop a tool capable of recreating urban environments in a collaborative way and associate digital services to them. There are two kinds of tools that can be related to this kind of project. The first kind is capable of making available a collaborative virtual environment, such as Google Earth [1], Second Life [2] or OpenSim [3]. The second kind provides services associated to an urban environment. Examples are foursquare [4], Gowalla [4] and "A minha rua" [5].

Google Earth, Second Life or OpenSim offer interactivity and collaborative work to their users. Google Earth [1] is an application provided by Google, which has the purpose of representing the whole world virtually. In order to accomplish that, the application uses satellite images, aerial images and geographical information. The majority of the represented places are in 2D but, in certain areas, 3D representation is available. The visualization is made from the top, and the users, in a first stage, see a flat image of a vast terrestrial area. As the user zooms in, the flat image becomes

more detailed and gives him more detailed information about a specific region. When the user uses a bigger zoom, a more oblique view of the region is offered so the user can have a better perception of how that place looks like. In the areas where 3D is available, it is offered to the users a frontal view so they can see the buildings as they are, therefore enhancing the users' experiences. This tool can be used for entertainment or with scientific purposes, bringing a lot of advantages and opportunities in research areas.

Second Life [2], from Linden Lab, is a collaborative virtual environment that intends to be a simulator of the real life. To have access to this virtual environment, the user just has to register and download a viewer from the official website. This viewer provides an intuitive interface with a high level of interactivity where the user can customize all the aspects of his avatar and profile [7]. Besides that, the user can build almost every kind of objects and associate textures and/or scripts to them. The scripts allow programming the objects behavior (for example, an object that follows an avatar), send messages, and communicate with Web services, amongst others. Linden Scripting Language (LSL) is the language used for programming objects, which intends to be an intuitive language so everyone can use it with no major difficulties.

OpenSim [3] shares many aspects with the Second Life. The big difference between both is that with OpenSim the user has complete access to the server-side aspects. Besides that, this tool is open-source so who uses it can extend it according to their needs. Another advantage is that the server can be hosted locally and that can bring more flexibility on development.

Regarding to foursquare and Gowalla [4], they share the same concept: they are social networks based on location. The users use mobile devices to check in, meaning that they share their location and, additionally, they can give some feedback about that same location. With Gowalla, for example, the user has a virtual passport and when he checks in at some place, he collects a stamp. There is the possibility of receiving rewards that can be awarded spontaneously or according to the number of times that the user checks in at a specific place. The rewards can be, for example, virtual items that the user can keep or discard. The user can also leave virtual items as a reward for other users [6]. Real rewards can also be awarded such as discount coupons, movie tickets, etc. To have access to these services the user just needs to register and install the proper application that can be found in the respective websites.

The project "A minha rua" (meaning "My street" in English) is directed to local authorities. This project promotes the civic duty giving to the citizens of one determined place the possibility of expressing their dissatisfaction or reporting issues related to the public spaces [5]. The adherent local authorities have, in their website, a space reserved for this service, where the citizens can fill up a form to report the anomalous situations. The user just has to identify the issue and, optionally, can attach some photos or even propose a solution for that issue. At any time, the users can view all the reported situations and check how the process is being handled. This project intends to foment the citizenship activities, giving one more active paper for all the citizens of a certain region and, at the same time, improve the urban environments management.

All the analyzed tools provide a set of interesting features over urban environments. The project that we are developing contemplates all this features and

combines them in a single platform, where the users can have access, through an intuitive and natural interface, to a set of digital services. Due to the collaborative nature of the project, the platform offers to the users the possibility of contributing for a higher level of visual fidelity. The users will be able to, for example, edit the visual appearance of the elements that constitute the virtual urban environments or share any kind of information related with them.

3 Technical approach

The concept of collaboration consists in operate or execute an action in a joint way, having a mutual aid in the execution of tasks without having any hierarchical relation or obligation between the collaborators [8][9]. The spontaneous collaboration of users in order to achieve a common goal can result in social and cognitive gains [10], thus, we can stimulate these gains to all the users of this project through collaboration and, at the same time, promotion of citizenship and civic duty awareness.

The creation of the elements that will constitute those environments could be modeled individually but with that procedure a lot of resources would be consumed and that would significantly delay the project. The use of procedural modeling is the solution to this problem as it allows building 3D models from a set of rules that are processed using computer graphics techniques [11]. The collaborative environment will be built based on OpenSim, which will be extended to enable import urban elements produced by a procedural modeling system. These procedures will be followed by the implementation of digital services.

3.1 Architecture

Like it was said before, this paper is focused on the tasks related with the development of a collaborative virtual urban environment and the services associated with it. So, in this section, we give more emphasis on the client-side architecture. A scheme of the general architecture is presented in Fig. 1.

The application is based on client-server architecture. In the client side we have the "Collaborative Urban Environment" that is the users' entry point. The access to the collaborative environment is made through a client application that will recreate the urban environments based on interaction with the system's server. The "Procedural Modeling System" contains all the necessary mechanisms for collecting and processing information associated with the urban environments. The information associated to the models that constitute the virtual urban environment is stored in a database called "GIS/Urban Information". Depending on the service that the user requests, it can communicate with the server and retrieve information from the "External services" database when it is requested information about external services or it can be processed by external Web services. The "Administrator" is the only one that has direct access to the system so he can solve possible problems and make the maintenance of the system with no restrictions.
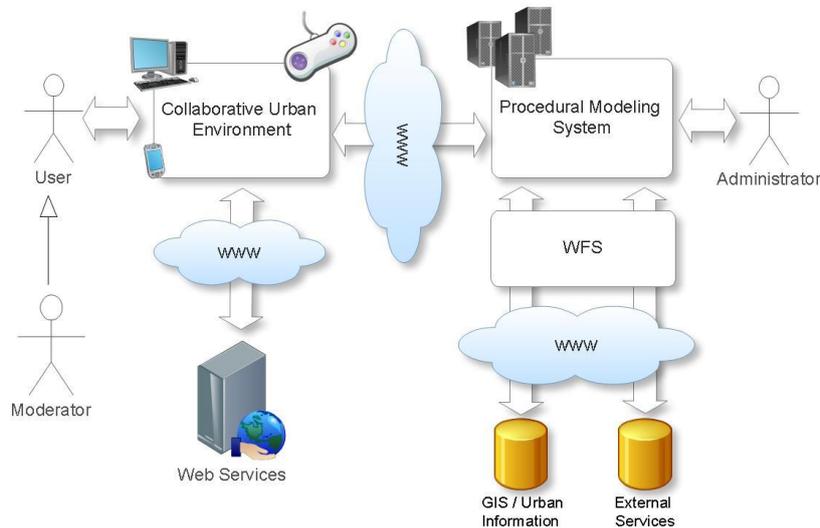
Fig. 1. General Architecture of the collaborative environment.

This project will be divided in two modules developed by different teams: the first team will be responsible for creating a unified model of information in order to create set of rules and process them. The second team will be responsible for processing those set of rules and create the virtual urban environment and all the services associated to them. The following sections are more directed for the second module, since it will be the work done by the authors.

3.2 Actors

There are stipulated three types of users: the "Mobile Device User", the "OpenSim User" and the "Administrator". To use the platform all users must be registered. Once users are registered, they will have access to their login credentials and to their own profile, which can be fully customized.

The main difference between the "Mobile Device User" and the "OpenSim User" is in the way they connect to the platform. Like the names suggest, the "Mobile User Device" uses mobile devices to have access to the platform and the "OpenSim User" uses a desktop or a laptop (with OpenSim installed). In terms of functionalities the difference resides in the fact that the "Mobile Device User" can only view images of the virtual urban environment while the "OpenSim User" can explore and discover the virtual urban environment through an intuitive 3D interface.

The "Administrator" is responsible for supervising the whole system and guarantee that the whole system is running properly. He have the power to act directly on the platform if some problematic situation arises.

3.3 Collaborative Virtual Environment

To have a better perception of how the system works in terms of functionalities available from the point of view of the user, a use-case diagram has been built and is presented in Fig. 2.
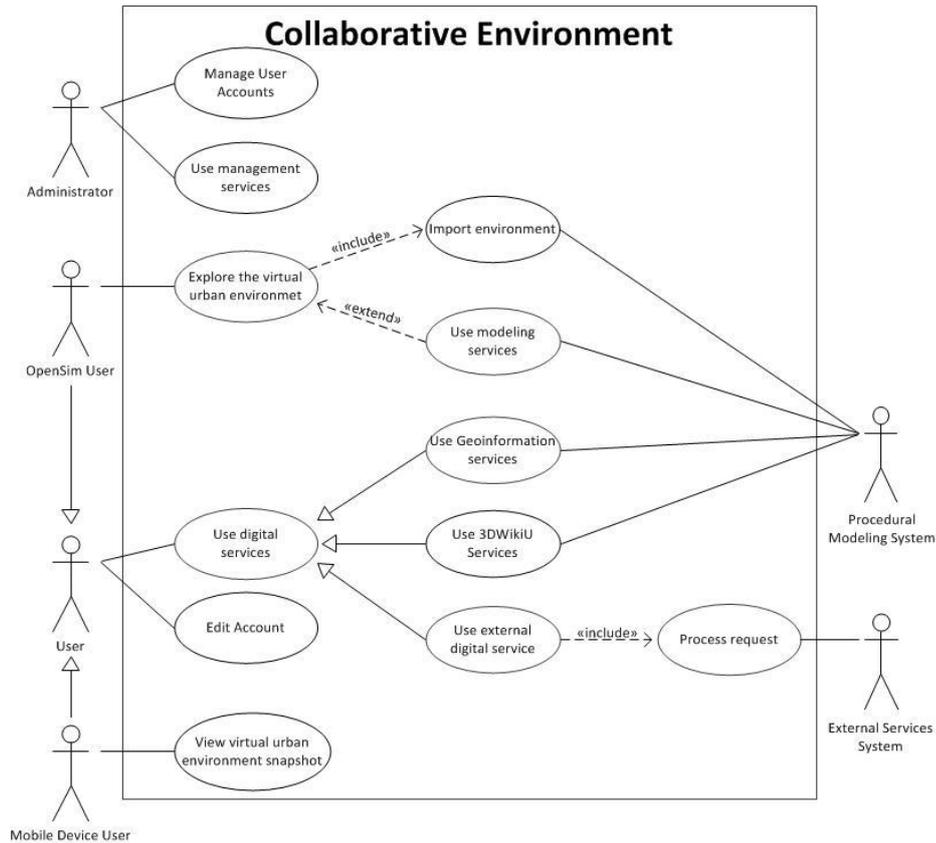

Fig. 2. System use-cases.

This diagram presents the users that are registered in the platform. These users have the possibility of editing their account details or to use the digital services available. There are three types of services that can be used at any time by any user: the geoinformation services, the 3DWikiU services and the external services. The geoinformation services are related to the information associated to the elements that are represented by the 3D models that populate the virtual environments; the 3DWikiU services are the original services of the platform like the service similar to "A minha rua" that is intended to develop (it has not been set yet which services will definitely integrate the collaborative environment but the selected ones will be designated by 3DWikiU Services). These two are processed by the "Procedural Modeling System" (presented in Fig. 1). If the user uses the third type of service, it

will be processed by an external services system that provides the functionality required to execute the service requested. Two possible examples of external services are: a hotel reservation or the purchase of an item in some store through the platform.

In Fig. 2 it is not represented the direct access that the "Administrator" has to the system because the diagram only contemplates the functionalities available for the users through the collaborative environment.

3.4 Digital Services

This project intends to explore, essentially, two main areas: citizenship and e-commerce. The citizenship concept can be promoted by the offer of public services in a collaborative way to the community, i. e., by the offer of public services where the citizens can work in a cooperative way and improve the quality of life in their community. It is intended to develop a project similar to the project "A minha rua" where users can report situations that need the attention of the local authorities and, at the same time, give the possibility of the users propose a more clarified solution due to the nature of our platform that allows a collaborative work with visual results. Other situations that can be here explored are polls to decide how and what to build in certain places, monitoring functions to preview the traffic or to take a look at the weather forecast.

E-commerce can stimulate local businesses due to the possibility of the user acquire goods or services in a remote way through the collaborative environment that is intended to develop. The system should accept orders, reservations or any other kind of service that allows to the users get the products that they want remotely.

The social aspect is also important to build a strong community with civic duty awareness. An aspect that can promote the cooperation between citizens is related with urban planning services. It is also expected that it can be provided to the user a reliable 3D replica of the real urban environment, built based on geographical data, where he can navigate on it and have a perception of how the real urban environment looks like. But the added value that we intend to give our platform is the possibility of collaborative edition, meaning that, at the same time the user navigates, he can modify any building in order to make it more similar to the real one. These modifications can be done on floors, textures, houses, streets, parks or any other urban environment related object. The users will also have the possibility of communicate between them via chat or voice.

4 System prototype

The project that is here presented has the intention to be a collaborative environment that recreates virtual urban environments with a set of digital services associated. For testing, purposes OpenSim has been installed and some buildings were created there, in order to make an approximate simulation of a virtual urban environment. This task was performed to have a better understanding of the requirements and procedures that are required to successfully accomplish the objectives proposed. The Fig. 3 illustrates the general aspect of the environment created.

To access the virtual world, the use of a viewer was needed and, in this case, the viewer used was Hippo OpenSim Viewer [12]. Around 30 buildings were created so the virtual environment could resemble an urban environment in order to evaluate the level of visual fidelity that OpenSim can offer.

Fig. 3: Overview of the environment created with OpenSim

After having one collaborative environment configured and running without any problems, it is intended to associate digital services with the objects that recreate urban environments elements. That will make those objects an extension of the real ones and offer to the user a new set of advantages with remote access to their services. In order to test this aspect with OpenSim, a script has been created to be possible such integration. The script is associated to each object and, when an object is touched, it detects the UUID (Universal Unique Identifier) of that object and opens a media browser that is built in on the viewer. In that browser it is possible to open webpages, so the script is set to open one particular PHP webpage that gets the UUID of the object and gives information about it. The architecture is shown in Fig. 4.
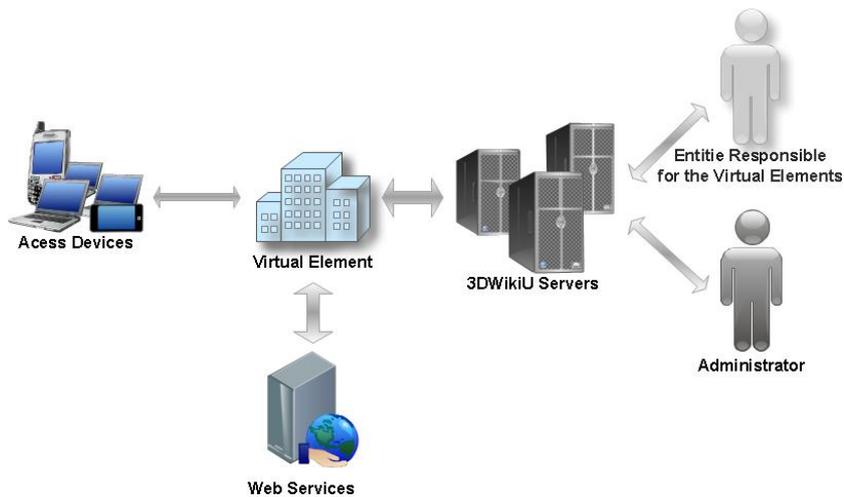

Fig. 4. Architecture of the access to the digital services

So, from an entry point (which can be a desktop or a mobile device) the user has access to the urban environment where are located all the virtual elements that recreate the urban environment. When a user touches one of those elements, that element will communicate with the 3DWikiU servers to retrieve the desired information. This can be done based on Web Services or through the 3DWikiU Servers. The entities responsible for that data are the entities responsible for the real world elements represented and the administrators. The first ones are responsible for information about the products or services available and the administrators are responsible for all kind of information that can be associated with that same element.

OpenSim can be an interesting tool to this project judging by the preliminary tests that have been here documented. Also, OpenSim has a lot of functionalities that promote collaborative work and the interface of the viewers (in this case the Hippo OpenSim Viewer) is intuitive. Regarding the OpenSim browser, he can be valuable to offer digital services since it is possible to communicate with Web servers without any problems. Further tests will be made to test the real capabilities of the OpenSim and to see how it will react when dealing with a considerable amount of data. With these preliminary tests OpenSim has shown to be a tool with the quality needed to accomplish the objectives proposed in this project.

5 Conclusion and future work

Some tests have been made using OpenSim to simulate the urban environments and the results were good but a set of more demanding tests have to be done in order to determine definitely if the OpenSim will be used to implement the proposed architecture. After the proper choice of the tool that we will use to recreate urban environments, it will be developed the necessary mechanisms to allow the generation of the elements that will recreate the urban environments in the virtual world. That process will be made recurring to procedural modeling.

It will be also made a study of potential digital services that are relevant to the collaborative environment that we intend to develop. After this study is complete, the most interesting and relevant digital services will be selected. The aspects that will be important to determine either to select or discard a digital service are related with the importance and added value that they can bring to the collaborative environment users.

At last, the selected services will be implemented and integrated in the collaborative environment. The digital services will have their basis on the 3D objects that are part of the virtual urban environment.

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