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# Modeling Immersive Virtual Environments for a University: A Case Review

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**Abstract:** Currently, much of video game development includes use an engine that allows users to combine the design of environments, programming, and immersion through the compatibility with virtual reality (VR) tools. The design modeled in a 3D environment combined with VR experience allows us to create an immersion and greater realism from a first-person perspective. Tools for modeling environments expands every year with more options in the development and texturing of the objects to be used in a project, but a software engineering approach must also be considered in these types of projects. This paper presents a case of modeling and creating a “Virtual Tour of the Universidad de las Américas” VR application. The main objective is to present a technological solution to support the visits of future students of the Universidad de las Américas, in a more accessible way for everyone.

*Keywords:* Object modeling, 3D Environment, VR, VE, Immersion, Virtual Reality, Virtual Tour, Virtual Environment

## 1. Introduction

This paper proposes a procedure to create an immersive virtual reality application implemented in the Admission’s department at Universidad de las Americas (UDLA), as well as in university fairs, allowing applicants to get to know the UDLA Park university campus through an immersive tour. This VR application has reconstructed four three-dimensional areas located in UDLA Park Headquarters: photo studio, library, clinic hospital and vet laboratory. The tour through VR application allows the applicants to find out about the academic infrastructure offered by the University, as well as how these spaces are distributed within the campus. In addition, the VR application allows interaction with some objects and scenarios that will provide information using multimedia resources that the university already has, for example, promotional videos of Careers within some Faculties like Medicine and Communication.

By promoting the use of cutting-edge technologies such as the Oculus and its peripherals, the user of this VR application can maintain movement through all scenarios, as well as easy interaction with objects thanks to the ergonomics of the Oculus touch controls. For better user experience it is necessary to have a virtual reality headset minimally in the Oculus Rift version. This VR application does not include the design of the facade of the UDLA Park campus and only allows interaction with objects that are in the areas that were previously specified.

## 2. Methodology

Creating an immersive application can be a challenging work, especially if it is not a video game. Several techniques must be considered for the creation of 3D objects and the creation of immersive virtual environments, in addition to considering the application of Software Engineering approach.

### 2.1 Development Process

One of the first approaches to the software engineering process for the construction of VR applications (Fencott, 1999) identifies "interaction theory" as the foundation of the engineering approach and mentions the need to incorporate engineering processes into the creative process of designing virtual environments. In his work, (Eastgate, 2001) already proposes a sequence of stages for the creation of virtual environments. These activities include specification, Virtual Environment (VE) overall

design, resource acquisition, VE detail design, VE building, testing and implementation. Another proposal mentioned in (Molina et al., 2005) indicates that, similar to creating a web, mobile or desktop application, VR applications require planning, design, construction and testing.

According to (Vergara et al., 2017) an immersive VR application is classified as an application with "exploratory type of interaction level" when the user can move through the virtual environment and can select the objects with which he/she wants to interact. Therefore, the VR application developed in this Capstone Project can be considered as an immersive virtual reality application because it allows the user to navigate through the virtual environment and interact with various objects within it, using specific hardware (Oculus Quest) which completely introduces the user into a virtual world by using glasses with two small screens placed in front of the user's eyes.

Methodological contributions mentioned in the previous paragraphs have been used as a reference to define a development process. Table 1 displays the process used in this Capstone Project.

Table 1. Resume of Activities in Software Development

| Activity | Description |
|---|---|
| **Definition of Requirements** | One of the main activities of the University's Admissions department, is to offer tours to show the university campus and its academic infrastructure to new students and people interested in studying one of the Careers offered. Several circumstances may prevent a person from being able to take one of the tours offered in person, for example, when the person has a physical mobility limitation such as the use of a wheelchair. But today, when the world is experiencing a forced mobility restriction due to Covid-19, it has become even more necessary to have a technological solution that allows a person to take a virtual tour of the University's facilities. Thus, the requirements specification was based on the definition of the following:<br>- Campus spaces to be virtualized (Bookstore / Photo Studio / Clinic / vet laboratory)<br>- The objects and multimedia content in each virtual environment<br>- The basic interaction of the user with the objects in each virtualized environment<br>- Navigation between virtual environments |
| **Design** | The design of a virtual space begins with the capture of photographs of the spaces to be modeled, which will allow the creation of plans and the definition of the objects within the space, considering the interaction that they will have with the users. |
| **Modeling and Construction** | Once this form of abstraction of each environment has been achieved, continue with the creation of the 3D objects, their texturing and then the integration of these in their respective plane to create the required virtual environments. The navigation and the definition of the appropriate lighting for each virtual environment are the last activities of the modeling. |
| **Testing** | The testing process is iterative, continuously building and integrating objects to be tested. The first type of testing is performed with conventional computer controls (keyboard, mouse and screen), using them to verify the layout of objects in the spaces. The second type of testing is performed with specific VR hardware (Oculus Quest), to verify the user's navigation through the different virtual environments and the behavior of the objects when the user interacts with them, for example, the multimedia content placed within each environment. |

## 2.2 Tools for modeling and VR environments

To realize modeling and VR activities, there are a lot of sophisticated tools. This project uses Unity and ProBuilder tools. Unity is a cross-platform game engine designed to support and develops 2D and 3D video games, simulations for computers, virtual reality, consoles, and mobile devices platforms (Unity, 2020). It is commercial software developed by Unity Technologies. Unity provides three-dimensional manipulation and simulation through functions defined using programming language. 3D representation of space in VR allows a real approximation to places that the developer wants to build and discover by first person view (FPV). ProBuilder is a tool that helps us to convert basic shapes like spheres, pyramids, cubes and others into some nice scenes. The prototyping of a scene, game or action is so important for testing the viability of a project and save money because it makes easier the process to see the results of a product instead of materializing it.

## 3. Creating VR Environments

In this section some examples are presented because of the execution of the activities defined for the creation of 3D environments. Figure 1 shows a summary of the steps required to create a 3D environment.

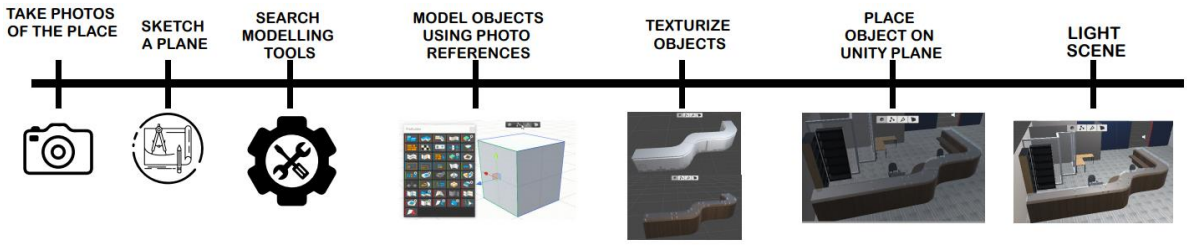


Figure 1. Steps for Modeling an immersive environment.

### 3.1 Preliminary design for the 3D environments

To create a 3D environment, a preliminary design was carried out using some drawings or blueprints to know what shapes must be used. Adobe Illustrator help us to determine the use of the correct measure units and calculate the space where all objects will be located before the design of the scene. Once the place for objects were defined, texturing and lighting process can continue, as well as resizing and adjusting the scenario. The use of a measurement scale where 1 meter in real life is equivalent to 1.7 meters in Unity has been predetermined.

### 3.2 Modeling Environments

#### 3.2.1 Photo Studio

The photography environment was designed and modeled with polygon shapes and prefabs objects specially for the green screen and lights (Figure 2a). Paper texture was used for texturizing light panels. The way to get textures can be downloading images and uploading to user's assets for applying it in objects as the one described. For creating objects as the microphone, polygon shapes were used and texturizing it with images to make it more realistic. Additionally, the merge component was used for optimizing and grouping the object.

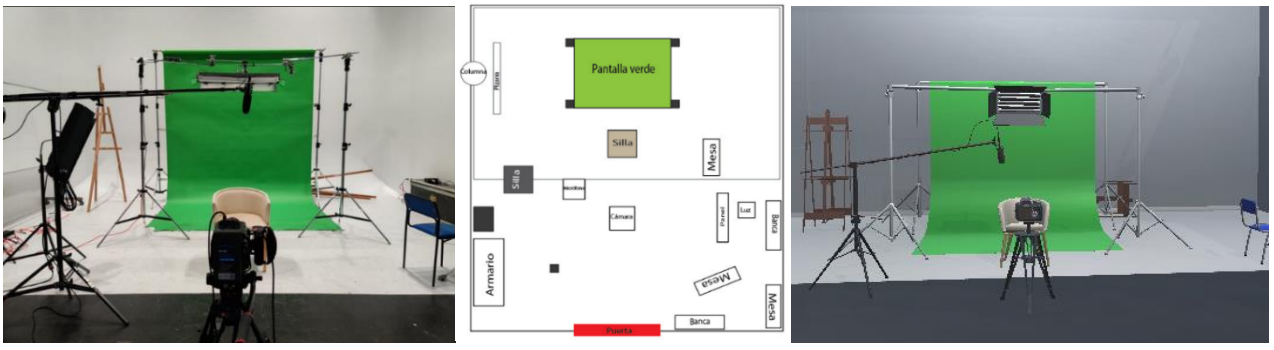


Figure 2. Photo Studio: a) Photo, b) Plan, c) VR Environment

#### 3.2.2 Library

A library is the place where students can get access to numerous books and resource for their task. To replicate, we used the photography scenario and a plane or blueprint created in Adobe Illustrator (Figure 3b). The design can be compared between the real-life photo of the library environment in the Figure 3c. For this environment, models for a computer, chair, bookshelf and table are also needed.

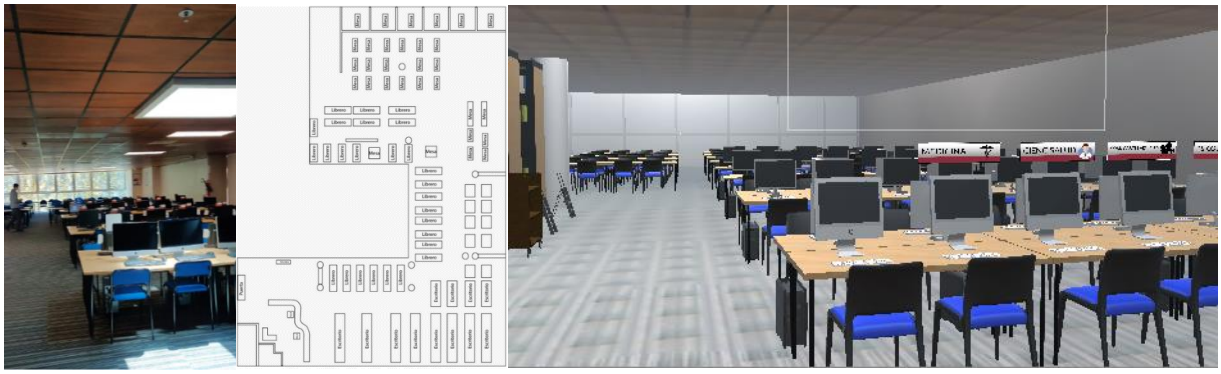

Figure 3. Library: a) Photo, b) Plan, c) VR Environment

The library was designed and modeled according to the objects visualized in Figure 3a. Polygon shapes and prefabs objects that can be imported from internet sites were used. We used the edge tool in ProBuilder to create the main table in the library and bevel component to give them realistic shape. Also, for optimizing the quantity of objects that are inside the library (chairs, books, tables, etc.), we merged object component and grouped numerous objects so the FPS fluidity will not be affected while running the application.

### 3.2.3 Simulated Hospital

Our Simulated Hospital model includes stretchers and patient avatars that makes the environment more immersive for every user interacting with it. The blueprint in Figure 4 shows the clinic hospital simulation design.

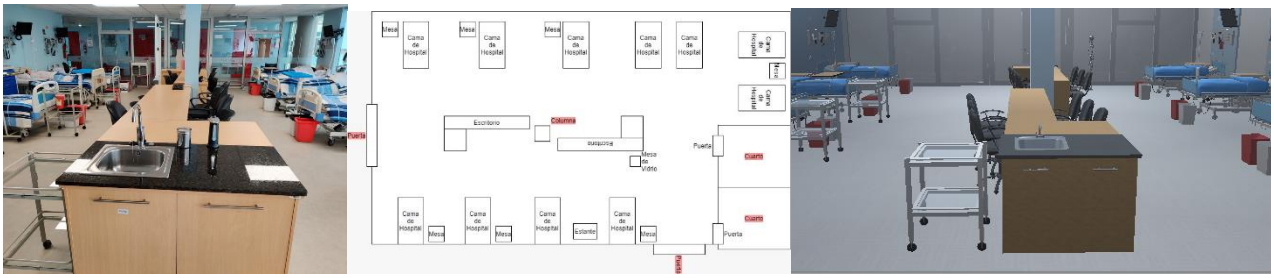

Figure 4. Simulated Hospital: a) Photo, b) Plan, c) VR Environment

The simulated hospital was designed using prefab objects specially for the wheelchair and beds. Many additional objects were created with polygon shapes and primitive shape objects. The use of ProBuilder was very important for the details in the walls like cables, clocks, and hospital components above every bed. The torus prefab was the component used for creating objects visualized in the Figure 4c. The same method was used for other scenarios, using the component merge for optimizing the whole object.

### 3.3 Texturizing the Environments

The use of images for creating material as texture (e.g. a chair or a desk) is the best option for texturizing more complex objects in the project. In Figure 5, the process of texturizing can be observed. The figure shows the base 3D object, then the process of creating the material in the middle and combining with the final model on the right.

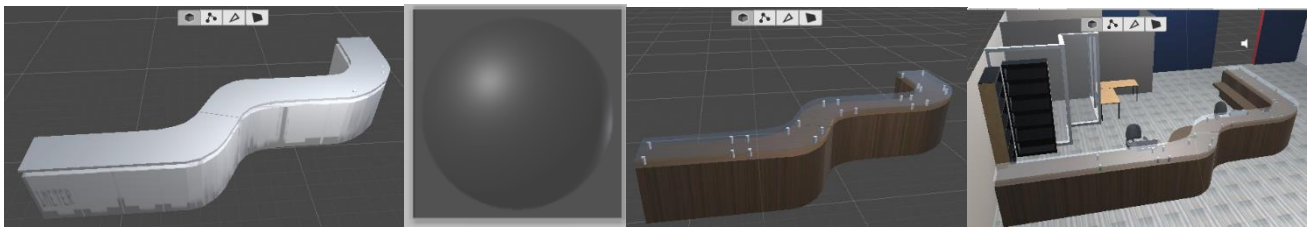

Figure 5. Texturizing a Desk

The design of the table is a notable example that the user will encounter inside the virtual library. The table has a characteristic shape that uses different materials. One of the materials is glass. For creating this material, we needed more complex textures with some lighting effects to create the reflective property.

### 3.4 Placement of assets

An asset is a prefabricated 3D object that can be modified adding any type of texture. In most cases these objects only come with a basic colors and to give them a realistic appearance it is recommended to add textures as described earlier in the paper. There are many sites on the Internet where assets are housed that can help fill 3D environments since they are common objects such as tables, chairs, desks, doors, windows, among others. While the use of these objects facilitates the modeling of many scenarios (for example, modeling a theater stage with floors, ceiling and walls) the details that make up many scenarios often include more complex figures and objects. Unity has an Asset Store that allows users to download assets for free. These assets are a collection of objects that will allow us to create an environment and its details in a very simple way so these objects can be correctly located on the canvas and turn the union of those objects in whatever scenario minded.

### 3.5 Lighting

The lighting is something important in any 3D modeling, since, without light sources, the texturing of the objects would not be applied correctly. Additionally, the quality of the scenes would drop drastically, creating a very poor atmosphere. For this reason, it is important to place sources of illumination that allow the objects to look more real. There are some considerations that can be taken when starting to place lighting on user's stages. The first is about global lighting, since by activating this feature, the user can see how the light will behave differently, giving much more attractive and realistic results. The second is to consider the colors in the objects, that they are more pleasant to the user's eye, for this reason it is recommended to avoid saturated colors, and a final consideration would be to play with the direction of the light, to allow the user to see different angles of the stage, to understand how the lighting behaves depending on the object.

## 4. Product Testing with Oculus Quest

The Oculus Quest is the original all-in-one gaming system designed for virtual reality. This device allows users to play virtually anywhere with just a VR headset and controllers. Oculus Insight translates user movements in virtual reality regardless of user position and offers monitoring throughout the room without the need for external sensors. The user can look around, take cover, and turn the tide of battle from wherever user are in the play space. With Oculus Touch controllers, the user can translate hand movements and gestures directly into the game. Use buttons and throw and catch objects in virtual reality with realistic and intuitive precision (Oculus, 2020). Oculus Quest and Quest 2 have a technology called Oculus Link that helps unity users visualize the environment that is being created and test a preliminary scene of the final product to be sure about the

measures, spaces and objects that are surrounding the user so it can get a better and realistic experience. This let the developers to recognize optimizing issues, wrong dimensions, and extra adjustments.

## 5. Summary

For modeling and designing a 3D environment, the process should start gathering information about the real environment, in this case, some pictures of every angle was taken for having a perfect reference of measures for modeling objects and environment. Also, pictures of textures should be gathered for texturizing our environments. Then, the process continues with modeling the main space with walls and specific measure for each environment. After that, one should start designing 3D objects according to the measure of the room and the pictures. For modeling each object, ProBuilder and specific downloaded 3D objects from internet was used, then the objects were adjusted each environment in the application. Textures was used for giving color and realism to the environments. When all our 3D objects were created, start placing each of them in every environment according to the pictures. Finally, for giving a realistic view, lightning components must be added to provide color and texture for each environment.

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