3D Virtual Content for Education Applications

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Abstract — **In this paper we present the process of creating 3D models to develop augmented reality applications-oriented to the teaching-learning process. We present the process of creating three-dimensional models from conceptualization, polygonal modeling in 3ds max, creation of mapping coordinates in RizomUV, to the process of creating PBR materials in specialized soft-ware such as Substance Designer, Alchemist, and export and importation to Unity 3D. The developed models are incorporated into a virtual reality platform, which allows to exploring the flora and fauna of the Cotopaxi National Park, Latacunga, Ecuador.**

Keywords - 3D model; augmented reality; virtual reality; PBR materials.

I. INTRODUCCTION

Throughout history, several advances have been observed in the field of the creation of 3D content for various media such as film, television, videogames and the internet where these are mainly disseminated [1]. The demand for creating three-dimensional content has been increasing in recent years, due to the emergence of new technologies such as virtual and augmented reality, used in the field of education, leisure, science, medicine, among others [2]. Virtual reality is the sensorial tool that perhaps more accurately allows humanity to search, find and decipher the new keys that will lead it down the path of knowledge, apprehend, know and have fun are the fundamental axes of this new medium [3], such is the case that the development of content for these new media is fundamental if you want to develop virtual reality and augmented applications in order to achieve an immersive experience, so that the immersion is truly realistic the system must be able to create an complete sensory simulation or as close as possible to it, being the fundamental axis the visual immersion supported in the development of 3D content [4]. Currently, the quality of graphics and realism play an important role in the development of these applications, this implies the need to improve computer generated content [5]. Therefore, the work that artists perform behind the applications of virtual and augmented reality is fundamental. So in this project we use technologies to develop content focused on virtual and augmented reality applications detailing the processes used to generate this type of content using specialized software such as 3ds max among other tools.

Educational models have evolved over the years, adapting to reality and the needs of society, thus involving technology in the teaching and learning processes through multimedia applications, access to information through the Internet, virtual classes, communication channels, etc. [6]. Virtual reality is being used as a tool for the teaching-learning process in several research projects, for example an implemented virtual system has been developed that allows real-time bilateral interaction between the user and the virtual environment with the aim to stimulate the abilities of children with autism spectrum disorder [7]. The possibilities are endless, complex virtual worlds are created that can be used not only to entertain and entertain, but also to educate people, in fact the educational sector is one of the most benefited by this type of technology as a tool of teaching [8], but in addition to academic issues, it is possible to go further and cause empathy by putting people in complicated situations, such as groups of refugees, racial discrimination, etc. Virtual reality is not a tool for video games, it connects people in an extraordinary way that has never been seen before with other media, changing the perception that people have about others [9-10]. The effectiveness of using this type of technology in the teaching-learning process has been proven in a study by Stanford University that divided its students into two groups, one that would use virtual laboratories and another group only traditional teaching methods, where it was surprisingly confirmed that the effectiveness of learning increased surprisingly by 76% in the case of students who used virtual labs [11].

Finally, the immersion of virtual reality is limited only by our imagination and by how we decided to create, explore and take advantage of the virtual world. In 1965 Ivan Sutherland declared: "Do not think of that thing as a screen, think of it as a window, a window through which one looks at a virtual world." The challenge of computer graphics is to make the virtual world It seems real, it sounds real, it moves and responds to the interaction in real time, and even that it feels real "[12].

II. SYSTEM STRUCTURE

The development of new technologies in recent years has allowed an increase in the creation of virtual and augmented reality applications, which generates the need to create content for these new audiovisual media. The development of educational 3D content is growing and is one of the best ways for students and teachers to take the teaching-learning process to a higher level.

Figure 1 presents the process of creating 3D content focused on virtual and augmented reality applications; usually you start with an idea or a need, you look for references of the object or character to be modeled, the model is created using polygonal modeling techniques based on basic primitives, the UV coordinates are generated to map or texturize the model, they are added lights are generally used 3-point lighting to make tests, if the model is going to be animated, you must create a skeleton

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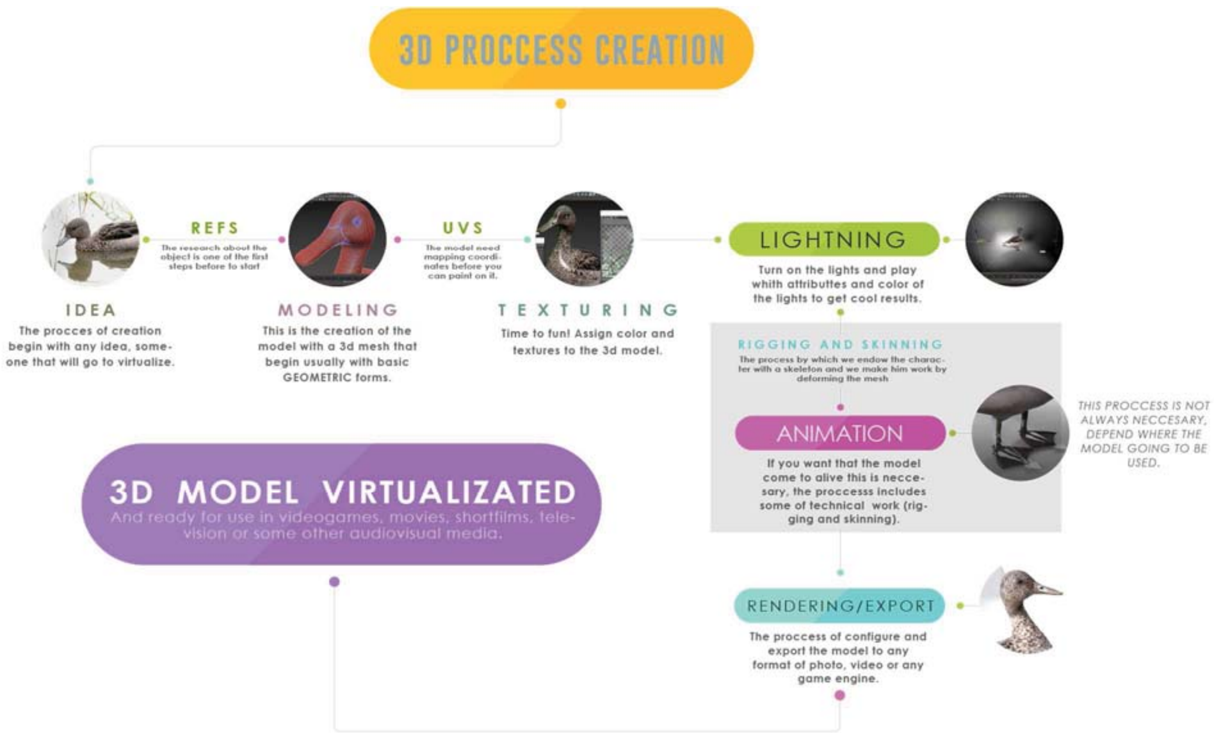

Figure 1. Process of creating 3D models

for the mesh to deform to the movement, rotation or scale of the same, and finally after animating the 3D model it is it exports it to the video game engine that is being used to develop the virtual or augmented reality application. Finally, the finished product can be used as an asset or resource to strengthen the communication, interactivity and immersion of the user of the virtual reality application.

III. 3D CONTENT CREATION

A. *Idea and References*

Every process of creation begins with an idea, or a need to virtualize something. The search for references plays a fundamental role in the development of virtual content, since it is a visual aid for the creation of 3D models, they are basically a base on which the content is constructed, since it is a visual aid to know the characteristics of what is going to be virtualized such as can be seen in Figure 2.

Figure 2. Reference images for the creation of the 3D model

B. *3D ModelingEcuaciones*

The creation of three-dimensional models is usually done using polygonal modeling techniques, splines (lines) and even through the use of new techniques such as photogrammetry. The process used for modeling is polygonal modeling, as can be seen in Figure 02, due to the advantages offered by ex-porting these elements to any videogame creation software such as Unity or Unreal Engine. The software used for character modeling is 3ds Max.

The process of polygonal modeling basically consists of modifying position, rotation and scale values of vertices, polygons and segments, starting from a base that is usually a three-dimensional object such as a cube, sphere, or cylinder according to what is required to model using different techniques until it is concluded.

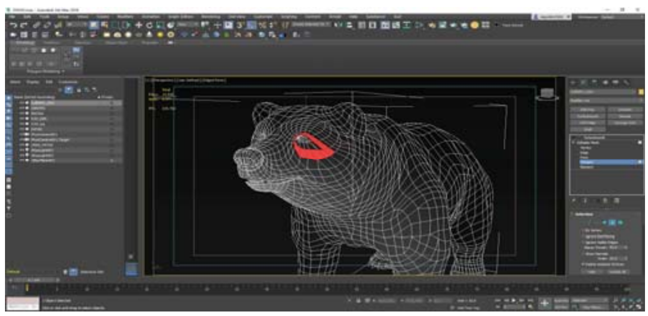

Figure 3. 3D character polygonal modeling

C. *Uvs and Textures*

The 3D model needs mapping coordinates to texturize it efficiently. Being clear enough, you can not apply a texture of a 2D image to a 3D element without first dissecting or opening the

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object to take it to a 2D plane and be able to paint it or texture it appropriately as can be seen in figure 3.

The creation of textures was done in the software Substance Painter and Photoshop based on photographs of hair of real animals as can be seen in figure 04. It is important to note that the textures exported from Substance Painter are fundamental to achieve photorealism, among the most important we have: diffuse, glossiness, normal and reflection, Figure 5.

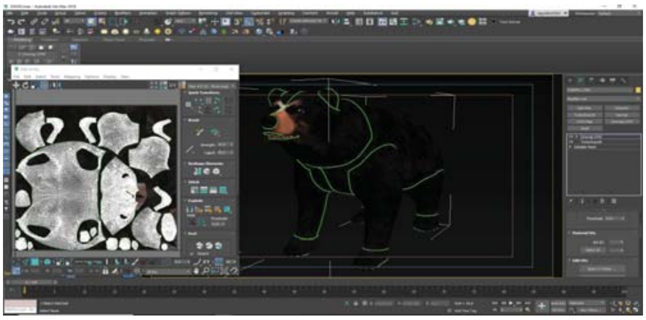

Figure 4. UVs

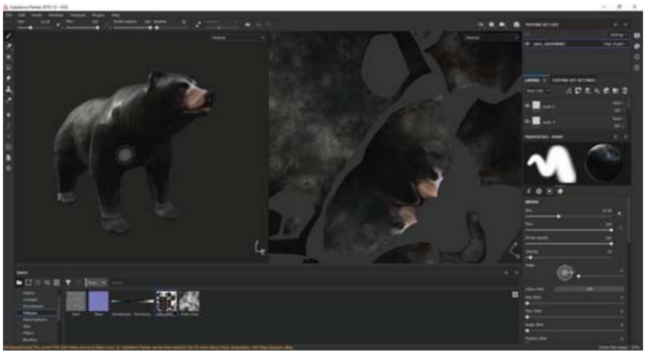

Figure 5. Texturing process in Substance Painter

D. Lighting

Although the 3D models will later be exported and finally configured in the Unity or Unreal Engine videogame creation software, several lighting tests are carried out in order to experience how the materials behave with the light as can be seen in the Figure 07. Generally, the type of lighting used as a base is known as 3-point lighting, it is important to emphasize that this type of lighting can vary depending on the requirements of the project.

Figure 6. 3-point lighting

E. Rigging and skinning

Because the character will be animated, he must first go through the process of rigging and skinning, which basically consists of providing a skeleton in this case to the spectacled bear and configuring it so that the mesh is deformed based on the influence of the bones on the 3D model by rotating them and moving them, as you can see in figures 07 and 08.

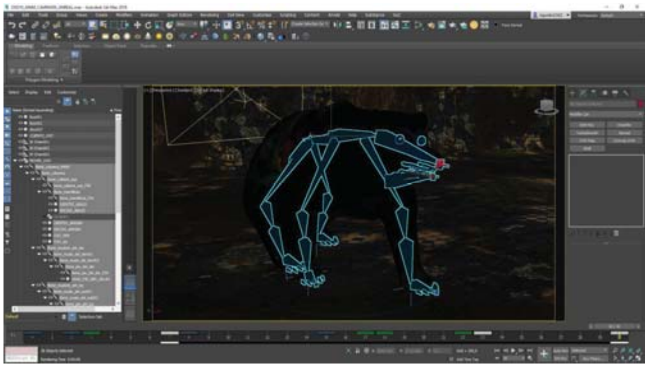

Figure 7. Rigging

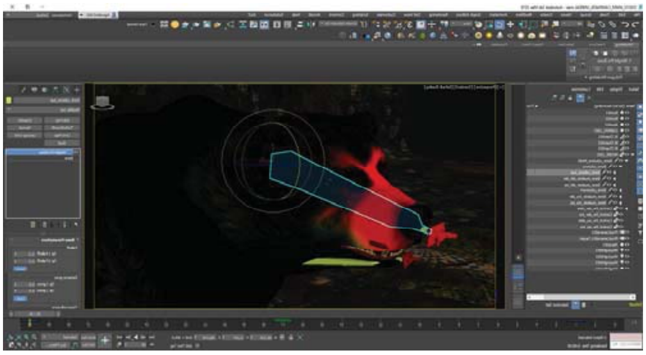

Figure 8. Skinning

F. Animation

Once the 3D skeleton has been configured, we proceed to animate a walk of the model to later be able to export it to Unity or Unreal Engine, as can be seen in Figure 09. Always keeping in mind several of the principles of animation created by veterans. Disney animators.

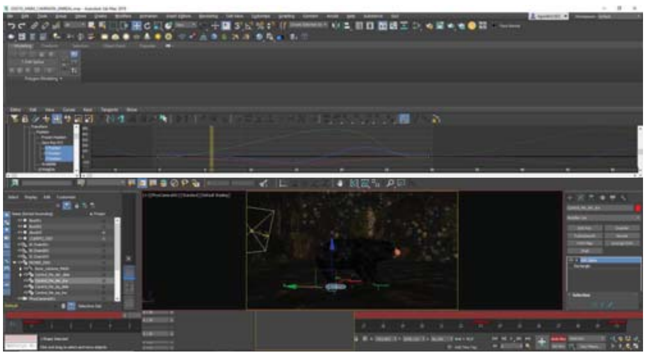

Figure 9. Animation

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IV. EXPORT AND IMPORT 3D MODEL TO A VIDEO GAME ENGINE

We proceed to export the animated 3D model from 3ds max to Unreal Engine or Unity, to finally configure the materials and lighting worked before but already within the video game engine used. In the case of Unity, the artist who develops the content can create a Prefab (3D model pre-configured and ready to import in any scene with textures included) facilitating the work flow of the team in charge of the virtual reality and augmented project. In the case of the animation of the walk, the model was exported in alembic format, which allows importing the animated 3D mesh without the need of bones or controls. Fig. 10.

Figure 10. Animated 3D model imported to Unreal Engine

Finally, the models can be visualized in virtual or augmented reality depending on the project that is being carried out, with the appropriate configuration for the platform on which it will be launched.

V. RESULTS AND DISCUSSION

This section presents the implementation of 3D models (objects, flora and fauna) in an application of virtual reality and augmented natural sciences oriented to the exploration of the natural resources of the reserve of the Cotopaxi National Park, Latacunga, Ecuador. Figure 11 shows the start interface of the application developed.

Figure 11. User Interface

We worked with the digitization process indicated to recreate the tourist area of the Cotopaxi National Park, as can be seen in Figures 12 and 13, so that students can interact with the augmented reality application. You can see the routes, flora and fauna of the sector.

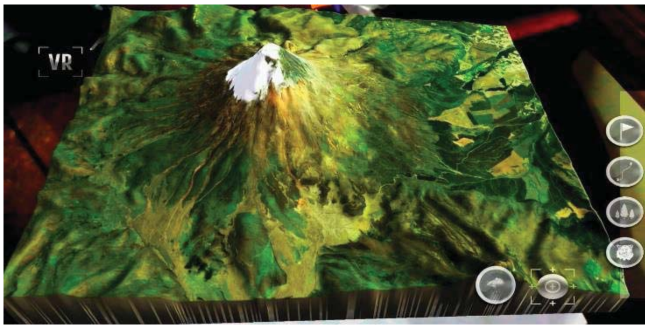

Figure 12. Augmented reality application

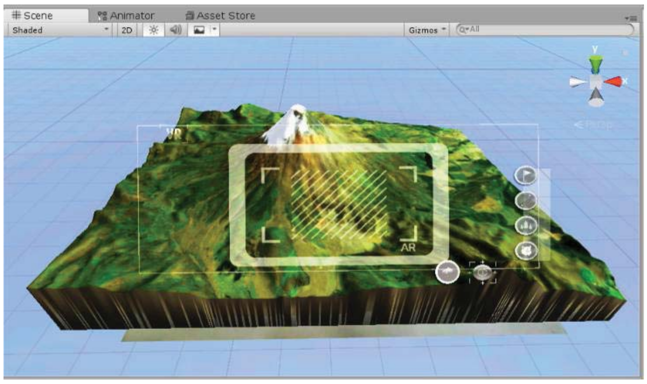

Figure 13. Augmented reality application developed in Unity3D

On the other hand, in Figures 13 and 14 you can see part of the virtual reality application, in which you can see several of the 3D objects created in order to guide and teach users useful information that can also be observed in the Cotopaxi National Park.

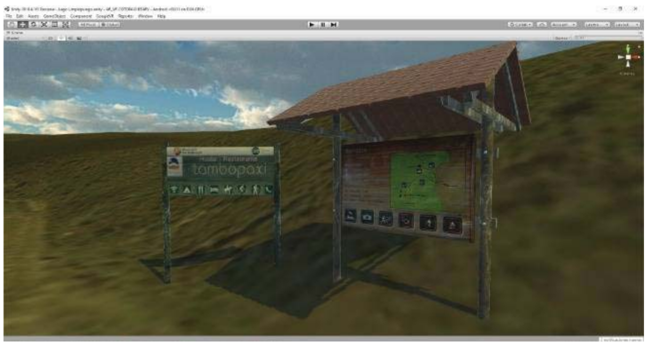

Figure 14. Signage imported to Unity as Prefab.

Figure 15. 3D models imported to Unity.

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The processes of creating content for virtual and augmented reality are usually the same, although there is a constant evolution in the software used, not many years ago new technologies began to appear such as Substance Painter, Alchemist or Quixel, as you can see in Figure 13. That they allow the user to work creatively and efficiently with textures, to mention one of the advances. For this reason, it is adequate and it could be said that it is even necessary to update the knowledge of processes that are constantly evolving with the emergence of new technologies

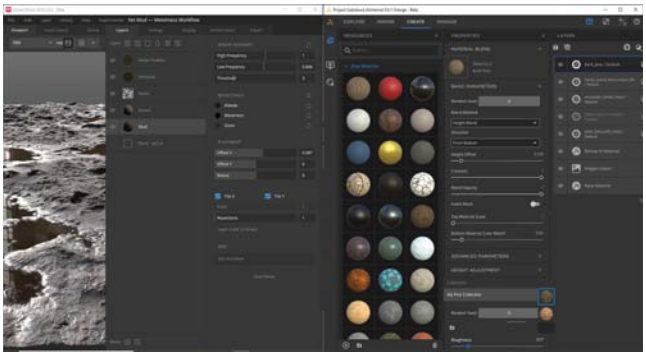

Figure 16. Quixel and substance alchemist

VI. Conclusions

The development of new technologies strengthens the processes of creation of 3D content, which can be applied not only to virtual and augmented reality projects but also to countless other more conventional means, realism in the applications of virtual reality is just around the corner, for this reason it is important to be at the forefront in the creation of photorealistic content to achieve a complete immersion of the user. Virtual Reality is an extraordinary experience, which in a few years will be a beneficial tool in people's lives, isolates the subject from the real world and puts it in a new world, where it can acquire experience and knowledge. In fields such as health, it has been used to show treating illnesses, allows complex or impossible tasks in the real world, is a tool that stimulates creativity, strengthens the empathy of people, can make us more human, improve the way that we educate our children, we can explore the world with applications in tourism and geography. Virtual and augmented reality have an infinite number of possibilities that will transform the life of society within a very few years.

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