

Article

Creation of a Virtual Museum for the Dissemination of 3D Models of Historical Clothing

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Abstract: Museums have been the main centers for the dissemination of cultural heritage throughout history. In recent years, they have been increasingly digitizing their content, so that it is now common for each museum to have free digital content available on the Web. This can be photographs of the works with detailed information or even objects created in three dimensions. It is also common to find virtual museums, which might be a representation of an existing museum that has been digitized or a museum created only in digital format. This paper describes the creation of a virtual museum of Spanish clothing from the 16th century, one that exists only in digital format, accessible from a computer or digital tablet. In order to create the museum, various documentation and drawings or pictures of the clothing of that time were studied. The costumes were then created in a specialized 3D costume-modeling program called Marvelous Designer. A 3D model of the exhibition hall was created in Blender, and finally, everything was assembled in the Unity videogame engine, where the interactive part was also added, allowing the virtual visitors to walk through the hall as if they were visiting a real museum.



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1. Introduction

The terms “virtual museum” and “digital museum” are commonly used synonymously to characterize a very broad concept that encompasses all types of museums or digitizations. For example, McKenzie [1] applied the term “virtual museum” quite broadly when referring to a collection of electronic artifacts and information resources, i.e., virtually anything that can be digitized and made available on the Web [2].

The emergence of digital museums is connected to advances in Web technologies. The book *The Wired Museum: Emerging Technology and Changing Paradigms* [3] predicted that technology would enable museums to achieve interactions with content and audience participation. Although the author of this book also mentions possible current problems, such as content overload and lack of quality control, he also speculates on the possibility of a “metamuseum”, a museum that exists exclusively on the Web, as in the case described in this article. One of the first virtual exhibitions [2] was originally called “The Museum Inside the Telephone Network”, which was a library of digital archives.

Nowadays, virtual museums can be of various types [4] and are a feasible resource for disseminating content on the network [5]. In the beginning, the digitization of museums consisted of photographing the elements and posting those images with their descriptions on the network [6]. Later on, virtual museums appeared, which were digitizations of an already existing space. These digitizations were videos, i.e., a virtual tour recorded with audio describing the entire museum [7]. These videos can also be 360-degree interactive, which allows turning the head by moving the mouse, the device, or by using virtual reality glasses and looking sideways during the visit [8].

Some virtual museums are realized via Google maps technology, where the user can walk through the space and observe the different rooms [9]. The user can move between viewing points that are located in the center of the different rooms and observe what is a three-dimensional panorama. There are also panels with additional information or photographs to expand the data.

Other technologies allow the creation of virtual tours of existing museums, such as photogrammetry [10], 3D scanning [11], or the use of 360-degree cameras that add a multitude of points of view [12,13].

On the other hand, there are virtual museums that are not copies of reality but are instead digital spaces that represent works of art in a virtual scenario [14]. In this type of museum, the models that only exhibit two-dimensional works are quite frequent and easy to create. There are many applications on the network that allow incorporating images in a 3D space and adding some additional information if necessary. In the virtual environment, the visitor is in a three-dimensional room and can zoom in on each painting and obtain more detailed material that is either written or accompanied by additional images. It is possible to zoom in and see the painting in much more detail than in real space. These museums are often not a copy of a real museum and are created only to exist online.

This type of museum also includes three-dimensional objects. They can be three-dimensional elements that are digital copies of very sensitive or difficult-to-exhibit artifacts. These objects are digitized using techniques that are not harmful, such as laser scanning or photogrammetry. The scanned models can either be displayed on digital screens inside a museum or in a virtual one online [15].

There are also fully virtual museums with 3D objects that have been created just for this purpose and are not copies or recordings of existing museums or objects. This requires a much greater investment than simply digitizing a space and objects that are already available. For this, it is necessary to create in three dimensions the works to be exhibited and incorporate an interaction that allows the visitor to move properly in that environment. This is usually carried out with exhibits where there is only documentation or objects that are historically faithful recreations, as in the case of clothing, where there are few actual examples, or those that are difficult to preserve and exhibit.

The creation of the virtual museum described in this paper is part of the project “Virtual historical reconstruction of San Cristóbal de La Laguna”. This project aims to create a virtual reconstruction of a 16th-century city that can be visited through virtual reality glasses or with an application via a computer or digital tablet. It is intended to show interactively what the city of San Cristóbal de La Laguna was like centuries ago, at the time when the Italian engineer Leonardo Torriani was in the city, working on the cartography of the town [16]. Special attention was paid to the protagonists from the 16th century and the town’s inhabitants. For this purpose, the streets, houses, and buildings of that time were recreated using 3D modeling programs. In addition, characters dressed in 16th-century costumes were added to create a closer and livelier environment. The virtual museum is a subproduct of the project and will also be part of the final version as a fictitious room that can be visited, as it is considered important to show in detail the clothing of that time. The objective is to demonstrate a feasible procedure for creating a virtual museum of clothing of which only descriptions, drawings, or patterns are available, without advanced equipment or higher technical knowledge and at low cost.

2. Background

Museums have long recognized that fashion and, with it, historical or traditional dress is an important subject for study [17]. Costume museums are dedicated to dress and clothing, as well as footwear, beauty products, embroidery, furs, jewelry, lace, needlework, silk, textiles, uniforms and fabrics, and other fields related to fashion. The conservation of clothing is a complicated issue, and the best way is to keep it in rooms created for this purpose to minimize deterioration. However, during an exhibition, the conservation of clothing can be affected by exposure to light, humidity and temperature, dust and

contamination, materials in contact, and stress from inadequate support and handling during assembly [18].

Modern technologies offer new ways to disseminate clothing in digital formats. Virtual reality allows the creation of new digital spaces and new ways of displaying clothing. Lu and Bian drafted three possible methods: a static panorama, which is obtained by taking a photograph with a 360-degree camera in a real exhibition; the dynamic panorama, which shows a 360-degree video of the exhibition; and 3D modeling of virtual clothing [19].

It is now common for museums to have websites with basic information. In the case of costume museums, as these are pieces that are difficult to preserve and display in many cases, it is common to have a catalog of the pieces photographed with corresponding data [20].

For more than ten years it was considered that digital museums were going to have a growing audience, although this audience differed significantly from those who visited a museum in person. In fact, virtual visits are commonly used to search for information before the actual visit, for casual browsing, or to view specific content as well as for assigned visits during studies or work [21]. A virtual museum allows accessibility for the masses, anytime, anywhere [22,23], as well as for many people with mobility issues or who cannot travel to the actual museum [24], helping to disseminate material to a much larger audience. In addition, the general public has a great interest in new virtual realities so it can be expected that interest in virtual museums may increase in the near future [25]. The following museums have some of the most extensive digital collections.

The Costume Institute at The Met (New York) has 33,000 digitized pieces of clothing and accessories with a file of the main data for each item. The Museum at the Fashion Institute of Technology (FIT) (New York) has approximately 22 online exhibits or blogs where you can view photos, videos, interviews, text, etc., about each exhibit. Over the past year, they have also strengthened their digital presence with educational programs and social media presence. The National Museum of American History, Clothing and Accessories (Washington) has a gallery of nearly 3000 pieces, including fashion prints, photographs, and original illustrations, each with a detailed description and high-quality photographs. The Victoria and Albert Museum (London) also has extensive online information on events, collections, videos, etc. Each piece in the online gallery has photographs and a detailed description. The Kyoto Costume Institute Digital Archive (KCI) has a gallery with some 300 models organized chronologically. The Texas Fashion Collection Digital Library has 5838 digitized pieces. Finally, the Wayne State University Digital Dress Library has about a thousand digital files.

In recent years, new technological possibilities have arisen to exhibit collections of clothing and accessories, in addition to the photo galleries described in the previous paragraph.

Since 2016, the Drexel Digital Museum Project (DDM) has included a proposal to view certain costumes via an interactive viewer. The viewer allows zooming in on each piece and rotating the figure to view the costume from different viewpoints [26], approximating a 3D view of the costumes.

In 2015, Europeana Fashion emerged, a website that includes European fashion history from more than 30 European public and private institutions [27]. It features historical clothing and accessories, contemporary designs, catwalk photographs, drawings, sketches, prints, catalogs, and videos that are accessible and freely available. In 2017 the section We Wear Culture [28] joined the Google Arts and Culture project, to which 180 international institutions belong and offer diverse online content. It has digital objects, virtual tours of the museums, videos, images that can be enlarged in detail, etc.

An interesting proposal is the virtual museum of Valentino Garavani [29], a renowned fashion designer. It offers a virtual visit that only exists in digital form, one where the visitor can move freely and walk among the objects [30]. It is necessary to download an app that offers access to a 3D space with several exhibitions and rooms with Valentino designs. It is possible to observe drawings, videos, interviews, texts, and of course, a 3D model representation of his most outstanding dress designs. In this museum, the mannequins

wearing the clothes seem to be three-dimensional figures. However, it is only possible to see them from a single point of view [29].

Another example is the Christie's Virtual Tour: Catherine Deneuve et Yves Saint-Laurent. You can walk among pieces from Catherine Deneuve's private collection. It was created with a 3D scan of a real exhibition [12]. However, it does not allow the user to move freely or observe the clothing from different angles, which is described as a 3D browsing of photos mimicking three-dimensionality [20].

Another interactive and virtual museum that emerged in 2020 is the virtual exhibition "The Queen and The Crown", which brings together the costumes of two hit Netflix series, in collaboration with the Brooklyn Museum [31]. It is a virtual museum created at a time when it was difficult to travel or attend in person. The interactivity of the virtual space is reminiscent of a video game, where it is possible to approach each dress, see it from all angles, and get information on details, photographs, and videos.

There are several important museums that preserve Spanish clothing, such as the Fashion Museum of Catalonia, the Textile and Costume Museum in Barcelona, the Costume Museum in Madrid, the Ansotano Costume Museum in Huesca, the Alhajas Museum on the Vía de la Plata in León, etc.

Most of these museums have some of their pieces in a digital environment. Since 2016, browsers can access the Museu de la Moda de Catalunya [32], an online platform that gathers and makes available to the user hundreds of historical pieces of clothing that are part of public collections scattered throughout the Catalan territory. This was carried out because only 5% of the existing garments are available to the public. This museum functions as a digital catalog, with each piece photographed in detail and with extensive additional information.

The Costume Museum in Madrid has a virtual tour created by Google where you can tour the entire exhibition, both inside and outside [33]. This visit is experienced in the same way as "walking" the streets using Google maps. Inside the museum, there are points where we can place ourselves and from there have a 360-degree view of each of the rooms. This allows us to get a general idea of the museum. However, most of the information panels are not visible and the details of the costumes cannot be appreciated.

In the project described in this article, a completely virtual museum of 16th-century Spanish costumes was created, of which there only exist a few preserved real pieces. The costumes were created in three dimensions using 3D modeling programs. The visitor can approach each costume and observe it from all angles.

This article describes the research conducted on virtual museums and the possibility of creating virtual museums for the dissemination of heritage in a simple and feasible way at a low cost with accessible technologies. It shows a workflow that enables the creation of 3D models of clothing in an achievable way and that can be made available in a virtual museum that is freely accessible online. It facilitates the simple and direct dissemination of heritage that allows the user or interested persons to visualize the clothing of the 16th century in a 3D space.

The project aims to create a virtual museum that can be navigated like in a video game, and where it is possible to view each costume from all sides. For this, it was necessary to build both the space and each of the costumes with 3D programs and to add the possibility of interaction via another dedicated program.

3. Materials and Methods

3.1. Costume Choice

The fashion that prevailed in all European courts in the 16th century was that of Spanish fashion, or what is known as "Spanish dress". This clothing is not available as a complete collection in any museum, and there are no longer any real examples of complete garments, but only some loose pieces or reconstructions. In the collections in Spain, we only found a doublet from the 16th century in the Museo del Traje. However, it should be noted that there are preserved treatises on tailoring used for the training of

officers and masters of this profession that include patterns for the garments used at the time [34,35]. The main reference regarding clothing use in Spain is considered to be the work of Carmen Bernis: *El Traje y los Tipos Sociales en el Quijote* (The costume and social types in Don Quixote) [36]. This work describes the clothing used by the different strata and trades of society, illustrated with works of art of the time. On numerous occasions, the author also provides scale reconstructions of the patterns for the garments obtained from the tailor's books, fundamental for the dress-modeling software. The collection of garments in this work covers male, female, and children's clothing across the social strata: court, middle and humble. It also considers the religious sector with different male and female orders, military dress, and the clothing of men of science and letters. In general, some pieces that make up the dress of some sectors are the same, varying only in the quality of the fabrics and the richness of the ornaments. The style, type of garment, and workmanship of court dress were imitated in other social strata.

The men of a high social stratum generally wore dresses, the term being understood as a set of garments that were generally made of the same fabric and color, although this is not necessarily so. In the case of the nobility, the materials were luxurious. The soldiers wore colorful costumes with garters holding up the stockings, a waistband with a flap for the sword, and a sash. Depending on the scenario, it is possible to distinguish between dress clothes and a similar, more ragged style. The colorfulness of the soldiers contrasts with the broad, dark garments worn by clergymen and men of letters and science. In the case of women, in the same way as in men's fashion, the courtesans, the commoners, and the humble were distinguished by the luxuriousness of fabrics, ornaments, etc., since they imitated the fashion of the court.

To show how people dressed at that time, a selection of clothing was created that shows the style of dress in 16th-century Spain. Several models were created for each sector, with at least one male and one female model. The virtual museum includes the following sections:

- Dress of wealthy people or royalty;
- Dress of the middle social sector;
- Clothing of the lower social class;
- Religious dress;
- Military dress.

3.2. Tools and Software

Throughout the whole process, we used 3D modeling programs to create the human figures, other programs to add an animation that allowed moving the figures into a certain posture, and then specialized software whereby the clothing was created. A program was also used to create the exhibition hall with its lighting and other elements, and finally, all the parts were united via a videogame engine that allowed adding the interactions inside the virtual museum. In the above order, the programs were the following: MakeHuman, Mixamo, Marvelous Designer, Blender, and Unity.

The MakeHuman program was the first step; it is a free application that allows the creation of realistic human figures to be used in computer graphics. The initial model is a standard human that can be modified by intuitive controls to a more masculine or feminine human, changing the height, width, age, etc. [37]. The program allows exporting the characters in various formats, compatible with the following programs that were also used in the process of creating a virtual museum.

Mixamo [38] is a Web-based tool, with which 3D character animations can be created without any previous experience in these technologies. Animated characters can be created instantly. In Mixamo, a human skeleton can be applied to a character automatically, and a motion chosen from a very extensive library of animations can be added. The generated models can be used in numerous video game engines and 3D development software such as Unreal, Unity, Blender, etc.

Marvelous Designer is a professional program that specializes in the creation of clothes, fabrics, or similar items. It is used in the fashion design industry as well as in entertainment. In this case, a license fee was required. It creates clothing almost automatically from a pattern drawing [39]. It works with already built-in characters (avatars), although you can edit and customize them or use external avatars. The learning curve of this program is fast, and basic garments can be made in a few minutes without advanced prior knowledge of 3D modeling or sewing.

Blender is a free and complete 3D modeling program, one that allows working with almost all possibilities within 3D modeling, animation, application of materials, lights, rendering, etc.

Unity is one of the most popular video game engines. The download and license of this graphic engine have always been free, which makes it a powerful choice when developing projects. It also stands out for its multiplatform development capabilities.

3.3. Process

The process followed for the creation of the virtual museum of 16th-century Spanish clothing is described below. We started with the MakeHuman program and created a character according to the desired costume (Figure 1a). The designer can choose the gender and vary the character's characteristics such as the hair, eyes, shoulder width, and height, as well as a particular pose. In this case, the T-pose (with straight and extended arms) was required to animate the character correctly and add the clothing. The next step was to insert the 3D model of the human into the Mixamo online application. After registration, there is an extensive library of movements that are automatically applied to the human figure. In this case, a "sitting" movement was chosen to obtain a character in a sitting pose (Figure 1b). Next, it was necessary to make a rectification in the Blender program because when the model was exported using the Mixamo animation, the T-pose, which is necessary for adding the clothing correctly, was lost. To do this, the animated character was inserted into Blender, and the pose was added at the beginning of the animation [40]. The complete animation was then exported (Figure 1c).

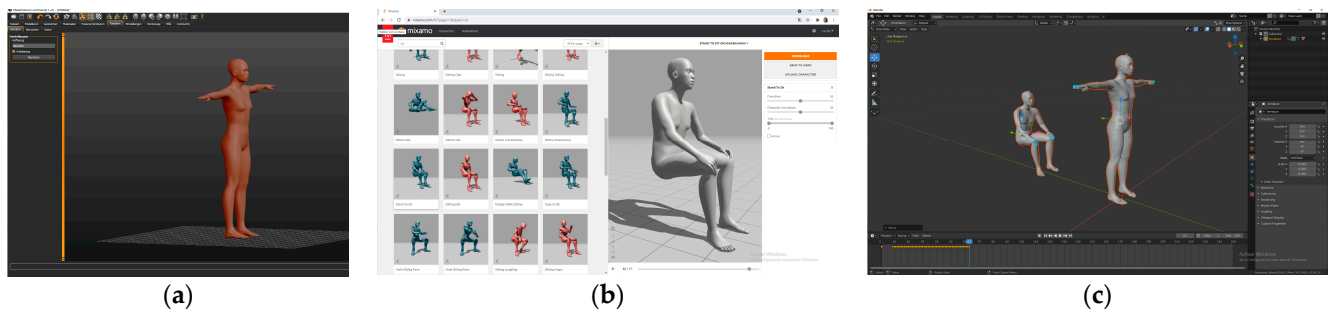


Figure 1. (a) MakeHuman program, creation of the initial character. (b) Mixamo program, the addition of the animation to the character. (c) Blender program, correction of the initial pose to T-pose.

Next, we started working on the clothing for the characters using the Marvelous Designer program. To create the 16th-century costumes, a thorough study of each model was required. The type of clothing worn at that time was similar throughout Spain. To get an idea of how people dressed at that time, a book called *Geometria y Traça Perteneciente al Oficio de Sastres* by the author Francisco de la Rocha Burguen (1618) was used as a basis [35]. This book contains studies, patterns, types of fabrics, and very complete samples of all the clothing that a tailor had to know how to make at that time. This manual is complex to understand for someone without knowledge of historical tailoring. However, in the book *El Traje y los Tipos Sociales en el Quijote* [36] the information is more legible, and the patterns are shown in a much clearer way, and it also includes drawings associated with the tailoring of that time (Figure 2). In addition, sources such as 17th-century men's dress patterns from 1600 to 1630 [41] and Web resources with historical dress patterns [42] were consulted. For

the other details of the costume, pictorial works of the period were consulted, where some characters appeared wearing the studied costume.

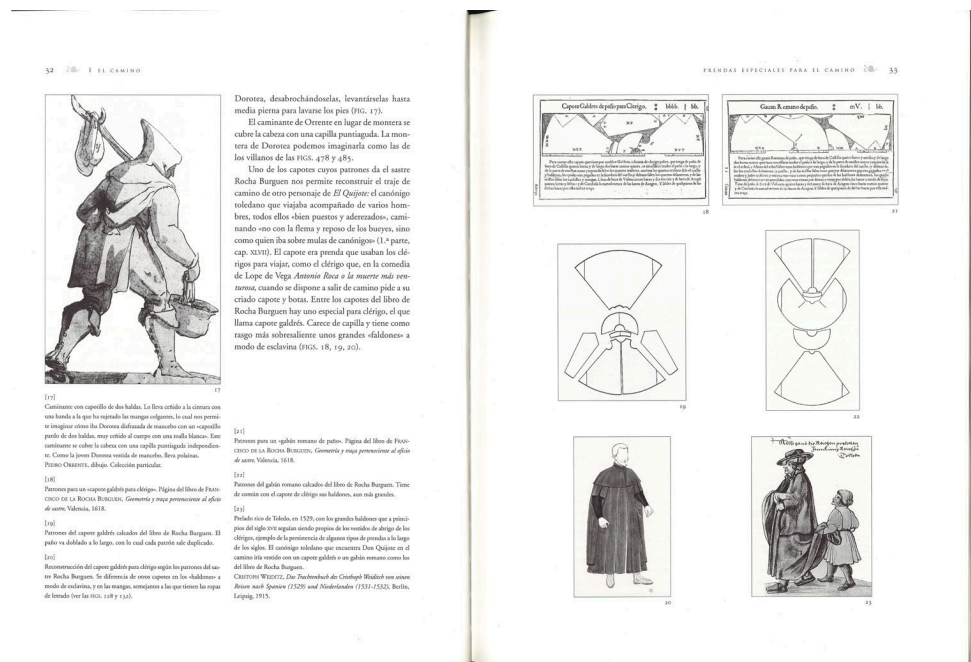


Figure 2. Costume and social types in *Don Quixote* [36].

The process in Marvelous Designer was as follows: first, the clothing pattern was imported as a reference in the program (Figure 3a). This pattern was used to draw over the main clothing pieces. Once the patterns were redrawn in one of the windows of the Marvelous Designer program (Figure 3b), the measurements were corrected and adjusted to match the proportions of the avatar (3D model of the character without clothes). Then, the different parts of the pattern were placed in the 3D window in the correct place on top of the avatar; the pieces were virtually sewn together and finally adjusted using the program options (Figure 3c).

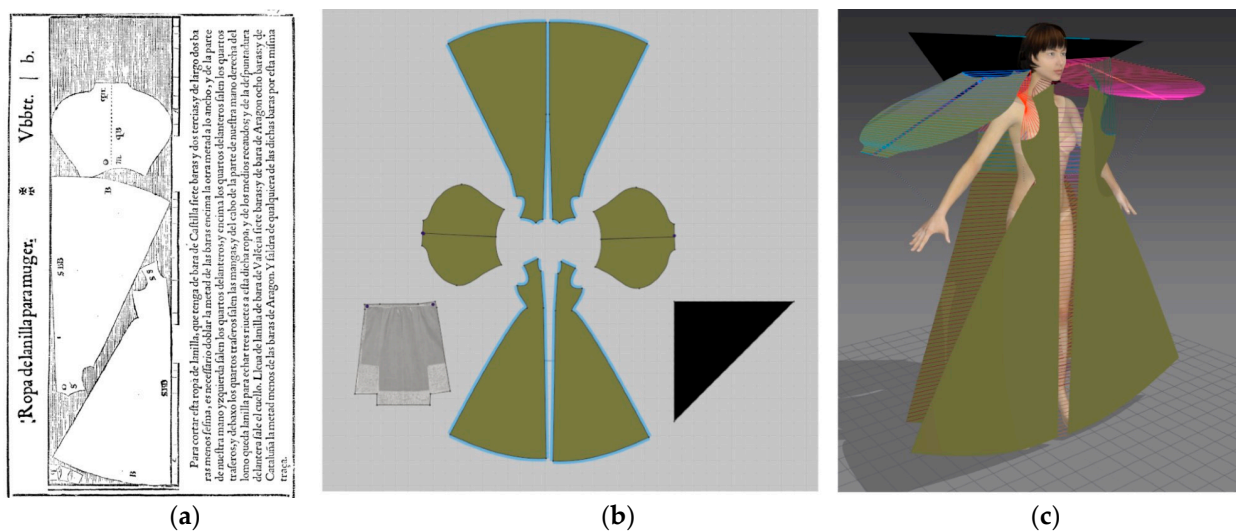


Figure 3. (a) Detail of the reference image of the pattern book [36]. (b) Pattern redrawn in Marvelous Designer. (c) Location in 3D space and virtual stitching.

For the clothing of the noble social strata, an exhaustive study was required (Figure 4a) because 16th-century clothing was complex and was described in the patterns in terms that are not commonly used today. When many details, seams, embellishments, etc., were added, the program needed more and more resources to animate the design. Likewise, once the model was exported to incorporate the figures into the virtual reality it required too many processing resources, so it was necessary to simplify the clothing as much as possible. To do this, we avoided creating all the details and embellishments in the clothing. We solved the problem of color changes in the fabric and the seams of different materials, buttons, etc., by drawing directly on the fabric. For this purpose, a flat image was taken from the pattern once all the measurements and details were adjusted. To this pattern, the texture was added using an editing program, such as Adobe Photoshop, adding the details, embroidery, changes of fabrics, seams, etc. (Figure 4b). By adding the details of the texture as a drawing on top of the fabric we achieved a result quite similar to the original but without the need for seams (Figure 4c).

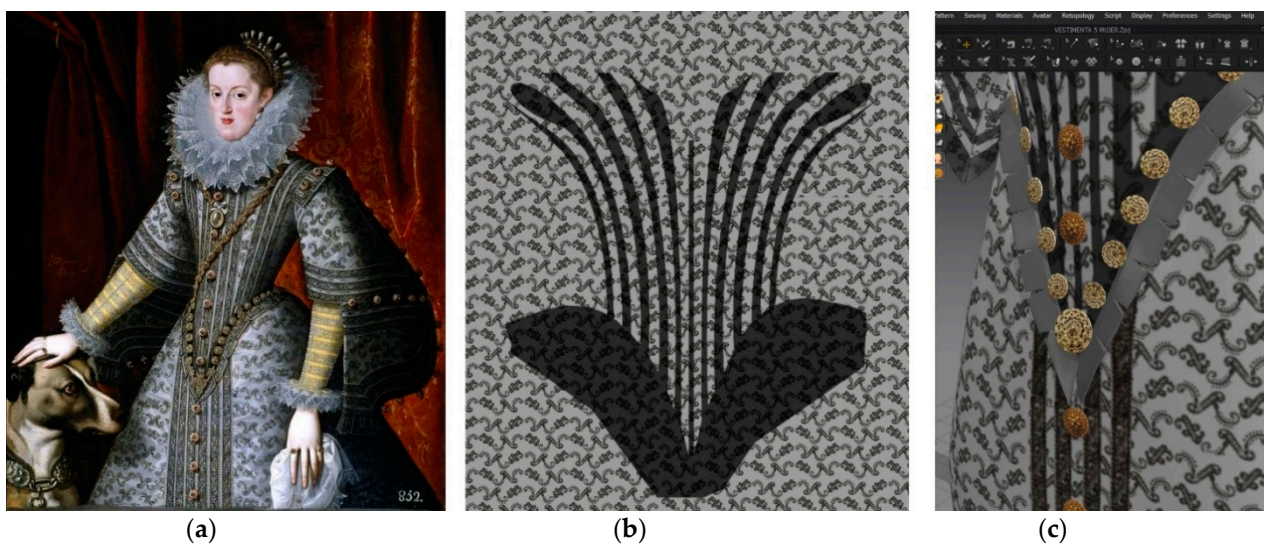


Figure 4. (a) Study of the clothing of the nobility: Queen Margarita of Austria, 1609, Author: González, Bartolomé (Source: Museo del Prado). (b) Details added to the fabric of the bodice (doublet). A single texture avoided a multitude of pieces of different fabrics. (c) Result in Marvelous Designer.

Once we had the characters with their clothes, we proceeded to create a space that would be the virtual museum where the figures were located. This step was performed in Blender, modeling the whole room with its pedestals, lights, information panels, textures, etc. This was carried out using the basic modeling tools of the program until the desired space was obtained. Once finished, the 3D model of the room with all its characteristics was exported from Blender and imported into Unity (Figure 5a).

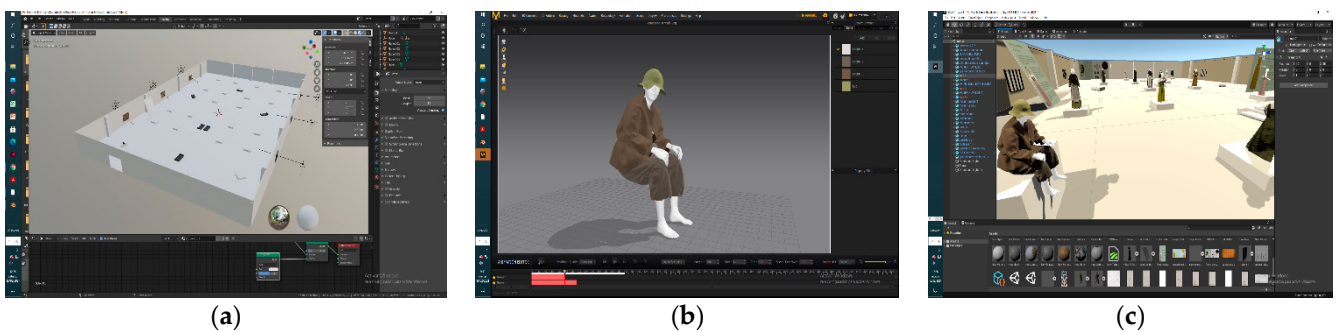


Figure 5. (a) 3D model of the exhibition hall modeled in Blender and inserted in Unity. (b) Character in the correct pose for export. (c) Showroom with the characters dressed.

Next, each of the 3D models of the characters was exported with the correct clothing and pose (Figure 5b) and then inserted into the museum space in the Unity program, where, with the correct adjustments, the textures and appearances of the clothing were maintained (Figure 5c). In addition, some information panels and a sign on the pedestal identifying each character, such as peasant, nun, middle-class woman, gentleman, etc., were added.

Once all the elements were integrated into Unity, we proceeded to add the interaction facility, which basically consisted of inserting a first-person controller automated by the program. This was a character that allowed a visit to the museum with a first-person view and that was handled with the usual controls of video games on the computer (arrows to move, the mouse to rotate the view, and the escape key to exit).

With this facility, you can visit the museum from the program. Given the multiplatform characteristics of Unity, we chose to export it to a WebGL version of the application, thus facilitating its dissemination on the Web to be accessible to others. The generated application uses HTML5 and JavaScript standards to allow visits to the museum from any version of PC browser. The mechanics of the virtual tour respond to the usual arrow keys for scrolling and mouse buttons for rotations. Colliders were added to prevent the user from passing through objects, characters, and walls in the museum. Prerendering of static objects was also used to increase the smoothness of the application by minimizing runtime lighting calculations.

4. Results and Discussion

A prototype of a virtual museum of 16th-century Spanish clothing was created and is freely available on the Internet and accessible to anyone who wants it from a computer or digital tablet at the following web address: <http://torriani.iaas.ull.es/museo/museo.html> accessed on 10 November 2021.

The clothing shown in the museum is not available as a complete collection anywhere, and there are no longer any real examples of the complete garments, only some loose pieces or reconstructions.

The interaction in the museum resembles reality as much as possible, as it allows the visitor to walk freely around the room and observe each design from any angle. The controls are similar to a video game, where the user moves forward or sideways with the arrows, rotates the view by moving the mouse, and uses the escape key to exit. The movement inside the museum is similar to that found in most current video games; this allows ease of use by visitors since they do not have to learn how to visit the museum. In addition, this project is considered beneficial, bringing culture to a young audience. The project improves upon the three-dimensional vision, compared to other existing models, such as the Valentino Garavani Museum [29], and there is no need to download or install any software as it works directly online. However, it has not been possible to achieve such an elaborate interaction as the virtual exhibition project, "The Queen and The Crown" [31], described in Section 2. Our project was achieved with low-cost technology and with no experts in 3D modeling or virtual scenery creation. To garner first impressions and verification of its reception, the application was tested with colleagues and some students. During the visit, none of them had any doubts about the way to move around. The average time of visit varied, depending on the interest in the topic of the person, just as in a real environment. Many were amazed by the detail of the costumes and said they found it interesting to be able to visit a museum in this virtual way.

The process was carried out with free software and without advanced knowledge of technologies. Very simple applications, such as MakeHuman and Mixamo, were used to create and animate characters. We then followed video tutorials to fix some details of the animation in Blender, which had very few steps.

Twenty-one different costumes were created with the professional design program Marvelous Designer. The created costumes are listed at Table 1. The learning curve was fast, with satisfactory results; however, this program requires a paid license.

Table 1. Costumes created for the virtual museum.

Group	Character
High-end, affluent or royalty clothing	2 Gentlemen 2 Women (courtesans)
Dress of the middle social sector	2 Women
Clothing of the lower social class	1 Girl
	1 Peasant 2 Women
Religious clothing	1 Nun
	1 Franciscan friar
	1 Dominican monk
	1 Clergyman with caldrés cape
	1 Holy Prosecutor
	1 Carthusian monk 1 Cistercian monk
Military dress	1 Officer of the guard 1 Spanish armor—knight
	1 Doctor 1 Nurse

The creation of the showroom in Blender was carried out in a few hours and without unnecessary complications, to lower the computational load of the rendering process.

Finally, the Unity game engine was used to compose the whole scene and add a first-person controller (Figure 6).

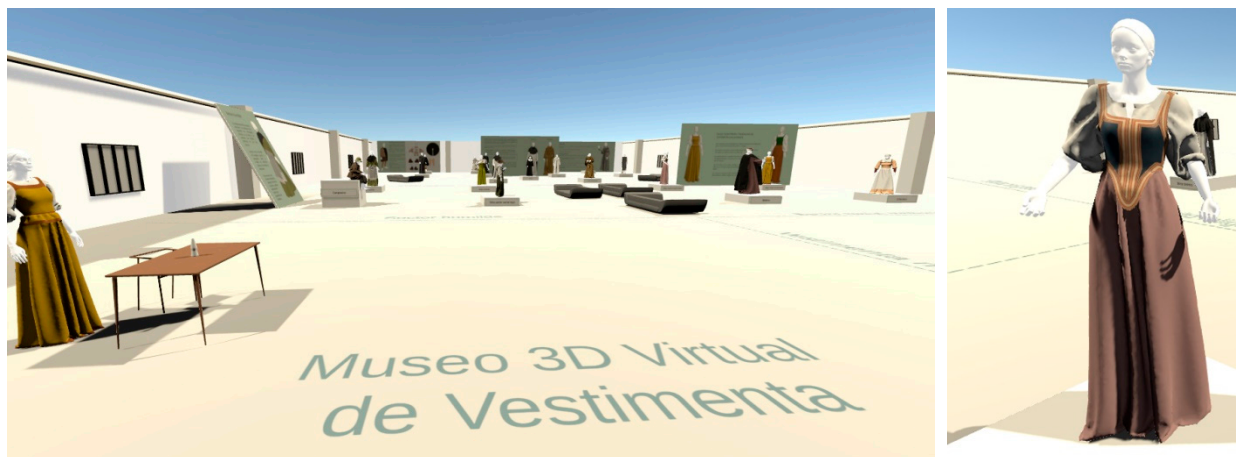


Figure 6. Interactive virtual museum for the dissemination of 3D models of historical clothing. Access on: <http://torriani.iaas.ucll.es/museo/museo.html> (accessed on 10 November 2021).

To make the project available on the Internet, the official website of the Virtual Historical Reconstruction of San Cristóbal de La Laguna research project was used (torriani.iaas.ucll.es). The server was provided by the Infrastructure as a Service (IaaS) service of the University of La Laguna through its VMware platform.

5. Conclusions

The creation of fully digital virtual museums, ones that are not copies of existing ones, is becoming increasingly feasible. The technologies that make this possible are within everyone's reach, and many are free of charge. This technology allows for the sustainable dissemination of historical clothing as it does not waste material resources and does not require people to travel to visit the museum.

Virtual museums make it possible to disseminate knowledge that no longer exists in a digital form, making it ubiquitously accessible. Low-cost 3D models can be created out of elements that have been lost or are difficult for the general public to access, as in the case of costumes that are prone to deterioration and require much manipulation to be displayed. That is why virtual museums are a good option to display costumes to the public, an undertaking that is otherwise complicated. Until now, virtual disclosure has been carried out with images; however, the possibilities of a 3D virtual museum allow a visit closer to the real-world experience. A virtual museum also allows for constant evolution or enlargement of the space, the addition of models, and the modification of existing information. The museum is on a university server and should be maintained there without any problems. The museum does not need any maintenance as long as there are no technical problems with the Web browsers.

The aim is to improve the project with students who will join with final projects or similar studies, as, for example, the final degree work in which the possibilities of interactive panels and a guide as well as exporting the museum into virtual reality for Oculus Quest 2 glasses are being studied [43].

The prototype museum that was made in this project allows us to observe a selection of Spanish clothing of the 16th century and to walk through a virtual museum as if it were a video game, which is as close as possible to a real visit. For future work, we propose to include additional interactivity in the virtual museum, such as information panels that open the possibility of seeing more details of each costume; characters that rotate or walk in front of us so we can comfortably observe each design; the possibility of interaction with the models, such as talking; etc. It is also possible to enrich the museum with costumes from other periods, as well as to add details of the clothing such as shoe displays, hats, or other accessories. It is also feasible to add multimedia material. On the other hand, a study will be designed to measure the perception of visitors. It is expected to obtain data on their observation of the details of the clothing, whether there are models they consider more interesting than others and whether it is also necessary to test the application with future users, such as high-school teachers or older people with an interest in history. In these groups, the aim is to verify if it is easy for them to move around the virtual museum and if they are interested in a virtual museum with these characteristics.

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