Interactive installations and virtual reality in the museum. The *Galicia Dixital* experience.

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Abstract

Recently, historical museums and other exhibitions are becoming more aware of the effectiveness of virtual reality spaces used along with other technologies to meet the challenge to offer new and complex experiences to the general public. Immersion and interaction together define the axis of such experiences, provided with new kinds of contents and singular applications designed for each specific case.

This paper describes the use of a set of computer graphic techniques which range from computer animation to simulation and virtual reality applied to display cultural contents in a permanent exhibition called Galicia Dixital located in Santiago de Compostela (Spain). This exhibition is devoted to show Galician culture, history, traditions and art through the medium of new technologies. This way, visitors have the opportunity to acquire knowledge of cultural and technological topics at the same time.

Introduction. The Galician cultural heritage. Galicia Dixital

Cultural heritage is, by definition, something that belongs to all mankind, a legacy deposited throughout the centuries for us, its present owners, being preserved by the institutions for our contemplation and enjoyment.

Nevertheless, cultural heritage has a singular feature that few human possessions have. The myriad of elements that compose it and their geographical dispersion makes impossible along the life of a person to enjoy even of a small part of this inheritance, that is composed, in the other hand, by fragments so different that range from the painting to the building, from sculpture to pilgrimage routes, from music to costumes, adding to the immense quantity and extraordinary diversity of existing examples.

The best way to know about the cultural heritage is by a desirable direct contemplation sometimes difficult to obtain apart from the nearby examples or the few trips a person can make in his/her life. The other traditional way to get information about it is by browsing printed information in art books, catalogues, guides, and only recently, through multimedia formats and the use of Internet.

Nevertheless, *knowing* differs from *experiencing*. It is certain that a painting may be reproduced with a certain level of quality for its enjoyment in other media such as a book or a monitor, however, the same does not apply to architectural spaces, the history of a relevant event, or an ancient tradition, just to name a few examples.

These pages focus on Galician cultural heritage, its manifestations, and the corresponding ways to present them to the public through the use of virtual reality and other technologies. Galicia

is a Spanish region located in the north-west of the Iberian Peninsula. It is considered an historical community with its own characteristics ranging from traditions to landscape. From ancient times, Galician inhabitants have had a strong liaison with the sea. Galicia also represents the ending and goal of a millenary pilgrimage route, the path of St. James, considered by many as the backbone that first supported the idea of creating Europe. Fingerprints trace of religious influence in Galician monasteries, cathedrals, and temples are some examples of the development of this heritage.

However, architecture is not the only cultural reference of this region. Traditions, costumes, legends, music, and all kinds of art have evolved with particular characteristics in this area. Altogether, they compose what we can call the Cultural Heritage of Galicia.

The authors describe in this paper how every kind of cultural manifestation has been displayed using a different technology in a permanent exhibition named as *Galicia Dixital* (Xunta, 2008), promoted by the Galician Government, where more than 290.000 people have experienced this diversity of contents. In most cases, special software had to be designed and hardware had to be created, adapted or redesigned to fulfil the requirements of every application; also, new ways of interaction (e.g. those of the Empty Museum) had to be explored.

Different applications for different manifestations of Cultural Heritage

In the following paragraphs, the use of a group of computer graphic technologies will be presented. Although some of the CG technologies (like frame-by-frame animation) are more or less classic today, others (like the immersive and walk-through virtual reality hybrid space called the Empty Museum) are more innovative. All of them are useful depending on the topic to be covered; hence, all of them will be described at varying length depending on their novelty.

Historical architecture. The Cathedral of Santiago de Compostela in the XIII century.

The Cathedral of Santiago de Compostela, an 800-years-old building, is considered a paradigm of Romanesque architecture. Today, its original form cannot be seen due to the numerous changes made in its façade and in its interior throughout the centuries. Nowadays, a magnificent baroque façade arises about its main entrance, covering what once was one of the most important works of the Romanesque sculpture: the so called *Portico de la Gloria* (Portico of Glory). A splendid rose window has also disappeared from the primeval façade. In the interior, the original luminosity has vanished since many lateral chapels, made afterwards, have covered the space occupied once by dozens of windows.

The making of a 3D digital model of a building like this involves the solution to special problems. Building such rigorous and precise geometrical model to be used as a tool for scientific study, popularisation of history, and the faithful representation of the past becomes a challenge. Even more when the amount of information associated with the building in medieval times is limited. Important documentation on the site was made by world-class specialists in medieval history and Romanesque art.

The goal was not only to achieve a virtual model but to obtain a geometrically-based narrative tool. The model had to be designed in organized stages that allowed the description and analysis of the temple´s constructive scheme, its formal and structured relation, and the showing of the building´s historical process.

Technically, the model is structured by 700.000 polygon mesh organized in 270 different constructive blocks. The use of a radiosity algorithm emulated lighting since most of the

illumination in the interior of the temple came from diffused reflections of light coming in from windows and openings which was reflected on the interior surfaces.

With this model, a documentary video was produced, mixing frame-by-frame animations and real video from the actual building. Some pictures of the model are shown in figure 1.

-Insert Figure 1 here-

The landscape as a natural heritage. S.A.N.T.I

Galicia is considered one of the most beautiful Spanish regions due to the diversity and beauty of its landscapes. Every year, millions of tourists come to this region to enjoy the green and blue horizon of its coast full of cliffs, firths, beaches and islands, and its inland regions covered by forests, mountains, valleys and canyons.

One of the objectives of the Galicia Dixital exhibition was to show this natural wealth to the pilgrims who came to Santiago with the sole purpose of completing the Way of St. James, thus offering them other interesting alternatives for extending their stay in the region.

In order to achieve this goal, the team of authors developed the Advanced System for Navigation over the Terrain (S.A.N.T.I); a real time simulation that allows the user to fly over the territory enjoying the landscape, and to descend to some significant cities and perform virtual strolls around their old quarters. The system is controlled using a very friendly interface, composed by a 1.10m ball and two keypads, as can be seen in figure 2.

The SANTI application uses a digital terrain model mapped with satellite and aerial pictures to give a high-resolution image of the terrain being flown over in real time. The performance of the application does not depend of the size of the database, since it pages both geometry and texture generating LOD's in real time and using a proprietary hardware independent clip-mapping technique. Since its first version developed in 1998, it has been used to show geographical areas of different size, up to 80.000 Km2 covering all the regions crossed by the St James way in the north of the Iberian peninsula.

It was initially designed to use satellite imagery, with a resolution of up to 10 m/pixel. The most recent version of the application is capable of displaying details up to 0.25 m/pixel from a mosaic of aerial pictures covering the whole Galician region using a database of 3.5 Terabytes, linked with a GIS server to display information of other types simultaneously. The description of the system can be found in the references (Hernández, Taibo & Seoane, 1999)**.**

-Insert Figure 2 here-

Saint James Road on a WindowVR

The Way of St James has been, and still is, the most popular, ancient and crowded pilgrimage route of the Old Continent. The pilgrimage is both a touristic and a spiritual journey in which the walker passes through many interesting historical places.

The Way of Saint James consists of a set of routes that converge in a final city. One of these, called *the French Way* is the most popular and well renowned crossing the Iberian peninsula from the Pyrenees to the most western point of Europe, the ancient roman *finis-terrae.*

In order to virtually visit the different locations crossed by the Way and to display immersive images of the monuments and urban spaces of the historical cities, the group of the authors developed an application (Hernández, Taibo & Seoane, 2001) capable of showing hyperlinked spherical panoramas on a commercially available apparatus designed for other purposes: the WindowVR® by Virtual Research

This interface consists of a flat tactile screen that hangs from a supporting structure, enabling total freedom of movement (within the area in which the viewer is located). The supporting wire and the data cables are held by a system of pulleys that allows the screen to be rised up or lowered down. The screen is counterweighted, so the user can move the screen without any effort. The user holds the screen by two joysticks, one on either side. The different buttons on the joysticks allow for various actions to be carried out.

The application developed for Galicia Dixital allows the user to imagine that he or she is holding a virtual window through which another place can be seen. When the user turns with the window in his or her hands in any horizontal or vertical direction, the window follows his or her movements, displaying the image corresponding to his or her viewing direction. When there is another interesting place to visit in a specific direction, the user is notified, and can “go” to this place by simply touching the screen.

-Insert Figure 3 here-

The Empty Museum. Physically walking through virtual worlds.

During the last decade, Virtual Reality matured and became a powerful displaying tool for cultural contents, especially those related to Architectural Heritage. Many examples of VR installations were implemented in exhibitions all over the world, from HMD based applications to Reality Centers and CAVE's.

With the use of those systems, VR proved its potential and clear advantages as a new medium to communicate things that can't be shown in other ways. The aforementioned installations are excellent in terms of immersiveness and sense of presence, but they have the limitation of the need of the user to stand in a fixed place while the contents move around.

The natural way a person experiences space, i.e. observing while moving in any direction, made it necessary for simulations in VR environments to use unnatural metaphors to describe the different movements that the user is allowed to make (Bowman et al., 1998). Using a joystick, mouse or other similar type of direction controlling interface, the user is expected to imagine he or she is being displaced around a virtual setting in an invisible vehicle controlled by the peripheral, feeling static at the same time.

The necessary use of the imagination to perceive the metaphor of the vehicle as something real takes away naturalness and, consequently, much of the sense of presence from the experience of the exploration. When moving through a space in the real world, the sense of movement that a person experiences is not only due to motion itself, but also to the kinaesthetic sensations of his or her own body in movement. The interpretation of our own movement combined with the perception of parallax helps us to understand the scale of what surrounds us.

The fact of letting the user walk around the VR setting increases the sense of presence for the experience because he or she moves naturally through a real space without the aid of artificial devices to simulate movement. This user does not need to practise in order to gain skills in moving

around and the sense of motion is completely real. The absence of wires is also an important factor to achieve the freedom of motion around the virtual/real space.

There are already several wireless systems, i.e. MARS (Höllerer et al., 1999), Archeoguide (Didier et al., 2001), that allow the user to walk freely without connecting to a workstation, while displaying the 3D contents; they are mainly applied to outdoor Augmented Reality environments. Other systems like VENLab2 (VENLab, 2008) allow a *wired* user to walk inside a room. The installation described in the following paragraphs consist in a wireless immersive VR system that improves the sense of presence in VR environments by allowing the user to physically walk in a room full of virtual multimedia and 3D animated contents, exploring the kind of worlds that may be designed to be experienced with that technology, adding other capabilities such as multiuser interaction in the virtual world. The technical description of the system can be found in the references (Hernández, Taibo & Seoane, 2002) (Hernández, Taibo, Seoane, López & López, 2003).

The idea is to use real space as one of the elements in the motion interface and as part of the actual virtual space. This, in itself, facilitates experimentation with synthetic architectonic type spaces. The contribution of the Empty Museum is based on the use of a new form of contents, where visitor's experience goes further than simple contemplation. Although there is still much to do, we have began the study of parameters associated with the perception of one's own movement and worked on new forms of interaction with the virtual contents and other users, based on the instant location and view direction of people who are experiencing the system.

The users of the Empty Museum experience space in a double way. On one hand, the space is what he/she knows as such, with known dimensions, a real area the person is conscious of being in. On the other hand, in that same space there are virtual objects. Not only the user sees and accepts these as inserted in the real space, but the user is also able to identify the size and position in relation to his/her own through parallax when moving around, closer or further from the starting point. The virtual space (not the objects inserted in it) is, therefore, as genuine as the real space,

inasmuch as it has its same properties. As a user, you see yourself immerse in a hybrid space in which it is easy to move around and observe the objects. Thus, The real space becomes part of the interface.

-Insert Figure 4 here-

The contents of the Empty Museum.

Here we describe some of the contents displayed using the Empty Museum. Some of them are intended to be experienced by one user alone, while other virtual worlds are prepared for holding several users simultaneously. Although the system can hold and has been used to display many types of contents, only those related to cultural heritage in Galicia Dixital will be described afterwards.

Art.

The Museum of Sacred Art

This world is inspired by Romanesque music, sculpture and architecture. The user appears in a hall where there are signs that make reference to certain medieval instruments portrayed in the stones of the Portico of Glory of the Cathedral of Santiago de Compostela. When drawing near to any of the signs, an image of the sculpture of the musician corresponding to the instrument named in a label descends towards the user and a three-dimensional model of the ancient instrument emerges from the previous image and its music begins to play. This allows the user to contemplate the instrument while listening to its sound.

The user walks around all areas of this virtual exhibition, observing the different instruments that, once displayed, remain visible or “already activated” (figure 5, left). The persistence of the

changes provides more realism to the experience, given that it is an attribute of things from the real world.

The Paint Gallery. Worlds in other worlds

The user starts out in a paint gallery that displays two works of surrealist art made by two Galician painters of the beginning of the 20th century. When walking through any of them, as *Alice through the looking glass*, the user appears in a moving, three-dimensional version of the painting, (figure 5, right) as if looking into the artist's mind. In one of the corners of this dream world there is a white cylinder that metaphorically represents a teleport cabin. When the user has finished examining the imaginary world, he/she can walk into the cylinder and be teleported back to the paint gallery where the experience can be repeated with the other painting.

This world displays a new feature, the inclusion of various worlds inside a single world. The user can be teleported from one to another very easily, based on a concept between hyperlink, since it acts as a link between two elements of information, and teleport chamber, given that it is perceived and works as such. The users accept this type of movement between worlds as natural and very easy.

-Insert Figure 5 here-

The Museum of Galician Arts. A Multiuser experience in the virtual environment.

This is a multiuser world that features most of the capabilities of the Empty Museum, displaying spatial and volumetric elements, spatial sound, multimedia with text, audio and video, 3D animation and avatars for other users present in the installation in an environment designed to

show seven different types of Galician Art: Painting, music, architecture, sculpture, literature, cinema, and pottery.

-Insert Figure 6 here-

This is what the visiting experience feels like: When entering the world, the user is immersed in a singular architectural scenario composed of stone and concrete elements within an open space. After a welcome voice message, he/she will see that some semi-transparent blue objects surround him/her. These blue areas tell the user where the action is. Each action corresponds to a different art. As the user approaches, an event takes place setting in motion a series of behaviours related to that specific art. (Figure 6)

-Insert Figure 7 here-

Apart from these six arts shown at different museum areas, users have been represented as part of the world, examples of a seventh art which is always present in the experience, i.e. pottery. Thus, users are perfectly integrated within the scenario, turning from mere watchers to being part of the exhibition content.

Galicia and the Sea

The world of the Galician sea.

Galician has a strong relationship with the sea. There are many traditions, legends, and traditional fishing industries related to the ocean. This world displays some of the marine life, traditional fishing arts, shipwrecks and sounds related to the maritime atmosphere.

The user appears in a marine setting, just above the water surface. There are seagulls in the air, crying out and flying around in circles, boats sailing, traditional mussel farms, and dolphins swimming and jumping out of the water. The user can dive underwater to see more objects.

When the user ducks, he or she then sees the submarine world. There is a certain surprise when the user finds what he or she would expect to see: shoals of fish, seaweed, mussels growing in the wires of the farms, a shipwreck... Vision becomes misty and the echoes of the sea depths can be heard, together with the sounds of dolphins that swim past nearby. (Figure 8, left and centre)

It is a much more dynamic world that in the previous case, as it includes specialized sound and animations that the user can discover by exploring the different corners of this world. The user passes from the surface to the underwater world in a natural way as would happen if he/she were really in that space on a giant scale.

The storm

Shipwrecks are a recurrent topic in people's memories in this region. It is not in vain that part of the Galician coast is called "The Death Coast".

-Insert Figure 8 here-

In this virtual world, we tried to transmit to the user the feelings of a shipwrecked sailor in the middle of a violent storm at sea. To achieve this, the user is placed in the middle of the room, while in the virtual world he/she can see a calm scene over the surface of the ocean. An island appears in the distance; singing seagulls pass by over his/ her head. Then, wind suddenly starts blowing, the sky starts covering over with dark clouds, raining begins, and the waves became progressively higher and wilder while a dense fog surrounds the user. The sounds of the tempest get louder, and remains of a ship float on the wavy surface. The user has to move so as to reach one of them to calm the water again. (Figure 8, right)

The use of specialized sound, particle systems for rain, fog, a realistic simulation of waves and foam, together with the activation of air fans during this simulation, make it a very vivid experience for the user.

Traditions and legends. The legends of The Way.

Again, the St. James Way is referred to it, but now under a very different perspective. There are a lot of tales and legends related to this holy route. The user will be faced with these histories while he/she moves through a scene that emulates in a non-realistic way the different geographical variations and places that a pilgrim has to visit to reach Santiago. As the user approaches any of them, the narration of the legend starts as the user becomes wrapped in a panorama of the place that he/she is visiting virtually.

-Insert Figure 9 here-

The History of Galicia. The Castrexo World

Galicia, like the rest of Europe, has a long history behind it: Roman invasions, Vikings, and Visigoths gave form to its very own cultural identity rooted in a bronze age culture called *cultura Castrexa*, named after their settlements, called *castros.*

The *Castrexo* World places the user outside one of the huts of a *castro.* The user can walk in, and several Bronze Age tools and elements of this culture are displayed: A loom, some pottery, a central fireplace, etc. An explanative voice activates as the user approaches them.

-Insert Figure 10 here-

Conclusions

The term *cultural heritage* refers to a wide variety of concepts such as architecture, literature, music, customs or legends. Computer graphics technologies, especially Virtual Reality are very adequate for bringing those cultural contents to the general public. The designers of these contents have a wide variety of technologies to choose from, and may consider which one is the best for each special case.

This paper describes several cases in order to share experiences that may be inspiring or useful to others.

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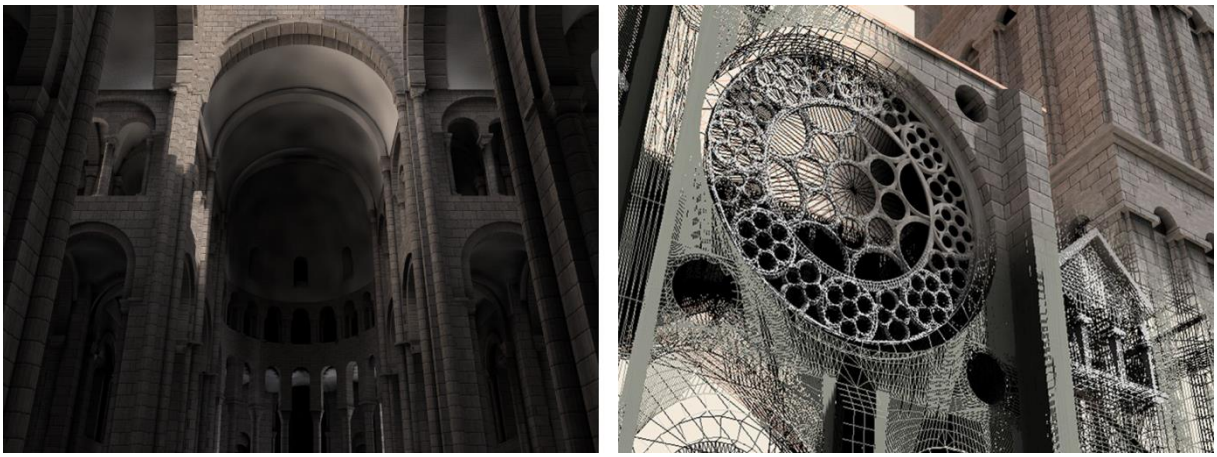

Figure 1. - Interior and main façade of the model of the cathedral of Santiago showing the radiosity mesh.

Figure 2. – SANTI

Figure 3. - St. James Road WindowVR application

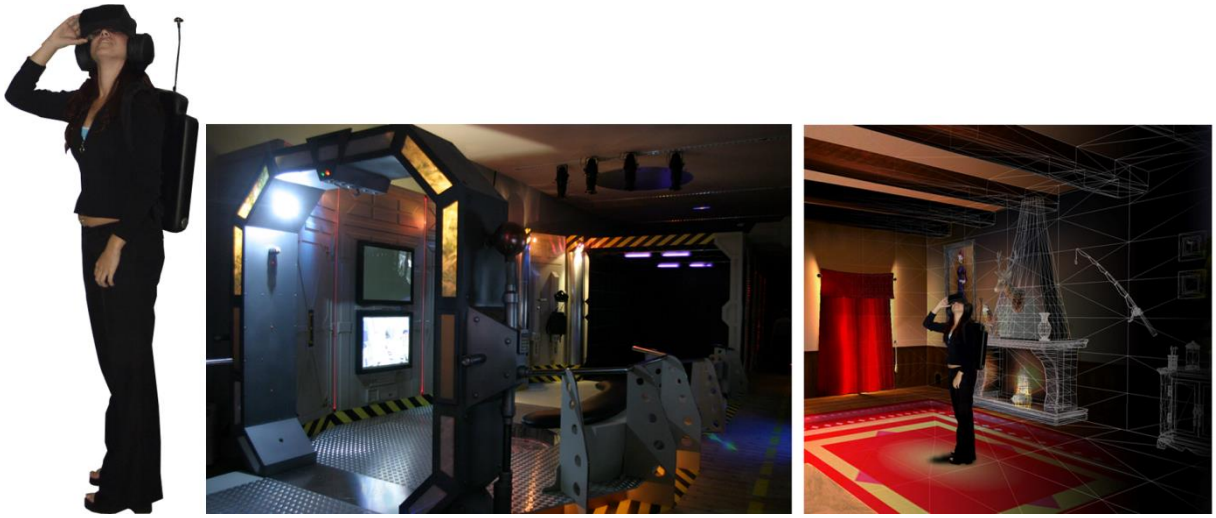

Figure 4. - The user, the installation (the walking area is in the furthermost dark room) and the feeling of the Empty museum

Figure 5. The feeling of the user in the Museum of Sacred Art and the Paint Gallery

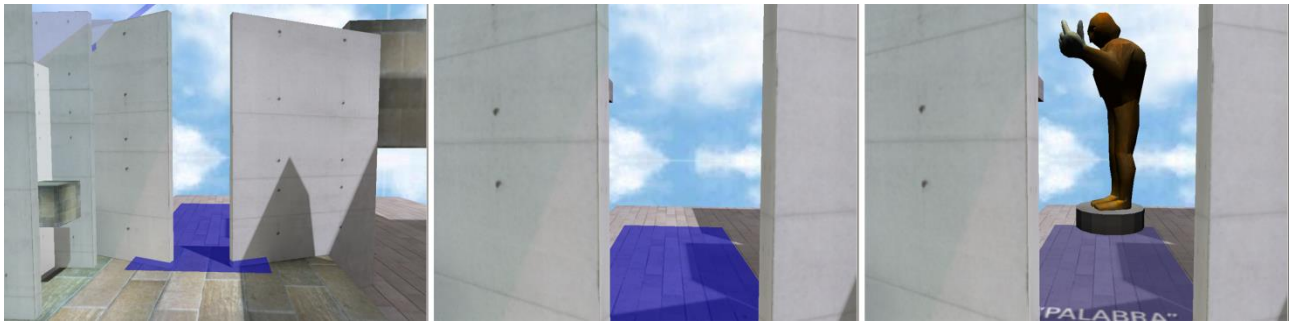

Figure 6. User view as he or she approaches to a balcony with a blue area that activates *the art of sculpture.*

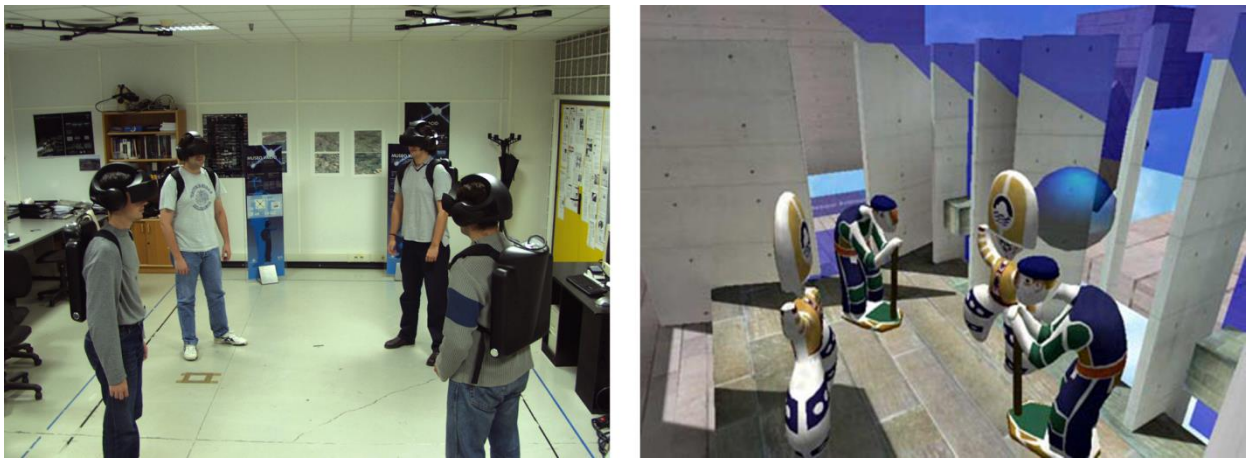

Figure 7. - Several users in the lab testing the Empty Museum multiuser feature. General view and user view.

Figure 8. The Galician Sea: user view and the user feeling after kneeling. User view of The Storm

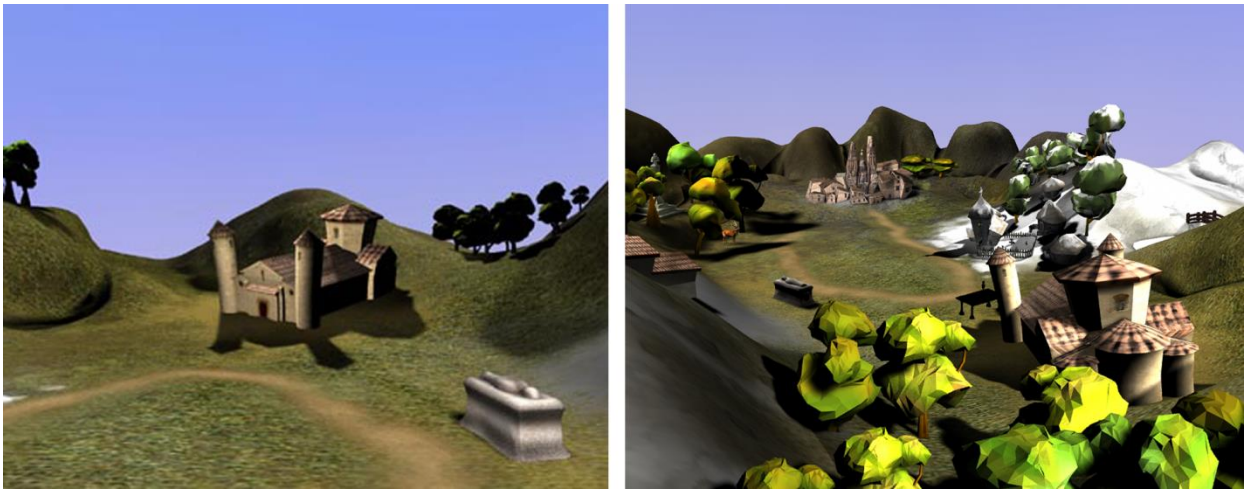

Figure 9. General view and user view of *The legends of The Way*

Figure 10. User views of the Bronze Age settlement