2013 International Conference on Virtual and Augmented Reality in Education

Educational Tourism Through a Virtual Reality Platform

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Abstract

This article presents a Virtual Reality Serious Game that allows the user to increase the knowledge about the city of Valladolid in Spain. With this goal, the Main Square and some of the historic buildings in the downtown have been virtually recreated. We have taken advantage of the characteristic tiled floor of the town hall square to represent a game board. Different tiled floors are squares which hide questions behind. The user plays using a Natural User Interface based on Microsoft® Kinect.

Keywords: Serious game; Virtual Reality, Educational Tourism

1. Introduction

Educational tourism is one of the trends that have higher growth in recent years [1]. Tourists are beginning to give more importance to new ways of knowing different tourist destinations, so the possibilities of learning grow significantly. On certain occasions, the learning activities at the destination are performed as annexed to the travel aim, but other times, the purpose of the trip is the learning itself. The most common way to know any city is through brochures provided by the Office of Information and Tourism. In this way these offices can foster a more attractive way to learn about the different aspects of the city.

However, Augmented and Virtual Reality technologies can be used to improve the user experience a step further in this learning process [2]. The first one is used mainly in the travel, while with the second one is possible to recreate the tourist space elsewhere. Other novel technique for tourism is based on the utilization of

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Serious Games: learning tools that pursue educational objectives, allowing players to get a set of knowledge and skills predominantly practical. In serious games, the number of games for the tourism sector is still quite low.

This Serious Game offers a different, fun and entertaining way to learn or review different aspects of a city such as history, geography, sports or art and literature. For example, after the tours to students from different schools and colleges, to foreigners or people from the city itself, this game can be presented as a complement to them in that will test the new knowledge that they have received.

Section 2 of this article gives key information on the design and programming stages, its user interface and other key aspects of the Serious Game. Section 3 subsumes some tests that were conducted in a laboratory with different final user profiles. Conclusions and discussion of results are included in the last part of the article.

2. Serious Game proposed

2.1. Game description and stage game

The Serious Game developed is focused on the tourism sector, with the aim to promote the city of Valladolid. During the game, the player acquires new knowledge of the city by answering questions related to various subjects as history, geography, sports, art and literature. The game takes place in the Main Square of Valladolid, thus it was necessary to reconstrudt in 3D the real buildings that surround the square, including the city hall and the statue that dominates this historic area of Valladolid. For this purpose, the 3D modeling program Trimble SketchUp [3] was used. The buildings were placed according to their real location, using photographs and images obtained from Google Maps. The space in the middle of the Main Square, where the monument to Count Ansurez is located, houses the squares that are part of the game board. Fig. 2 shows the complete stage and the disposition of such squares.
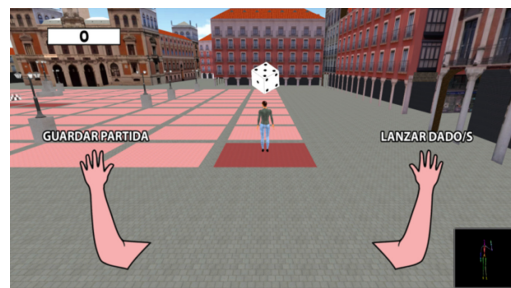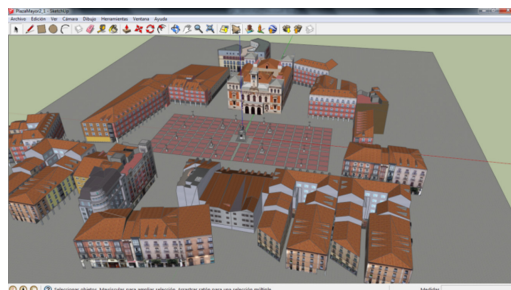

Fig. 1. Game initial vision

Fig. 2. Reproduction of the Main Square

2.2. User interaction

The game was programmed using the game engine Unity 3D [4]. The first step developing this game was the integration of the Kinect device in Unity 3D. This was done using Microsoft Kinect SDK [5] and a Unity 3D package known as Kinect Wrapper, which includes a number of scripts and prefabs that allow the recognition of the player within the scene. Using this package you can insert a skeleton in the stage that is able to play all the moves that the player makes in front of the Kinect device. During the game it is essential to detect the movements being made by the user: if a movement is allowed and expected, then an event in the game has to be triggered, while if the movement it is unrelated to character controls, nothing should happen in order not to spoil the game proper operation. All controls are done adding Box Colliders to different parts of the user skeleton (see Fig. 3), and using OnTriggerEnter(), OnTriggerStay() and OnTriggerExit() functions in different scripts, as well as different tags.
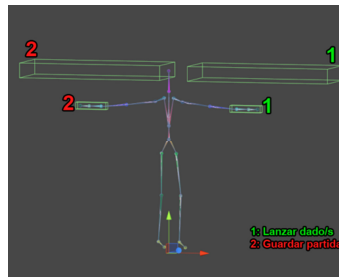

Fig. 3. Skeleton with colliders

The avatar mesh was created using the open source software Make Human [6]. This character model was then conveniently treated in Blender 3D modeling program. The work in Blender included creating an animation sequence representing a walk cycle (see Fig. 4)
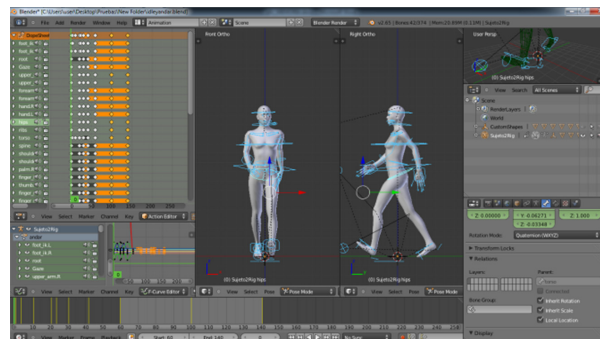

Fig. 4. Final state of the animated character in Blender

Once the character has both animations they are exported in extension .FBX for subsequent insertion into Unity 3D, which will be textured and with a new script, it will be indicated which of the two animations to play and when to do it.

2.3. Flexibility and XML question editing

A key design aspect of the Serious Game was that it should be easily configured or even modified using XML files. These XML files can be used to define basic variables of the game (i.e. the time available to answer

a question), but also the library of questions about the city, including the associated images and text. A questions file is created the first time you run the game with 100 pre-determined questions. Then, this XML can be edited, allowing the user to add, delete or edit questions in a simple way. A script is in charged of reading and writing the contents of the XML question file into a dynamic list of objects of class Question, which contains all the data that consist of each game question (see Fig. 5). This is a non-dimensional array, so there is no limitation in the number of questions that can be added. The memory for them is dynamically allocated during program execution.

Questions are showed randomly and they are not repeated while in the same game. To this end, an array of misplaced integer numbers is generated. This array is used to deliver the questions in the squares of the game board. The text of the question and the options are copied from the corresponding structure of the current question to different Text Meshes, which are part of the question card is presented to the user.

```
class Pregunta
{
    var elemento : int; //Number of question
    var cuestion : String; //Statement of the question
    var tipo : int; //History, art...
    var opcionA : String; //Content of option A, B and C
    var opcionB : String;
    var opcionC : String;
    var opcionCorrecta : String; //Contains which option is correct
    var imagen : boolean; //Indicates if it is a question with image or not
    var rutaImagen : String; //Relative path of the image (if it has)
}
```

Fig. 5. Question Structure

2.4. User interaction and avatar path

During answering time of a question, the game avatar continues reproducing the movement of the user and answer selection is done by raycasting. A script sends a 3D ray from the left or right hand, which can collide with any of the three answers. In each collision the tag of the question object is read. The gestures needed to play the game are:

- Roll the dice by lifting the right arm when asked to.
- Save the game by lifting the left arm when asked to.
- Choose the desired answer with the right or the left hand and keep on that position for 3 seconds to select.

Another very important aspect in the creation of the game is the system that manages the progress of the avatar on the board. To do this, each square that form the board is added to an invisible cube, each cube has an assigned Box collider. Also, for each one (except for those who are placed on squares that are intersections) was added a script that will allow detect events as if the player has already arrived or not the square indicated by the dice roll, if the player has reached the last square of the game or if it is the first run or not, after loading a game. The cubes belonging to squares that correspond to the intersections of the board are attached to another script, which in addition to the actions listed in the previous script, indicates the number of turns the player has to calculate the direction to take the character. At the same time, these special squares take another cube, also invisible with a new Box Collider. When the character contacts with this cube, it starts to turn around itself to complete a rotation of 90 degrees, which lets it towards the next intersection. In Fig. 6 the operation of the squares mentioned above is explained through an example. The player is in square 3, and after the dice roll it

must reach the green square. When the player starts moving, the array containing all the intersection squares is pointing to the first element, which is the purple square. Therefore, the character will walk in a straight line towards the center of this square. Once you get to it, the character begins to make the 90 degree turn, after which it verifies that the character has not reached its destination (green square). That is when you increase the array index containing all intersections squares, pointing to the second element, which is the blue square. Now the player aims this square, and move straight towards it. But at the moment when the cube touches the green square using your script, it is indicated that it's the target cell, therefore it goes out of the loop and this character movement stops.
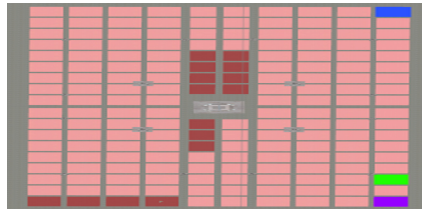

Fig. 6. Normal, turning and intersection squares

2.5. User feedback

In a serious game the player neither loses nor risks anything, because this is a simulated situation. For this reason he or she feels more relaxed to react to situations or exercises that take a risk of any kind: you can be wrong without suffering any consequences. In fact, one of the fundamental principles of these games keeps that for learning it is necessary to make mistakes.

Because of this, it is intended that the players, through a trial and error method [8], obtain new knowledge about the city of Valladolid: If you know the answer you will guess correctly; but if you don't, the fault will be indicated and the correct answer will be indicated, allowing the player to include this information in his knowledge.

3. Testing

To verify the correct operation of the Serious Game, various tests have been carried out in a laboratory of the School of Telecommunications Engineering. The variables that were changed from one test to another included:

- The player (height, age, virtual reality or game devices familiarity)
- The computer capabilities (integrated vs. dedicated graphics card)
- The output display device (3D TV vs. 3D projector)

A group of 10 people was included in the tests. Age was considered an important factor because older people are probably not so used to videogames and not familiar at all with augmented reality technology. The height is taken into account to check the correct operation of motion capture device. It is important to confirm that the real size of the person skeleton is scaled properly. Table 1 shows age and height of the participants.

Table 1. Personal information of the players

	Age	Height
Individual 1	23	1,75
Individual 2	24	1,82
Individual 3	24	1,66
Individual 4	25	1,80
Individual 5	27	1,90
Individual 6	32	1,78
Individual 7	37	1,73
Individual 8	51	1,86
Individual 9	56	1,71
Individual 10	58	1,75

Likewise, the application was run on 2 computers, which had one major difference: the graphics card. In the first computer, the graphics card was integrated in the mainboard. In the second computer there was a dedicated graphics card prepared for 3D rendering. Also, these computers were connected to two different output devices: a 3D TV and a 3D projector. Of course, for 3D visualization only the computer with the dedicated graphics card could be used. In all combinations of these variables the results were optimal and the users were very happy with the playability of the game. Of course, the players pointed out that the best immersion feeling was achieved with the 3D projection.

Additionally, during these tests a series of measurements on the duration of a full game, the number of questions asked and the number of questions the player matched and failed, were carried out. The game was played with a database comprised of 100 questions related to:

- Art and Literature.
- Sports.
- Geography.
- History.
- Look at the picture.

The degree of difficulty varied among the questions, including relatively simple questions, and others which require to have some prior knowledge about the city. Table 2 shows the obtained results. Additionally, everytime a question was failed the correct answer was showed to the user. This configuration helps the player to learn from his or her mistakes by a trial and error method. Following a timeout after the end of the game, the failed questions were shown again to the player to check if he had been able to memorize the correct answers. The results were quite satisfactory, being these questions correct in a percentage that ranged from 90-100% in all individuals.

Table 2. Results

	Time (mm:ss)	Number of questions	Corrects	Mistakes	Percentage
Individual 1	21:06	24	10	14	41,7%
Individual 2	23:34	27	14	13	51,8%
Individual 3	19:16	21	9	12	42,8%
Individual 4	25:49	25	16	9	64%
Individual 5	21:41	19	7	12	36,8%
Individual 6	22:14	21	14	7	66,7%
Individual 7	23:10	23	11	12	47,8%
Individual 8	24:53	25	8	17	32%
Individual 9	22:17	23	16	7	69,6%
Individual 10	25:13	27	15	12	55,5%

4. Conclusions

The developed Serious Game allows enjoying an immersive experience in the virtual 3D Main Square of Valladolid, where the user can learn about different data and aspects of the city. It is important to point out that the control of the game and the interaction with the virtual elements is done in a natural and non-intrusive way, meaning that it is not necessary to use any other marker or additional element of motion capture device. For this reason a great immersion is achieved, which increases even more if the game is displayed with a projector that allows 3D viewing. In this case, projecting the scene onto a wall, and enabling 3D vision, the feeling of realism was very high, giving the player the feeling of being in the Main Square at that time.

The developed system can be used as a new service to be offered by the Office of Information and Tourism of the city. It is a highly intuitive tool and it is easy to use for people of any age, no matter whether they are used or not to these new technologies. Furthermore, since the system does not require high cost hardware, it can be installed in private homes, allowing all kind of people to play and learn from their own homes without making any trips or travelling to the particular site. Because this is a Serious Game based on the method of trial and error, the player will not risk anything and can answer questions freely and without pressure. The game can be configured so that when the user fails the correct answer is highlighted, so he or she can acquire new knowledge about the city.

Also, the Serious Game is fully editable by simply modifying .XML files. It is possible to configure the content and type of questions depending on the final users profile. For example, it can be configured for children who have just completed a tour in which they have acquired new basic data of the city that they were unaware. In this case it is possible to configure a simple initial level and focus on global issues through a proper XML file. Then, the system could be instantly adapted for a group of adults who already have more information on the city. For this audience it is possible to change the level of the questions to make them more complex and focus on specific facts by simply changing the XML question files.

Acknowledgements

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