ArtScape: Gamified Virtual Reality Art Exploration

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Abstract

This paper presents multiple Virtual Reality 3D interaction, manipulation, and simulation techniques in the context of the 2022 3DUI contest of the IEEE VR conference. The proposed work provides the integration of 3DUI techniques and aims to familiarize and inform potential users about various artworks and artists. All techniques are implemented into the context of a virtual reality escape-room or treasure-hunt game, where the information provided for the paintings is necessary to solve the puzzles and as a result, contributes to an immersive experience where 2D paintings break into the 3D world creating a living artwork.

Index Terms: Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Virtual reality—3D Graphics;

1 Introduction

The importance of studying art is a well-defined notion, as the mere act can encourage self-expression, creativity and improve mental well-being by developing critical thinking and the ability to interpret the world around us. Particularly, regarding paintings, people can increase their cultural appreciation as they study the art style, the artist themself, and the message they were trying to communicate. Studying paintings from different periods can also enhance learning history for visual learners, as many artworks depict specific events and important people which helps absorb information better.
The rise of digitized mediums, such as computers and, for the last decade, Virtual/Augmented Reality Head Mounted Displays (HMD) which entertain and even convey complex messages in a more direct and immersive way can help educate people about classical paintings and maybe, even further enhance their impact on the modern world. These state-of-the-art technologies can pose as a medium to create interesting experiences which will introduce different ways of interacting with important artworks and, thus discovering their intrinsic value.
Our proposed 3D user interface design aims to deliver an immersive experience to the end-users, where they will learn interesting details about important artworks and grasp the messages that they tried to communicate through a virtual reality serious game. The aforementioned interactive user interface presents a gamified scenario, where the acquired information will guide the player to escape the room by finding the hidden key. Section 2 highlights the interaction techniques used, following adequate literature. Section 3 outlines the core concepts and gamification elements of our serious-game design. Section 4 discusses the challenges faced and possible extension of the present work.

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2 Design

For the design and implementation, we took into consideration portability for the contest, hardware, and spatial limitations, user-friendly design, interesting game play, and easy-to-learn game mechanics and interactions that the players will get quickly familiar with, to come up with a plausible solution.

One of the techniques that were used to interact with the objects in an immersive and innovative way was the **World in Miniature** technique [1]. During this, the player can interact with objects (translation, rotation) in the VR environment by manipulating their respective miniatures in a platform being presented in front of them (Figure 1). To do that, we proceeded on using basic linear algebra for each object in the scene by considering the respective reference points (real world and platform). From the real-world to miniature scale, we initially, computed the required scaling vector, by comparing the floor's scale in the VR environment and the mini-platform's presented in front of the player. Next, we compute every vector from the floor's position to each object's position. Afterwards, We multiply each vector with the scaling vector and add the output to the vector starting from world space's origin to the position of the platform, for each miniature.Finally, we apply the same rotation to the miniature object. The same steps take place in the reverse process

By selecting this technique, the player is able to emulate the barricade construction by the revolutionaries to fight the royal army in Eugene Delacroix 's "Liberty Leading the People" painting. In our implementation, the WiM technique was further enhanced by placing in the miniature platform, objects that the player can interact with and others that cannot (highlighting their outline as a visual cue) along with a **Voodoo doll** for each soldier [2].

Figure 1: The World in Miniature technique applied in game. The player can interfere with the various avatars' actions.

For some challenges, the player is required to use both their hands so we implemented certain bimanual techniques. There are four distinct classes of bimanual interactions: symmetric-synchronous, symmetric-asynchronous, asymmetric-synchronous, and asymmetric-asynchronous [3]. Specifically, we used a symmetric-asynchronous metaphor as the player must complete a two-handed task in which each hand is assigned an identical role but it is not necessary for the hands to do simultaneously the task to achieve the desired result. This is achieved by detecting when each of the hands completes the desired action without limiting the other

hand's actions. This kind of interaction gives the player the ability to interact with an object from any given distance without the need of synchronizing both hands as it might be difficult for some players [4]. Bimanual interactions in VR can resemble real-world interactions, thus increasing realism and improving immersion. By using long-distance interactions we eliminate the real-world limitations, thus providing an enriched virtual experience.

Another way to interact with certain objects in the virtual environment was created by combining the **GoGo** and **Virtual Hand** paradigm [5]. This new interaction technique extends the capabilities of the aforementioned implementations and is used mainly for long-distance interactions. When the user points at a specific object, their hand is transferred to the location of the object, where the user can grab it and move it. To achieve this, we use the method of raycasting. When we find a raycast hit from the virtual hand to an interactable object we translate the hand to the intersection point of the ray and the object. Furthermore, we make a rotation to the hand, so it always points at the interactable object, as the user moves their hand around, for more realistic behavior. To further extend this interaction, we replicated a resize technique used in the famous game Superliminal [6]. As the user moves around an object, its size changes in real-time so that it always matches their perspective. By using this forced perspective technique, the user needs to scale down an enormous object. Then, they can match the smaller object with the corresponding painting to unlock a hidden object and progress.

Some other challenges require the player to interact with a painting, by inserting 3D objects into them or extracting 2D elements out of them and conveying them as 3D objects in the virtual world. All they have to do is place their virtual hand inside the painting. By entering the painting's world, the player's hand will be confined, and they will see its visualization in two dimensions. Through this, they can interact with some specific painting's entities and either grab them and bring them into life or grab them and position them on a highlighted spot. For the computation of the 2D hand's position, we applied the xy (red and green) axes of the VR hand's position onto the 2D hand (Figure 2). Additionally, for the cases that the 2D hand goes out of the painting's bounds, we used transparent layers on the edges of each painting, to hide the hand when necessary.

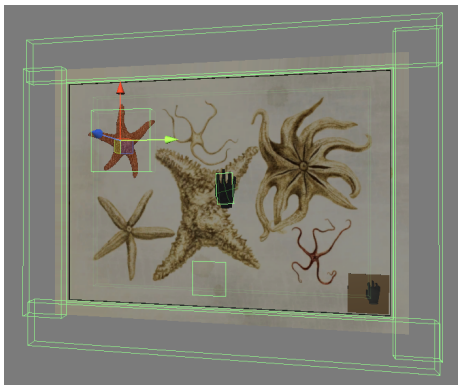

Figure 2: The 2D-3D system.

3 ArtScape Game

The game was designed in Unity3D engine utilizing the Unity XR plug-in framework to support cross-platform experiences. Through the development process, the Oculus Rift and Oculus Quest 1 head-mount displays were used. Rokoko's smart-suit motion gear was also used to achieve human-like animations.

First, the player finds themself in a small room which is the tutorial room. Then, with the help of a robot companion, they will be introduced to the various possible interactions and game mechanics: grabbing, long-distance interactions, inserting and extracting objects from paintings, rescaling, and the World in Miniature technique with which they can position the door to progress to the main room.

In the main room (Figure 3), they can see various paintings and objects. As the game progresses the robot assistant gives hints and information about the paintings. The player must notice any differences between the original paintings and the ones in the room and think outside of the box as to what can they must do to get the clues from all the paintings. Leonardo da Vinci's "The Last Supper" has a hidden melody and Eugène Delacroix's "Liberty Leading the People" will set up a real-life battle in the middle of the room where the player must help the revolutionaries reach to the other side. Then the player learns about the surrealist René Magritte where nothing is as it seems. In "The Art of Living" a small balloon-like head needs to blow, in "Man in a Bowler Hat" the pigeon is hiding a clue, and finally the famous "Son of Man" but with the apple missing.

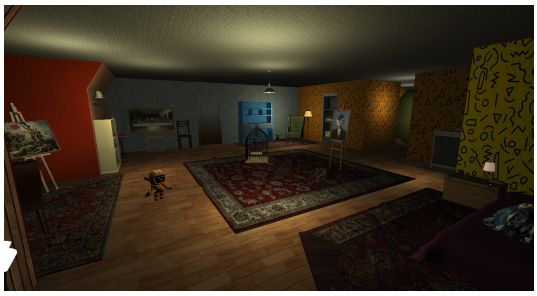

Figure 3: The main room.

4 Conclusion

The present work discusses the design and development of an educational escape-room game with various challenges, that is focusing on the education of the users about artists and their art and is also allowing them to explore the illusion of a 2D-3D world. Apart from the gamification elements, innovative 3DUI techniques were implemented, based on the literature, to offer the users a more immersive experience with significantly increased accessibility.

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