Escape-INF-VR: An Accessible VR Escape Game Proposal for Blind Individuals

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Abstract. Head-mounted displays can exclude blind people because they rely heavily on visual cues. However, it is possible to include disabled users if some accessibility principles are applied. Then, this work proposes an accessible VR escape room called Escape-INF-VR to demonstrate the application of accessibility guidelines. Additionally, the document outlines related research on escape, accessibility, and virtual reality. Finally, it presents the game's development process up to its current version.

Keywords: Escape Room · Virtual Reality · Accessibility · Blindness.

1 Introduction

Head-mounted display applications can be heavily visual, and this situation can exclude people with disabilities, especially blind people. Then, this work proposes the development of an accessible VR application by implementing specific accessibility guidelines. The application is a VR escape game for blind and sighted users, and it is called Escape-INF-VR. This demo aims to show some examples of appropriate features for blind users and describes a part of the development process towards the current version of this game. It is also important to note that this is an ongoing project, so there is still some relevant work to be done.

2 Related Work

An example of a game related to an escape room, accessibility, and virtual reality is "Access to Escape" [1]. This VR escape room was developed with intentionally inaccessible features to serve as a learning environment for sighted developers. After completing the game, they understood the key principles for making games accessible. These principles are often referred to as accessibility guidelines. However, it is essential to note that this game was not designed for blind people.

Another example of a VR game is "Loud and Clear" [2], where sighted individuals experienced the challenges of being blind in an escape room environment. This game focused on designing the audio to provide dynamic and powerful audio feedback. However, this game did not have a blind person evaluation either.

Lastly, the "Legend of Iris" is a VR game which was designed for blind people [3]. However, this game was not part of the escape-the-room genre. Instead, it was an adventure game in which the player had to complete some navigational tasks using only his hearing.

In conclusion, there seems to be little research on making VR escape rooms accessible to blind people. This may be because escape rooms rely heavily on visual cues to solve puzzles and find objects. As a result, it may be a complex genre to turn accessible.

3 The Escape-INF-VR Game

The Escape-INF-VR game[3] aims to provide an accessible experience of playing a virtual reality escape room for blind people. Nevertheless, this game also has visual elements that sighted people can play. Then, this game intends to follow the concept of a game for all[4].

This game was inspired by the infrastructure of the Institute of Informatics at Federal University of Goiás (Fig 1). Consequently, the virtual environment aims to mimic real spaces by using a 1:1 scale. It is a single-player escape room game where the player is trapped inside the Institute of Informatics and must escape the infrastructure by exploring and interacting with various elements.

In its current state, Escape-INF-VR was designed by selecting specific accessibility guidelines from the literature and adapting them to the needs of the Escape Room VR genre [5,6,4]. Several implemented guidelines include informing about "object presence", using "meaningful audio for game feedback", providing "guidance by sound cues", providing a "tutorial phase", and using "cooperative design" [10]. However, additional guidelines are expected to be incorporated in future versions of Escape-INF-VR.

It is important to note that this demonstration was developed using the Meta Quest 2[5] and the Unity game engine[6], specifically, the Unity editor version 2021.3.31f1. Furthermore, the virtual environment was generated using the OpenXR[7] plugin for Extended Reality (XR) applications and the XR Interaction Toolkit[8] as the VR framework. This framework provides a set of components and dependencies that can be used for development in Unity, such as a "XR Origin",

[3] The last demo version is available at https://github.com/Angelinis/VR_Escape_room_2021

[4] The idea of a game for all is derived from one game that is designed for "people with a wide range of diverse requirements and/or disabilities" [9]

[5] https://www.meta.com/quest/products/quest-2/

[6] https://unity.com/

[7] https://www.khronos.org/OpenXR/

[8] https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@2.0/

Fig. 1. A gameplay screen from Escape-INF-VR.

a "Camera" with an "Audio Listener", "XR Controllers", a "Locomotion System", a "Dynamic Move Provider", a "Snap Turn Provider", and more.

This demonstration works with Unity's built-in panning of audio sources, which takes an "audio source" and calculates the distance and angle from the "audio listener" to provide directional audio cues [8]. In addition, it also considers specific 3D sound settings of the "audio source" to render the audio cues only at a certain distance from the objects. This is achieved through the "Volume Rolloff" property by selecting "Linear Rolloff". However, using an audio spatialization plugin instead of Unity's built-in spatializer is still recommended to get a more realistic and immersive experience when using spatial audio or 3D audio [7,3].

On the other hand, this demonstration also adapted some components (scripts) from the "XR Origin" to provide better accessibility. Specifically, the "Dynamic Move Provider" and the "Snap Turn Provider Base" scripts were adapted to add footstep cues when moving around the environment and to provide orientation feedback when performing a snap turn (rotating a certain number of degrees). Another significant change was to turn off the ray interactor on an XR controller. Instead, the ray interactor is restricted to one XR controller and has a range of 0.1 meters. This change was made to avoid accuracy issues at longer distances.

Besides, this demonstration employs the "XR Simple Interactable" component to initiate audio descriptions of objects when the XR controller enters a box collider. These changes were inspired by the accessibility guidelines above and by interaction and discussion with a blind user.

Finally, all these changes contribute to providing descriptive feedback to users when interacting with objects via controllers, walking, and rotating. Furthermore, the game's spatial audio was also designed to assist users in spatial orientation by using some sound sources as landmarks.

4 Conclusion and Future Work

Escape-INF-VR is an ongoing project that aims to provide an example of how to develop accessible VR escape rooms. Furthermore, the objective is to demonstrate that head-mounted display devices can be accessible to blind individuals when they incorporate the requisite features. This is accomplished by applying game accessibility guidelines to achieve a certain level of accessibility.

For future work, the Escape-INF-VR game will be completed by applying more accessibility guidelines. Then, to assess the level of accessibility within the game, it will be tested and evaluated by blind people or HCI experts.

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Technical Requirements

Online video link: https://tinyurl.com/Escape-VR[9]

Technical requirements:

- Extension cord for charging at least three devices: an HMD, a laptop, and possibly a monitor or TV.
- Internet connection for broadcasting HMD view.

Physical space requirements:

- A monitor or TV is desirable to display the broadcasting of the environment.
- An area with a minimum dimension of 1.5 meters by 1.5 meters.
- A table to accommodate a laptop and possibly a monitor or TV.

[9] The video is accompanied by Portuguese audio and English subtitles.