2222: An accessible game to promote environment protection awareness

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Abstract. *Accessibility in games remain largely inaccessible to visually and hearing impaired people. In this work, we introduce 2222, an accessible maze game that promotes a real inclusion, through resources such as auditory orientation and equity in the game mechanics, reducing the disparity in the gameplay experience between players. Furthermore, we also brought environmental awareness within our narrative to inspire players to transform our reality.*
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1. Introduction

Over the past decades, video games have become a mainstream form of entertainment, being a prevalent form of leisure in the twenty-first century [Aguado-Delgado et al. 2020]. Moreover, they are also increasingly used for other purposes than entertainment. Educators are discovering the cognitive potential of games in the classroom, and they have also been used for health, different areas of business and politics, to shine a light on different cultures, subjects, as well as to promote personal development and mental and physical rehabilitation [Kato 2010].

However, despite the increased level of interest in games, accessibility barriers within these products have made them almost unusable for people with disabilities (PWD), leading not only to their exclusion from this social phenomenon, but also to frustration when they are not able to experience the entertainment that those activities should be able to offer. Therefore, access to gaming is a quality of life issue, and it is crucial to promote a more inclusive society and recognize the universal right of access to culture and leisure [Hauge et al. 2018].

Accessibility in games can be defined as the ability to play and experience a game in full even when players are under restricting conditions, such as visual, auditory, mobility, or cognitive impairments [Aguado-Delgado et al. 2020]. A game that provides equal opportunities to its users for playing and experiencing it completely, independently of the player's impairments, can be established as an accessible one. A work that inspired us is Pyvox 2 [Gaudy et al. 2009], an audio game playable without visual nor verbal instructions, based on a approach of finding out how interactivity works, doing so without the need of textual instructions, being accessible to visually impaired people and also to those who speaks different languages without the need of translation.

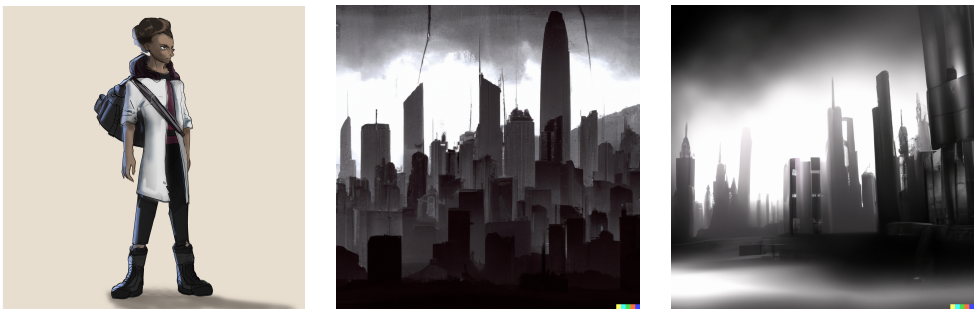
Therefore, we propose 2222, a 2D maze game that allows the player to guide themself not only using the sight, but also through the sounds emitted by the walls of the labyrinth. Moreover, all of the game main mechanics such as tutorials on how to play the game, limited field of view to provide the same level of difficulty to all players and basic accessibility resources[1], were thought with the endeavor to achieve an enjoyable gaming experience despite of the disparities among the players.

Another aspect that we are going to address is the environmental awareness development, aiming at environmental education and inferring an action and reaction set of social and individual attitudes towards the environment. Raised by a narrative built upon a dystopian scenario caused by irresponsible exploration of natural resources [Krenak 2019], we aim to bring acknowledgement to the people about the consequences of reckless destruction of our environment.

2. Proposed Game

2.1. Game Lore

The game narrative happens in the year of 2222, hence the game's name, and it is built upon a dystopian scenario (Figures 1b and 1c) caused by a big company, Elav Corporation, massively exploring the world's natural resources, specially a metal named cinzal, which enabled the development of better technologies. Such metal, when extracted and treated, not only produces a huge amount of trash and pollutants, but also releases a gray and dense fog, that permanently stains everything it touches - even the skins of people and animals - as a consequence, it became present everywhere. Owing to this, the colors of the world started to disappear. To study this aesthetic, we generated the environment concept arts using the artificial intelligence system Dall-E, that can create realistic images and art from a description in natural language [Ramesh et al. 2022].



(a) (b) (c)

Figure 1. (a) Protagonist Concept Art, (b)(c) Environment aesthetic concept arts generated by the Artificial Intelligence Dall-E.

The protagonist, Ada (Figure 1a), is the new leader researcher of the department of materials studies for industrial nanotechnologies development of Elav, where she was designated to research about the unexplored properties of cinzal. During her journey she got access to the only area in the world from which the metal was extracted, but as she would get to know about this place, she became more and more caught in a tangle of mysteries and inconclusive answers about it, leading even to an unexpected connection

[1]https://gameaccessibilityguidelines.com/basic/

between the exploration and her grandfather, that had gone missing inexplicably a couple of years ago. All those unanswered questions led her to explore an arcane and unregistered maze that she found during the research.

2.2. Game Mechanics and Dynamics

Our game is developed using the game engine Unity[2]. It is based on a 2D maze mechanic, so the general challenge that the user is going to face is to guide a character through a set of mazes, which essentially consists of not knowing a direct path to get from one or more points to other points in the map. Tracks are not limited in spatial sense but also strategy of choices.

Generating the Maze: We developed a maze generator algorithm to randomly generate mazes that are not only customizable in size and sprite and builds a different map each time the game is played, but also provides the best performance possible by creating only 3 gameobjects, regardless of the grid size. Moreover, it generates the exit and start point at diagonally opposite sides, reducing the odds of the player getting an extremely easy solution. With the aim of helping the community of developers, our implementation will be available as open-source code. The algorithm is a randomized version of the depth-first search algorithm [Kozlova et al. 2015], also known as flood fill algorithm [Gonzalez and Woods 2007], where the maze is represented by a two-dimensional array - corresponding to a grid of cells, each cell starting with four walls. We chose this strategy due to the fact that maze generated by a depth-first search has a low branching factor and contains many long corridors, because the algorithm explores as far as possible along each branch before backtracking [Cormen et al. 2009], thus, being the ideal result to a maze game.

Grid Movements: In order to create a more intuitive movement system and less error prone for the sound orientation, the player will only be able to move in blocks, in other words, it can move from one cell to another on the grid, exclusively displacing itself entirely from the current position to one of the adjacent neighbours.

Field of View: We have also added a feature aiming equity, generating a field of view, limiting the area of the maze that the player can see, using the narrative that it was caused by the smog due to pollution. The purpose here was to make sure that people that are not visually impaired wouldn't have the advantage of being able to see a bigger area of the maze upon those who could only guide themselves through the sounds emitted by the nearest walls.

Game Modes: The first game mode is an arcade one, an increasingly difficult fixed length method, where every time a player solves a maze, another level, with the difficulty of the maze increased by one in the two-dimensional array, will be available. The story mode, on the other hand, is going to provide to the player the idea of finishing the game once it completes all previously established levels, getting into an end of the narrative.

[2]https://unity.com/

Tutorials and Progressive Difficulty: For an enjoyable game experience, it's important to offer the player a difficulty neither too hard nor too easy. In order to make that possible, the player can complete some tutorials that offer levels with progressive difficulty [Gaudy et al. 2009] that will introduce him to the core mechanics of 2222.

2.3. Accessibility Guidelines

A notable evolution in current digital games, compared to slightly older games, is that some accessibility features, previously considered not so relevant or impossible are now widely used by the industry [Andrade et al. 2021]. Features such as well-organized and intuitive interface, color contrast in the User Interface (UI), simple controls and remapping possibilities for keys, color blindness filters with intensity adjustment and even the possibility of selecting different languages are some of the main basic elements so that the game is considered minimally accessible [Hauge et al. 2018].

Even though we have made significant advances, there is still a difficulty, or lack of interest, by a portion of game industry - especially in the mainstream industry - in creating products that are able to meet the demand of players in relation to game playing in an egalitarian way. A common problem is when game designers think of accessibility as adaptations in games and mechanics already developed, as if it's just a feature to be done after the game is ready [Hauge et al. 2018, Andrade et al. 2021]. To create increasingly accessible games, the process must be reversed. We should first think about accessibility issues that players have, and then think about mechanics that solve or mitigate those obstacles. Thus, we were able to innovate in the creation of mechanics to efficiently serve this audience, reducing the disparity in the gameplay experience between players and reaching at the mechanics that guide *2222*.

2.3.1. Accessibility for visually impaired people in maze games

One of the biggest obstacles for the visually impaired people while playing digital games is both spatial and temporal navigation [van Tol and Huiberts 2006]. To solve the first one, when the game begins or whenever a new level is created or there is a relevant change in the scenario, it's going to be available a resource of audio descriptions - additional voice-over that describes what is happening in the scene visually - both in Portuguese and in English, according to the game configuration set by the player. Furthermore, to enable a visually impaired player to consciously move around the maze, overcoming the barrier of spatial navigation and having an egalitarian experience of limited field of view mechanic, we have implemented a sound localization system.

When the player collides with a wall it plays a musical note - specifically chosen upon an empirical study of what would be pleasant to the listener, aiming to avoid getting the player annoyed by the sounds -, corresponding to one of the 4 collision possibilities - as the movement is grid-based and the maze is always square, we have the following possibilities: right, left, down and up. When the player collides with more than one wall simultaneously, the notes are played sequentially so they can be heard separately. Thus, we create a sense of localization in the player, as they can know where to go based on the sounds that are not being played cooperatively with logical association. Likewise, there is also an audible warning at the beginning and end of the maze, so that the player can temporarily locate himself within the game.

3. Conclusion

It is crucial to promote the development of games built upon accessible mechanics that provide the same gaming experience for everybody, regardless of their limitations. Having this goal in mind ever since the beginning of the game design is the key to get to a final product that is truly inclusive. Therefore, we proposed to make a maze game that could give the same experience to all players, whether they had disabilities or not. That approach led us to resources such as audio localization, audio description and limited view of field to provide an equality of gaming experience.

Our next steps involve testing the game with visually impaired people, considering that even though we have tested our game blindfolded, it is necessary to gather the requirements to improve PWD experience while playing the game. Besides, we will finish the story game mode, the implementation of some features, make final adjustments and to turn the game into multi-platform, so far it is only available as a desktop application. Finally, we intend to make the maze creation available as a C# open-source code.

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