Inclusive games: Accessible game design for the visually impaired

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Abstract. Accessible game design is a key effort aimed at creating games that transcend physical and cognitive limitations. By carefully integrating a series of functions and strategies, designers empower players with various abilities to participate in the interactive field. Resolve visual barriers through high contrast visual effects, scalable fonts, and alternative color dependent information. Auditory elements are accompanied by visual cues or subtitles to ensure that the game narrative can be understood by auditory impairments. By utilizing customizable controls, motion sensitivity adjustments, and optional input methods, motion challenges are overcome. Recognize cognitive diversity by providing clear explanations, intuitive interfaces, and adjustable rhythms. This inclusive approach promotes innovation and encourages developers to explore new paths in game design, resonating with a wider range of users. As the gaming industry places increasing emphasis on usability, it emphasizes the industry's commitment to equal participation, while enhancing the creative process of each participant and enriching game gameplay.

Keywords: game design, game framework, 2D games, accessible game.

1. Introduction

The emergence of video games to add fun to the entertainment industry, attracting millions of people around the world, has come to be referred to by many as the 'ninth art'. However, this 'art' is something that people with visual impairments cannot enjoy in the game world, depriving them of this rich and interactive medium. When embracing the principles of inclusion and diversity, a new concept emerges: accessible game design (Accessible game design refers to the intentional and thoughtful development of video games that accommodate a wide range of players, including individuals with disabilities or impairments. This design approach aims to remove barriers that might prevent people with diverse abilities from fully engaging and enjoying the gaming experience.).

It is critical to recognize the enormous potential of accessible game design, where creators can do their best to bridge the gap and meet the needs of visually impaired players.

In this paper, the relationship among visual impairment and play, and discuss the input and output of play that can be felt by the visually impaired. Modify the games through user testing and feedback. Everyone will delve into the field of accessible game design, aiming to reveal the challenges faced by visually impaired players and innovative ways to overcome these barriers. By discussing the importance

of integrating universal design principles to not only enhance the gaming experience for the visually impaired, but also foster an inclusive environment for all players.

2. Designing inclusive 2D games

2.1. Overview of 2D game design principles

As the name suggests, a 2D game means that the game has only two axes, and all the objects are without volume or thickness [1]. One of the most classic 2D games is the level or level mode. As the name suggests, a 2D game means that the game has only two axes, and all the objects are without volume or thickness. One of the most classic 2D games is the level or level mode. The aim of this project is to make a 2D side-scrolling action game.

2.2. Key considerations for blind accessibility in 2D games

2.2.1. Auditory cues and feedback

Auditory feedback is the primary and most important way for blind players to get information. In the gamaker studio, it was very easy to create sound for the game: Just find the sound source of the protagonist and monster created on the Internet and the background of the game and insert it. In order to allow blind players to better determine the position of the enemy, adjustment pf the sound to the most appropriate position will be applied.

Audio Groups integration of various audio sounds. There are manage different types of sounds. For example, there are groups for music, background ambience, and various sound effects. So it is necessary to use several functions to play each sound [2]:

A**. audio_play_sound(sound)** for short sound effects;

B. **audio_play_music(sound)** for playing background music.;

C. **audio_play_sound_on(sound, x, y)** to play a sound at a specific location;

D. **audio_sound_gain(sound, volume)** [3] to adjust the volume of audio using;

E. **audio_master_gain(volume)** functions. This way, it's easy to control overall volume and individual sound volumes.

Here, to identify the direction and position of the sound source, the sound system can combine FUCTION C and D. In this way, the blind players can distinguish the proximity of the monsters without using eyes.

2.2.2. Game creation and optimization

Before writing the code to make the game, what is necessary it to create the game characters and the game background. The most common use of 2D horizontal board games is pixel art and it is also the least time-consuming. 'Piskel' can draw pixel pictures, and there are many existing pixel pictures and pixel backgrounds for us to use [4]. But the problem was that all the characters could move, and they had to move, so the game had to draw several running and attacking moves for each character [5]. And then put them together frame by frame [6].

As shown in Figure 1, all pixel characters will have action in the game, so when drawing pixel characters, you need to draw several different actions and connect them into a complete animation.

Figure 1. Every frame movement of the character.

As shown in Figure2, it is game character and monster. And Figure 3 shows the level background of the game. What need to know is when comparing Figure 3 and Figure 2, it would be impossible to put them on the same plane, so the layout of the background and character model will be set, the background should be put at the bottom, and then drag the character in and overlay it on the surface of the background image.

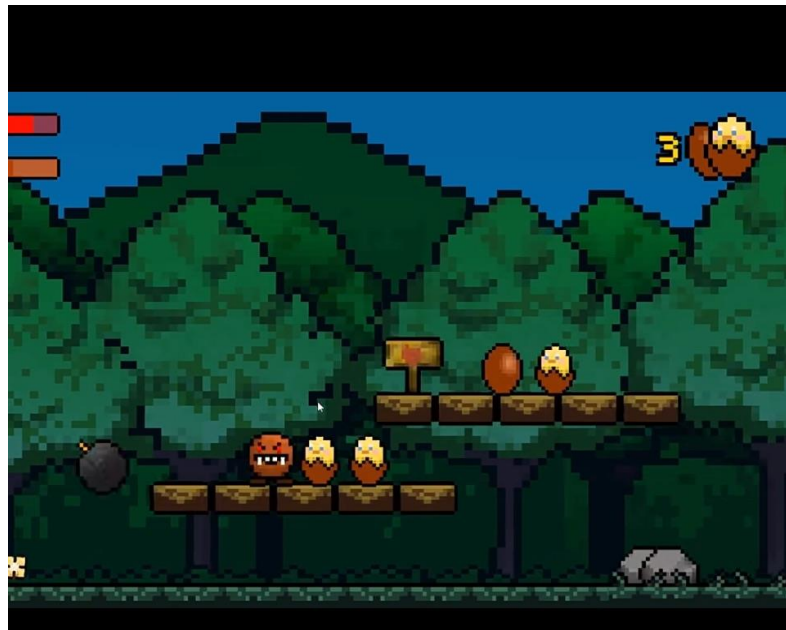**Figure 2.** Modelling and drawing of other characters.

Figure 3. Game background screenshot.

Figure 4 clearly describes the main overview of the entire game production, and all games can not be separated from these four major areas.

As shown in Figure 5, here it is important to note that both player victory and player death must be a complete loop for the whole game. If the player is killed by a monster, then the game level will not reach the next level, the player can choose to re-challenge the level until the completion, or choose to start from the first level [7].
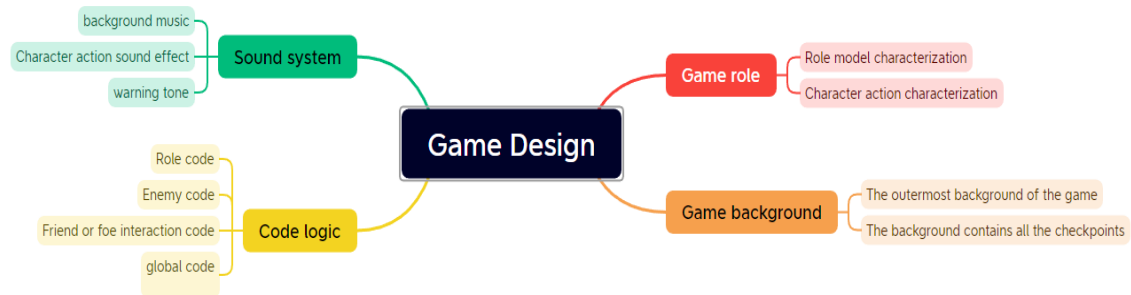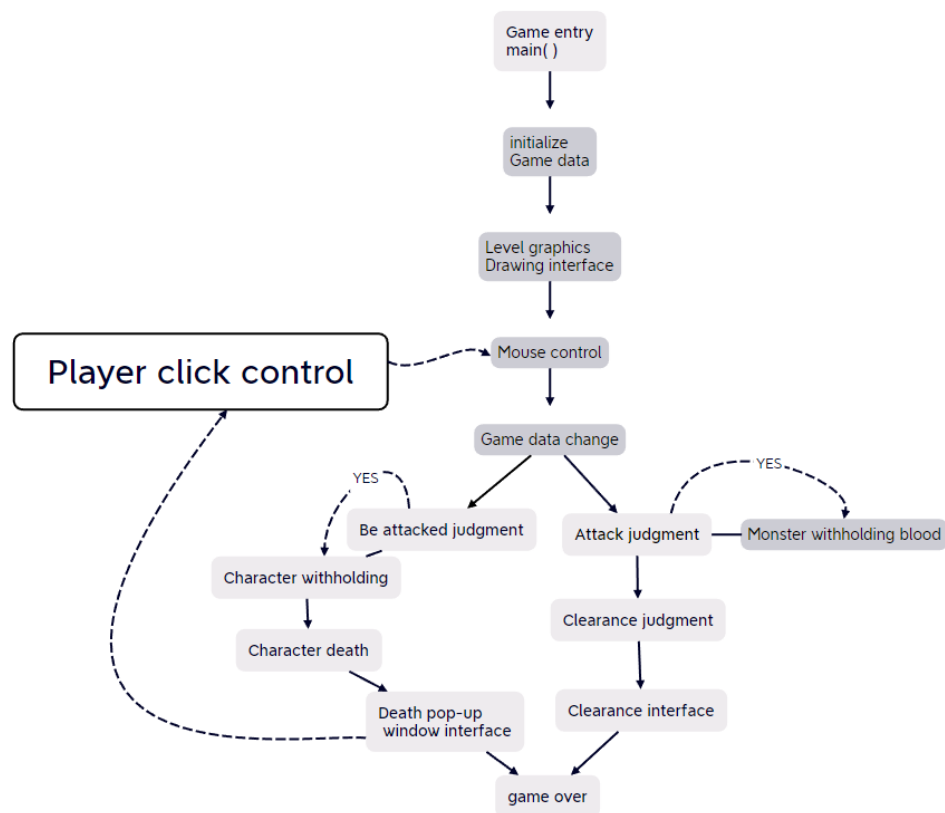
Figure 4. Game making mind map.

Figure 5. The whole process of game design.

2.2.3. Text-to-speech and voice navigation

Text to Speech (TTS) and voice navigation are technologies that provide users with voice information and guidance, and their existence can improve the accessibility of games and user gaming experience for blind players. Their working principle is shown below:

Text to speech conversion technology converts text into spoken language and expresses it through sound effects [8].

The whole procedure is shown below:

A. Input Text: User input text can be anything from webpage content to messages in an application;

B. Text Analysis: TTS software analyzes the input text to identify words, punctuation marks, and formatting;

C. Synthesis: The TTS engine processes text and generates a voice version. This includes selecting appropriate pronunciation, intonation, and rhythm based on language and context;

D. Play: Synthetic voice is played through speakers, headphones, or any audio output device. Users can hear the sound of reading the text aloud.

For voice systems, in addition to being used to communicate with in-game NPCS, usually using them to help blind players solve problems where they can't adjust the settings is good [8]. Such as volume, game buttons and other settings of adjustment. All the Settings will be read to the blind player through the voice system, and they only need to adjust the corresponding keyboard keys. For example, if he wants to turn down the volume, press the 'down' button [9].

2.3. Challenges and solutions
The following 2 points are the main contents of challenges and solutions:

A. Common challenges faced in designing for the blind;

B. Convey information through non-visual cues such as sound or tactile feedback.

2.3.1. Make sure the game mechanics are understandable without relying on visual effects
The game mechanics of a game like this are well understood, but although they are generally the same, there are many differences in details. The best way to show the difference is through announcements or game instructions. Since the blind can't see it by themselves, choosing voice is a clear and useful idea, which will give a brief introduction when entering the game interface. Of course, if they already know, they can skip it with the click of a mouse.

However, simple voice input can be boring and time-consuming, which is a big problem for our team. Not only accomplishment of the game, but a good backstory is the key to engaging players, especially the visually impaired. According to our team's many years of experience playing games and interviews with visually limited people, it can be found that when playing games similar to Battle, even normal people often can't see the specific location of the enemy, and at this time, players are listening to the voice position to determine the approximate location of the enemy. So, just add a 'footstep' hearing system to the game so that the visually impaired can determine the location of the enemy. The closer the enemy is to them, the greater the "footsteps" will be, and the "footsteps" will be smaller the further away. If the enemy is on the left, then only the left earphone track will have 'footsteps', if the enemy is on the right,' footsteps' will appear on the right earphone track. If the enemy is on the head, there will be 'footsteps' on both earphones.

2.3.2. How can they finish the game completion without outside help
Unlike other horizontal level games, for people with visual impairments [10]: a bunch of monsters appearing together is impossible to resist. So, it is necessary to lower the monsters' refresh rate, and of course do not let them spawn in the game interface at the same time.

More important is also the key to the success of the visually impaired players: how to determine the specific location of the monster.

Solutions can be divided into 2 parts:

Innovative solutions and best practices;

Balancing accessibility with game design aesthetics and mechanics.

This is a big challenge to adjust the difficulty of the game, follow the normal horizontal level, there will be a boss at the end of each level, but the boss for the visually impaired player is difficult. Initially, game teams increased the monster's attack power and attack frequency, but the test results were not good. Later, made the monster into a flying boss, and its health and attack power is the same as the elite monster [11]. However, this makes it difficult for the player to locate the enemy and even tortured to death by flying monsters. Finally, choosing enlarge the size of the boss (or increase the scope of the

monster can be attacked by the player, and then add a warning that the boss is about to attack for the visually impaired to avoid the attack and pull the monster).

3. User Testing and Feedback and future direction

Testing is divided into 2 parts:

A. Conducting effective user testing sessions;

Insights into Accessibility Needs: Blind gamers can provide firsthand insights into the challenges they face while playing. Their feedback can guide developers to create features like audio cues, text-to-speech, or tactile feedback, enhancing the overall accessibility of the game.

B. Incorporating feedback to improve accessibility.

Blind gamers can help identify bugs, glitches, or design flaws that might go unnoticed by sighted developers. Their involvement contributes to a more polished and refined final product.

Future direction is divided into 3 parts:

A. Emerging technologies and their potential impact on blind gaming;

B. Importance of involving blind gamers in the development process;

Innovative Design: Collaborating with blind gamers can lead to innovative gameplay mechanics that go beyond traditional visual elements. This can result in unique gaming experiences that appeal to a wider audience.

Representation and Inclusivity: By involving blind gamers, developers signal that they care about inclusivity and representation in the gaming industry. This can foster a more welcoming environment for gamers with disabilities and contribute to a positive image for the industry.

Advocacy and Awareness: Involving blind gamers can help raise awareness about the importance of accessibility in gaming. Their participation can encourage other developers to prioritize inclusivity in their projects [12].

C. Opportunities for further research and development.

Market Expansion: Creating games with accessibility features can attract a larger player base, including blind and visually impaired individuals [13]. This can lead to increased sales and greater success for game developers.

4. Conclusion

First, when designing a 2D game, everyone must understand the core logic of making a 2D game. Then, in the process of making games, everything is needed to consider all aspects of sensory feedback, especially for blind players to strengthen the transmission of auditory and speech systems.

In the process of making a game, the game production is needed to divide into four parts: the sound system, the game characters, the game background, and the code. After each is completed, the four plates are combined to check whether any errors are reported. Finally, blind players are invited to play and give us suggestions to modify the game.

Accessible games are created to ensure that people with disabilities can also enjoy and participate in the game world. By integrating features such as customizable controls, captions, visual cues, and optional communication methods, these games provide an inclusive experience for players of all abilities, empowering everyone to play such games. Its appearance has many advantages. Making games accessible not only promotes diversity and equality, but also allows more users to share in the fun and social nature of games, fostering a sense of belonging and connection in the gaming community. In addition, accessible game design encourages innovation and creativity within the industry, resulting in new game mechanics and experiences that benefit all players.

Improving accessibility in game development is critical to creating a more inclusive gaming experience. Developers can prioritize this by incorporating features like customizable controls, subtitles, color blind options, and other means of communication to make the game enjoyable for everyone. In addition, raising awareness of the game through forums, articles, and social media can help create a more accessible gaming environment.

Inclusive game design can change the future of gaming by creating experiences that cater to different players. It promotes accessibility, representation, and empathy, making games more fun for everyone, regardless of their abilities, background, or identity. This approach creates a more dynamic and innovative gaming environment that reflects the richness of the global community.

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