



TECHNICAL UNIVERSITY OF MUNICH

DEPARTMENT OF INFORMATICS

Bachelor's Thesis in Informatics: Games Engineering

**Game Design Principles for Story-Based  
Action Role-Playing Games Played  
without the Sense of Sight**

Felix Borst





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**Grundsätze des Game Designs für  
geschichtenbasierte Action-Rollenspiele  
die ohne Sehsinn gespielt werden**

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I confirm that this bachelor's thesis in informatics: games engineering is my own work and I have documented all sources and material used.

Munich, 15.09.2020

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## **Abstract**

In computer games, more and more emphasis is placed on graphics in order to improve the gaming experience, this can be seen in the increasingly realistic titles. However, this cultural good is withheld from people who are severely visually impaired or even blind, as there are hardly any opportunities to play them without the sense of sight, especially in the big worlds of action role-playing games.

In this bachelor thesis, game design principles are sought that make playing such games possible without the sense of sight. The main focus is on the use of audio and haptic feedback in order to achieve a gaming experience similar to that in a normal game. For this purpose, the most important game elements are analyzed and techniques developed for these so that they can also be used without the sense of sight. The main focus here is on wayfinding areas of interest and artificial cues.

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# 1 Introduction

Computer games have become an increasingly important cultural asset in recent years. These games are used by a growing part of the population, according to Verband der deutschen Games-Branche 2020 in Germany 42% of the population occasionally or even regularly play computer games [6]. There are hardly any differences between men and women [6]. Especially by the average age you can see that in recent years the proportion of older people who use computer games has continued to grow. While the average age in 2014 was still 31 years, in 2020 it rose to 37.5 [5]. This makes it clear that not only young people play computer games, but throughout all ages of the population.

Due to the ever-increasing number of players, the game industry is putting more and more money into new titles [7]. With increasing emphasis on better graphics and hyper-realism, which is also due to the fact that the hardware is getting better and better.

Computer games are developed for the broad masses. This also includes blind and visually impaired people. But it is hardly important that physically impaired people can use these games. A lot is already being done with regard to accessibility, but not the same amount is being done for all groups with restrictions. When running for the best graphic, the severely visually impaired or blind part of the population falls by the wayside.

According to the World Health Organization (WHO), however, at least 2.2 billion people are affected by visual impairment or blindness [9]. In Germany, blind and visually impaired people are not counted [2]. However, it is estimated that there are around 150,000 blind and 500,000 visually impaired people [1].

Of course, there is the possibility for blind people to play games by memorizing (like a blind man played Zelda [8]) and there are also games specially developed for blind people. But only a very few blind people are likely to be able to play a major current AAA title, although the gaming experience that is primarily concerned will probably be lost.

The core idea of the present paper is to find game design principles for story-based action role-playing games that developers can integrate into new games in order to improve accessibility, so that these games can also be played without the sense of sight. For this purpose, a scenario is developed that summarizes all the important properties



of an action role-playing game and the tasks that arise during such a game the main topics are wayfinding techniques, areas of interest, interacting with objects, combat systems, menu guidance and cognitive load.

## 2 Related Work

In the past, of course, a lot has been written about the topic of computer games with impairments and there are also a number of games that have been specially developed for people with special impairments, but there are only a few mainstream games that meet the large number of requirements to be played by really everyone who want to play. In the following, a brief overview of the most important works and games is given on which this work is based.

### 2.1. Literature

There are already works on the subject of games for the visually impaired people and the accessibility of games for people with disabilities. The papers that are most relevant to this work is listed here.

#### 2.1.1. Computer Games That Work for Visually Impaired Children

Computer games that work for visually impaired children [16] describes the work that research and development on computer games does especially for blind or visually impaired children aged 3 to 10 years. This project was carried out in collaboration with several European institutes and organizations and funded by the European Commission. In the course of the project, various mainstream games were examined and some of them adapted to the needs of the target group so that they could be played by them. In addition, case studies were conducted with some of these games.[16]

One of them was "Reader Rabbit's Toddler". In the original version of the game, the player can access various educational activities. In the modified version, some of these activities as well as the navigation in the main menu have been adjusted. Alternatives were implemented for all outputs (mostly audio). A device called Tactile Board was used for the input.[16]

A second game called "Mudsplat" was developed based on the classic arcade game "Space Invaders". Traditional functions of arcade games such as levels, high score, extra lives and bonus objects have been implemented in the game. [16]

In addition, 14 game rules were developed for the target group based on the results of the research work and information about the games themselves.[16]

### **2.1.2. Guidelines for the Development of Accessible Computer Games**

Guidelines for the development of accessible computer games [12] describes the work of the AGRIP project. Efforts have been made to develop techniques and make mainstream games accessible to blind and visually impaired players. [12]

AudioQuake was an adaptation of the existing mainstream game Quake [L17]. This was made playable by blind Gamers by adding an "accessibility layer". A multitude of challenges had to be solved when developing this level. One of them is navigation. This was divided into two parts, global navigation and local navigation. Global navigation is about navigation towards the final goal and local navigation is about navigating between events in the surrounding area. Supporting effective local navigation was a primary priority. For this purpose, a tool was developed that warns the player about enemies and teammates nearby. To do this, a radar-like element would be developed that would use sounds to indicate the position of the enemy. This sounds changes in height and frequency depending on the position and distance of the player from the enemy. Serialization is another challenge. For this, multidimensional problems have been reduced to one-dimensional problems. Another component of the work is prioritization. This means that different types of information (enemies, obstacles, etc.) receive different types of priorities. Several previous paradigms are discussed there. [12]

### **2.1.3. Accessibility in Games: Motivations and Approaches**

Accessibility in Games: Motivations and Approaches [11] is a white paper published in 2004 by the Games Accessibility Special Interest Group ([www.igda.org/accessibility](http://www.igda.org/accessibility)) (GA-SIG) from IGDA (International Game Developers Association). On the one hand, important definitions are given, such as the definition of accessibility for games: "Game Accessibility can be defined as the ability to play a game even when functioning under limiting conditions. Limiting conditions can be functional limitations, or disabilities such as blindness, deafness, or mobility limitations." [11]

As well as, definitions of individual types of disabilities and statistics about these disabilities in the population are given. In addition, possibilities for learning based on games

are presented. Another important part is a collection of guidelines that should help in the development of accessible games. [11]

There is also a list of supporting technologies and an overview of the current state of research. It is the first major release to show that it is possible and necessary to involve disabled users in the mainstream games. [11]

## 2.2. Specific Games

There are many games that can be played without the sense of sight. However, like all other games, the problem is that there are a lot of very bad games. Above all, it is essential that everything is explained well and that you always know what to do without a graphical user interface. Below is a small list of really good games.

### 2.2.1. Dead Vision

Dead Vision [L14] is a short story-driven horror audio game for PC, which resulted from a master's thesis at the University of Music and Performing Arts Graz. You play as a character who has to concentrate on survival in a sudden extreme situation. The highlight of the game is that it completely does without graphics and the player has to concentrate exclusively on the background noise. To do this, the player must always navigate towards the sound source or shoot zombies. In addition, there are no tutorials and noises that do not exist in reality. [13]

### 2.2.2. A Blind Legend

A Blind Legend [L15] is an action adventure for mobile phones that basically does without graphics. The game should not only appeal to the blind, but should also bring a blind gaming experience closer to everyone else. In the game you play a blind man who travels the world with his daughter and has to defeat enemies in a sword fight. Fights are carried out, for example, by wiping in the right direction at the right moment, whereby you have to hear exactly when and where an enemy strike. During the entire adventure, you are acoustically supported by the daughter. For example, she regularly says "Let's Go" and then goes in a certain direction. At the push of a button, she also says again where to go with "Left", "Right" or "Straight ahead". The menu and the instructions during the game are reproduced purely acoustically. [15]

### **2.2.3. Sound of Magic**

Sound of Magic [L16] is a mobile game that combines classic radio play with a fully interactive fantasy game world. This game was also not primarily developed for blind people, but uses fantasy as a stylistic device. Here you have to move through the open game world with simple gestures, conduct dialogues, use objects and learn powerful magic. Spells can be used, for example, by drawing a rune on the screen. The navigation and locomotion takes place through the rotation, whereby you can interact at any position (doors, objects, people, etc.). [14]

## 3 Wayfinding

An essential part of a story-based action role-playing game is to find the way around the mostly open world, do quests and find objects. To find the way around and to navigate to certain points, there is the umbrella term wayfinding. Wayfinding is not just about finding a way. There are many different definitions of wayfinding, but throughout this work the following definition will be used.

"Wayfinding is the cognitive process of defining a path through an environment, using and acquiring spatial knowledge, aided by both natural and artificial cues" [20]

This definition differentiates between the acquisition and the use of spatial knowledge. With regard to playing without a sense of sight, using the spatial information is rather easy, whereas obtaining this information is the difficulty. The acquisition of spatial knowledge not only relates to the structure of the environment, but also to awareness of one's own position and direction of view. Even in everyday life, blind and visually impaired people sometimes need a lot of time or help from others to cope with these tasks.

### 3.1. Wayfinding Tasks

Since the approach to wayfinding differs depending on the situation, wayfinding was divided into tasks in the other work. For example, in the paper 3D User Interfaces: Theory and Practice by Doug A. Bowman et al. [20] distinguished between exploration search and maneuvering. And in the work Taxonomy of Human Wayfinding Tasks of Jan M. Wiener et al. [21] a distinction is made between aided and unaided, with unaided again being divided into directed and undirected. This paper takes both approaches into account and combines them.

#### 3.1.1. Exploration

Exploration is about building up spatial knowledge without having a specific goal, usually not following a specific path but rather a random movement to interesting points. It is often used in games to explore new areas of the game world. In this case, a search is

not made for a specific quest or item, but rather where, for example, opponents are or new quests can be found.

In the paper by Jan M. Wiener et al. [21] a further distinction is made. Because exploration can not only be done in an unfamiliar environment but also simply take a walk through a well-known environment. A walk like this is not about gaining spatial knowledge, but maybe just taking random items with you. [20, 21]

#### **3.1.2. Search**

When searching, there is a specific goal in the area that should be achieved. In games, for example, this can be a quest item that needs to be found. Since the destination is known, search tasks are categorized as directed wayfinding. Search tasks not only acquire spatial knowledge (as in exploration), but also use it. Search tasks are divided into two categories, naive search or primitive search.

With the naive search, the target object is known but not the exact position. This means that the spatial knowledge is not sufficient to find the shortest path to the destination. That is why the naive search has to be explored until the target is found.

In the primitive search, on the other hand, the target and its exact position are known and it is only a matter of using spatial knowledge and knowledge of the own position to find the target. [20, 21]

#### **3.1.3. Maneuvering**

Maneuvering is about making small movements to a certain position in the immediate vicinity. This usually happens automatically during the search task. For example, if a certain item is to be picked up from many in the area in a game, it must be steered precisely to the right one in order not to pick up the wrong one. Since the destination is usually within sight, maneuvering is also categorized as directional path finding. Even when maneuvering, spatial knowledge is not only acquired, but also used. [20]

#### **3.1.4. Specified Trajectory Movement**

The last wayfinding task is to follow a predefined path. That means there is an existing path in an unknown environment that you don't have to find first. For example, if you sit on the horse in *The Witcher 3: Wild Hunt* [L10], it automatically moves forward on the main paths without the player having to indicate the direction. The Specified Trajectory Movement is mostly used to build up a cognitive map in the shortest possible time and to gain spatial knowledge.

This is not really a wayfinding task as the user is not actively moving through the environment. [20]

## 3.2. Spatial Knowledge

The different wayfinding tasks use spatial knowledge. The quality of the individual wayfinding tasks therefore depends on the structure of the cognitive map.

There are three different degrees of accuracy in spatial knowledge, that have been proposed by Siegel and White [22].

**Landmark knowledge** is the gradation of spatial knowledge with the least accuracy. This includes all visual characteristics of important points in the environment, including objects and their shape, size and texture. As an example, for Munich these would be the Frauenkirche, the airport and the Isar. These landmarks are easy to remember, especially for tourists.

**Procedural knowledge** describes the knowledge of certain routes that connect important places. They contain little visual information about the paths. As an example, a tourist usually knows the way from the hotel to the subway after the first walk.

**Survey knowledge** includes the most precise spatial knowledge of an area. It contains topographical information as well as the position of certain objects and the distances between objects. This knowledge is like a map of the area. To build up such extensive knowledge it usually takes a very long time as an example, even a local usually does not know all the streets of his city.



## 4 Artificial Cues

In games, techniques are often needed to get players' attention or to point out certain things to them. All of this information is summarized under the term artificial cues. Notes are important in games, but it is also important that these notes can destroy the atmosphere but can also be built in so that they do not attract negative attention because they fit the overall situation. There are several ways to incorporate these hints into a game. A distinction is made between screen layout and sound. Of course, these can also be connected to each other.

### 4.1. Screen Layout

There are various options for incorporating information into the screen layout. When an element is part of the story it is called immersion and when the user interface element is spatially embedded in the game it is called geometric placement.

As an example, if in a game the health of the player should be shown, this is done in the game *Dead Space 3* [L13] (Figure 4.1) by placing the display on the player's back and making it look like a part of the space suit. Or as a counterexample, as in the game *PUBG* [L12] (Figure 4.2) simply renders as a display over the screen.



Figure 4.1: Dead Space 3



Figure 4.2: PUBG

For games where the story and the atmosphere are important, it is often chosen to integrate the clues into the game as much as possible in order to achieve the highest possible degree of immersion. Most of the time, however, references to objects are integrated into the game and, for example, the life indicator is implemented using a head up display. As an example of objects that the player should find, this object can either have a large arrow hovering over it or it can only be subtly surrounded by a glow. Depending on the situation, a decision has to be made which means to use when and for what. In order to achieve the highest possible degree of immersion but the player does not overlook any important information.

### 4.2. Sound

Similar to the screen layout, the sound can also be used to draw the player's attention to clues by triggering sound. These sounds can also fit into the atmosphere sometimes more and sometimes less. For example, an non-player character can draw attention to itself by addressing the player. Or he just makes a “*bing*” sound to indicate that a dialog is available. The sound can also support the screen layout, for example if the player's life drops, the heartbeat can be heard.

## 5 Szenario

This chapter focuses on what a story-based action role-playing game is and what makes it so special. In addition, important elements are defined, which will be discussed in more detail later and for which explicit solution approaches will then be worked out with regard to playing without a sense of sight.

### 5.1. Definition of Story-Based Action Role-Playing Games

Action adventures are all about skill, quick-time events and climbing passages, and classic role-playing games are about dialogues and story. Story-based action role-playing games, which this work is about, represent a complex mixture of action-adventure and classic role-playing games. In action role-playing games, practically no skill tests such as Climbing or jumping passages are mastered. Switches or physics puzzles are also rather the exception. One of the most important distinctions, is how the character is handled. In contrast to an adventure game, most of the features of action role-playing games revolve around your own character and fighting. The player usually always starts at the bottom of the game, e.g. at level 1 with the simplest equipment and skills. Then he makes his way through the world in order to gain experience points, money and equipment through battles and solved tasks (quests). It is always an essential game content of role-playing games that the character is improved. The player is practically free in which "direction" he builds them up. Would he prefer a melee, ranged or some kind of "magician"? In an RPG, this is always his free decision. Fights are also carried out completely dynamically. Here the player can dodge or block attacks of the enemies and also counter-attacks. At the same time, there are various skills to defeat the enemies as effectively as possible. [10, 17]

In action role-playing games there is no such thing as a completed "level". However, a distinction is made between two basic approaches to difficulty. On the one hand there are games that provide a certain level range for certain areas. On the other hand, there are game worlds that are completely based on our own level and adapt. With the first

approach, the enemies get a fixed strength in a certain area. If the avatar of the player is too “weak”, he will not survive long in the corresponding areas. In the second approach, the enemies adapt to their own strength. The player can practically travel with Level 1 the entire game world without being careful of enemies who are too strong. With a higher level, however, the player will no longer encounter enemies who are too weak. Both principles have their own advantages and disadvantages, but in most of the Games the general level of difficulty can be set separately. [10, 17]

Over the years, of course, various sub-genres have developed under the action role-playing games. In this work, the main focus is on the story-based action role-playing games. A distinction is made explicitly between the pure Hack & Slay action role-playing games.

A brief insight into some of the most important games that are best rated by players and critics in history, for which the criteria of a story-based action role-playing game are fulfilled:

- Rogue [L1]
- Darkstone [L2]
- Gothic 1 [L3]
- Gothic 2 [L4]
- The Elder Scrolls IV: Oblivion [L5]
- Gothic 3 [L6]
- The Witcher [L7]
- The Witcher 2: Assassins of Kings [L8]
- The Elder Scrolls V: Skyrim [L9]
- The Witcher 3: Wild Hunt [L10]
- Horizon Zero Dawn [L11]

## 5.2. Most Important Game Elements

It is now clear what a story-based action role-playing game is, but with regard to playing without the sense of sight, it is still necessary to find out from which important game elements such a game consists. This chapter gives an overview of the most important game elements that are essential for finding your way around, the game experience, the controls and the operation. The game elements listed below will then be adapted in a later chapter to the requirements of visually impaired and blind people. [10, 17]

### **5.2.1. Wayfinding**

One of the most important elements in a story-based action role-playing game is wayfinding, what was dealt with in detail in chapter 3. This is essential for traveling and building up spatial knowledge. The player must not only find the way to the next quest, but also maneuvering to the destination at a certain point is an important part. There are also differences as to whether the player has to navigate long distances outdoors or in the shortest distance in buildings with many obstacles. Another point is to explore the area and discover new areas of the world and remember where they are. While the player is moving towards a goal, the atmosphere must be coherent and the gameplay must not be neglected.

### **5.2.2. Game World**

In order to be able to find the paths first, it is of course essential to give a game world in which you can move. With story-based action role-playing games, this is usually huge and freely accessible, decorated with many little things and details that contribute significantly to the gaming experience. With the help of the game world, the story is additionally embellished and due to the many details, the player sinks completely into the world. All of this is of course supported by the ambient noise and can thus influence the mood in the game. All in all, a perfect immersion is created.

### **5.2.3. Fights**

An action game can always lead to a fight on the way to a goal. Such a fight can take place against animals / monsters or against other players. Each enemy has an individual fighting style and the own character can use different tactics such as block dodging, etc. Furthermore, the overall goal must always be in focus, because you can also just escape from the fight or prevent it by simply sneaking past your opponent.

### **5.2.4. Quests**

Another essential part of story-based action role-playing games are the quests. The quests tell, among other things, the story that is an important part of such a game. However, such a quest must first be found, then accepted and ended after completion. Wayfinding is an important part of this. Quests can be structured in completely different ways; one time you have to defeat enemies, or you have to find an object or a person and

another time you have to say the right thing in a dialogue. In addition, you can usually accept other quests during a quest and postpone the previously pursued task and only pursue another one.

### 5.2.5. Non-Player Characters

The non-player characters (NPC) do not always have quests for the player, but they can have important clues about enemies, the environment as well as items, or you can trade with them. To do this, the player must first find the right NPC. It is also important that NPCs contribute to the story and atmosphere. NPCs can start dialogues when you are near them or when you speak to them. But there are also NPCs that are not intended for interaction.

### 5.2.6. Graphical User Interface

The graphical user interface should not be underestimated either as shown in Figure 5.1, it gives the player important artificial cues on the current state of health as well as an orientation aid via compass or minimap and directional arrows. It also shows how much ammunition is left and which weapon is currently equipped. Most of the time it is also recognizable when a person has a quest, or how strong an enemy is and their remaining health.

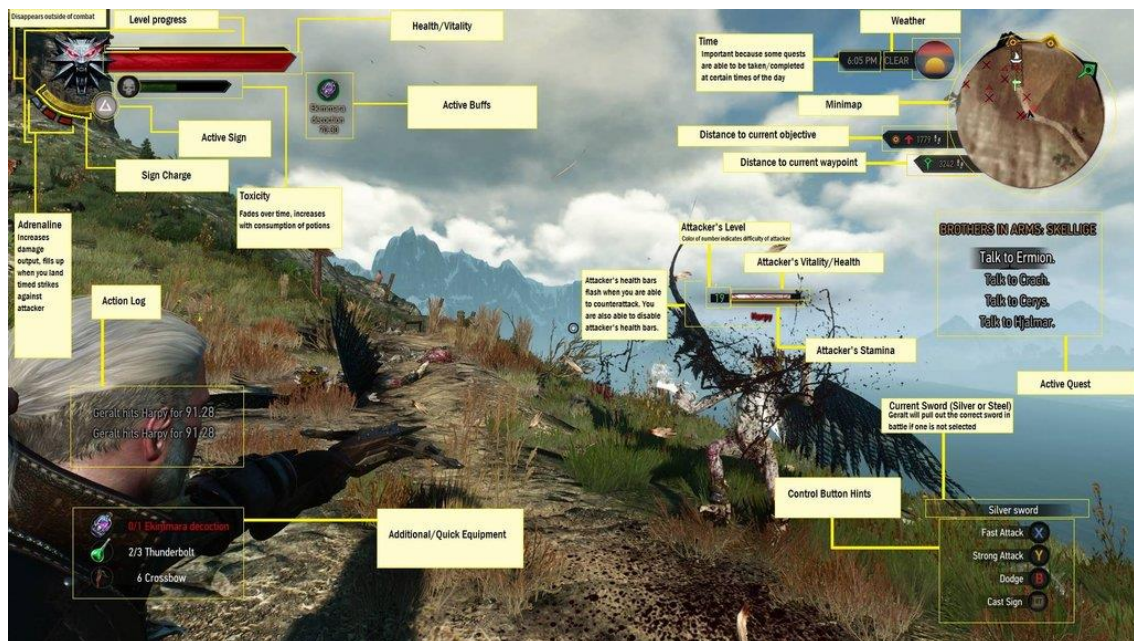


Figure 5.1: Witcher 3: Wild Hunt

### **5.2.7. Loot**

A component that is particularly important for story-based action role-playing game is crafting, whether building a new better weapon or making improvements with recipes, the parts for it have to be found and then put together in a submenu. It is important to find the right parts because mostly the character has a limited inventory. Furthermore, it must be possible to loot victorious enemies to get their items. A distinction can always be made between important and unimportant objects.

### **5.2.8. Interaction**

Interacting with NPCs or picking up items as well as opening doors is also a part that needs to be considered as the player needs to be at a certain location for the interaction.

### **5.2.9. Dialogues**

If the player is in a dialogue with an NPC, he must be able to understand what is being said and select suitable questions or answers in order to lead a convergence. The player should also know which of the answers that are available are important.

### **5.2.10. Menu Navigation**

The last but also important point is the menu navigation. A player must be able to start the game and finish it, he must be able to save and also be able to change settings. Furthermore, the player has to find his way through the mostly extensive in-game menus such as inventory, character customization or the quest list. It must be possible to find certain things in the shortest possible time. Especially in the inventory there are still certain specifications for each item that are displayed.

## **5.3. Example Scenario**

There are many different types of story-based action role-playing games which make it difficult to put them all into one Example. Therefore, only the essential game elements are used for the example scenario. The following scenario is put together from these game elements and based on the game *The Witcher 3: Wild Hunt* [L10] developed by CD Projekt RED in 2015, which is still seen as a benchmark when it comes to this genre.

At the beginning there is the start menu in which the player can start the game or make settings (menu navigation). After starting the game, the player must find a person in a building (wayfinding) and have a dialogue with this person (NPCs, dialogues and interaction). To do this, he has to navigate in narrow spaces and on several floors. Afterwards the building should be left and the way to a more distant object should be found outside (wayfinding). On the way the player will find various other useful items (loot / crafting) that may bring benefits in the later course. While the player is on the lookout, a fight will either await him (fight) or he will try to escape by undetected sneaking (wayfinding). Once the player has arrived at the object he is looking for, another object must be found and used in the area (loot / crafting and menu navigation). This is followed by the way back to the client (quest). Once there, a short conversation has to take place as a result of which the player receives new armor that he must equip (NPCs, dialogues and menu navigation).



## 6 Human-Computer Interaction

Since the mid-1980s, the mouse, along with the monitor and keyboard, has been one of the most important human-machine interfaces for almost all computer activities. However, blind and visually impaired people have the problem that they cannot see the mouse pointer on the screen and that an alternative interaction method is required for clicking buttons on the desktop, for example. Almost all story-based action role-playing games are designed to work as inputs with mouse and keyboard and as outputs with monitors, which is a big problem for blind people. In the following, some acquaintances and a couple of unconventional input and output options are presented, some of which are based on the book Human-Computer Interaction from 2003 [18]. These options are used to discuss how it can enable people with limited visual perception to interact with a computer game. In the further course some of these possibilities will be taken up again for explicit approaches.

### 6.1. Input

All means that the user can use to interact with the computer are seen as input.

#### 6.1.1. Text Input Devices

##### **Alphanumeric Keyboard**

Alphanumeric keyboards are the standard text input devices on computers today and are derived from the typewriter keyboard. The keyboard consists of a number of keys that have to be pressed with the fingers. Each key has a specific function. Almost all keyboards have a standardized layout, for example QWERTY or QWERTZ. In addition, most keyboards have small increases on the F and J keys, which makes it easier to find them on the keyboard.

##### **Chord Keyboard**

Chord keyboards are a special form of one-hand keyboards that have only a few keys and in which the input characters result from combinations of simultaneous key presses.

The disadvantage is the comparatively higher training effort, whereby normal character rates can be achieved after the learning phase is complete.

### **Gaming Keypad**

The gaming keypad is a reduced alphanumeric keyboard that can be operated with one hand. On these keyboards, only the keys usually required for gaming are available. Most of the buttons can also be freely assigned.

### **Speech Recognition**

New technologies and ever faster computers make it easier and easier to make entries using the Speech instead of the fingers. The so-called speech recognition converts the spoken into text and thus a keyboard is no longer needed. This technology is particularly interesting with regard to playing without the sense of sight, as commands can also be recognized.

## **6.1.2. Positioning, Pointing and Drawing**

### **Mouse**

In addition to the keyboard, the mouse now belongs to the standard input devices on computers. The mouse converts the horizontal orientation of the desktop to the vertical orientation of the screen. For this purpose, the movement of the mouse is scanned in the X, Y direction and transmitted to the computer. The cursor can thus be navigated precisely on the monitor. In addition, the mouse has a number of buttons that allow the user to perform actions at certain positions on the screen.

### **Touchpad**

Touchpads are touch-sensitive surfaces that are operated by moving the finger over it. Most of them can be found as a mouse replacement on laptops.

### **Touch Sensitive Screens**

Touchscreens are used in mobile phones and tablets and recognize the position of the finger or a pen that touches the screen. This makes it easier for the user to click on certain icons on the screen because there is no need to navigate with the mouse.

### **Joystick / Gamepad**

Joysticks and gamepads are input devices in which the pressure on the stick, in a certain direction, controls the speed of the cursor in this direction. There are usually several

small joysticks attached to gamepads, and buttons are also attached to the it, which makes it possible to play games with the gamepad alone.

### **6.1.3. Special Devices**

#### **Position Detection in 3D**

The position and orientation of a user in the room can be recognized with cameras or other sensors. Gestures can thus be used to perform actions on the computer. As an example, there is the Kinect from Microsoft. Even with modern VR headsets, the position of the head and hands in the room is tracked, which can be used to detect gestures.

## **6.2. Output**

All means are seen as output with which the computer can give the operator feedback.

### **6.2.1. Vision**

#### **Monitor**

Computer monitors are standard output devices on today's computers. In the past few years, these have been continuously improved, with the screen moving towards ever larger screens with ever higher resolution.

#### **VR Headset**

A virtual reality headset is a type of head-mounted display and is intended to offer the player the most realistic gaming experience possible. The player can look around 360 degrees by turning the head and moving in the room. This creates a virtual reality.

#### **AR Headsets**

An augmented reality headset is a type of head-mounted display and is intended to insert additional virtual information into the user's field of vision.

### **6.2.2. Audio**

#### **Headphones**

With headphones, electrical signals are converted into sound signals that are audible to humans. Headphones are used for audio output on today's computers.

Headphones are always placed directly on or in the ears. Modern headsets can also play surround sound. Headphones shield most of the ambient noise, which improves the sound experience.

### **Sound Systems**

The principle of a sound system is like a headset, except that it is not worn on the head but consists of individual loudspeakers that are distributed throughout the room, so surround sound can also be reproduced. In contrast to headphones, you can hear other ambient sounds during playback.

### **Piezoelectric Beep Speaker**

Piezoelectric beeper are devices that can reproduce individual tones. They are usually installed on computer mainboards to reproduce bios error messages.

## **6.2.3. Haptic**

### **Haptic Mainstream Devices**

There is haptic feedback, for example, with gamepads, which have the option of vibrating and thus giving feedback. The vibration can differ in frequency and intensity.

Other devices also have this functionality, for example there are computer mice that can vibrate, but cell phones and smartwatches can also be used as haptic feedback.

### **Braille Display**

This device is an output device specially developed for blind people who uses a screen reader to translate text into Braille and then output it on a mechanical line that the operator can then read with his fingers.

### **Haptic Gloves**

Especially with regard to VR, devices have been developed that should make immersion even more realistic. These include haptic gloves, which are intended to provide targeted feedback on the fingers so that the user believes they are touching something. One example is the Plexus VR Glove from Plexus.

### **Haptic Suits and Vests**

Another technique to make VR even more realistic are the haptic suits that give feedback to the whole body. With such a suit, the player can also feel in a game when touched. As an example, there is the Teslasuit from the company of the same name. These

systems can also serve as an additional source of information with regard to playing without the sense of sight.

**Brain Stimulation**

The researchers at Université de Lausanne have yet another invention in the area of haptics. Here the brain is to be tapped directly instead of just stimulating the skin. [19]

## 7 Points of Interest

In normal story-based action role-playing games, the player can usually find his way around what is seen on the monitor or what is heard in the headset. If the seen is no longer available, the player must still be able to find his way. Not every detail is equally important in a game and there are many objects that have been placed only for the visual atmosphere. For example, decorative objects in houses, NPCs in cities that do not offer dialogues or just trees in a forest. So, all of these things can be neglected in terms of playing without the sense sight. Of course, many items are needed for an authentic environment, but the atmosphere has to be reinserted later using other techniques. This chapter only deals with points that are relevant for the pure game. Figure 7.1 shows a screenshot from The Witcher 3: Wild Hunt [L10] showing a section of the map. There are even some points of interest shown.



Figure 7.1: Witcher 3: Wild Hunt. Screenshot

## 7.1. Important Points

Not only the location of quest items and NPCs are important for a game, but also a lot of other things. How these sights are made accessible to the blind or visually impaired player is the subject of a later chapter. First, the things that are essential for the game are described.

Two of the most important points in a game are the NPCs and the quest items. The NPCs must be found precisely because dialogues are held with them and these can give the player quests or information. The same applies to the quest items, which the player must be able to find in the world, which is why they must also be marked. Furthermore, all objects that can be interacted with or that can be collected for looting or crafting are also important. Signposts on the side of the road are an example of objects with which one can interact. Figure 7.2 shows an edited screenshot in which everything is marked in green with which The Player can interact.

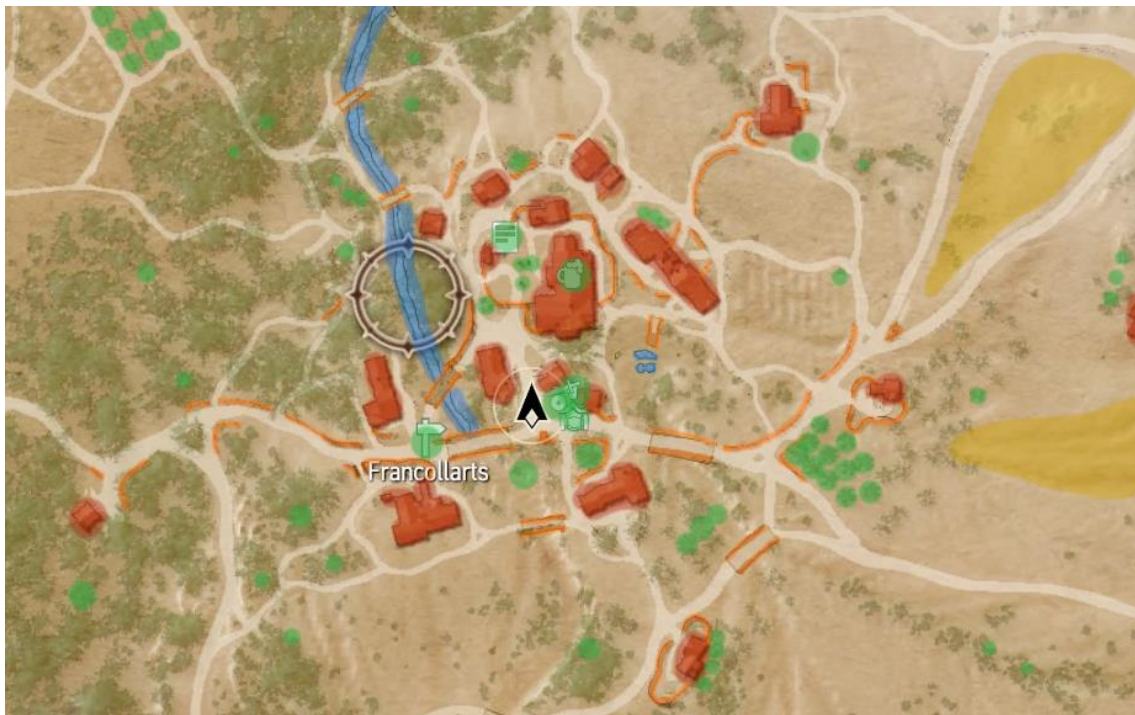


Figure 7.2: Witcher 3: Wild Hunt. Screenshot edited

It must also be possible to recognize where there are obstacles, for example fences, walls or entire buildings that need to be avoided. Buildings are marked in red on Figure 7.2 and other obstacles in orange. Some buildings can also be entered, here it is

important to find the entrance door. Once in a building there are also objects that prevent it from moving forward. These must also be recognizable to the player. It is also important here whether an object is in the same level as the player or whether a staircase has yet to be found. Also, Enemies must not be neglected, the player must also be able to pinpoint them to fight them or avoid them unseen.

Most things are not just simple points on the map, but larger areas that need to be navigated around.

## **7.2. Areas of Interest**

There are areas in story-based action role-playing games that have to be specially marked because the player may be too weak for these areas or simply die when he enters them. As an example of this, there are abysses that the player can fall into, the player would see on the monitor if he approaches an abyss and evade. A blind player needs support here and must be warned of such an area or prevented from getting there at all. In Figure .2 there are areas marked in yellow, this was taken as an example for areas with a steep slope that the player cannot enter. Furthermore, paths are important areas in which the player can stay to get to a certain location. These should also differ from meadows or fields.

## **7.3. Abstraction Level**

The abstractions level must also not be ignored. This includes points such as where the player wants to go and how important are individual points of interest in relation to the current goal. For example, blind players should not be distracted by items in the vicinity during a fight. For this purpose, each sound must be determined for what and when it is important and when it can be weakened in intensity or completely faded out.



## 8 Important Techniques

In order to make a game accessible to the blind, the most important game elements must be viewed separately and modified so that they can also be used without the sense of sight. In the following, techniques are described with which people with limited visual perception can be able to play story-based action role-playing games.

### 8.1. Wayfinding

In story-based action role-playing games, an essential part of finding your way in the open game world is to complete quests and chop items to improve your avatar. For this purpose, such quests and items must first be found and building up spatial knowledge is an important point in order to find your way around the world as well as possible. In normal games the player does this by walking around, remembering certain landmarks and later remembering where he saw something specific. The way to quests is usually shown as an artificial cue in the mini map or directly in the world as a path. When playing without the sense of sight, these artificial cues must be replaced by an alternative in order to give the player the opportunity to play the game. For this purpose, sound is set that the player can hear using a surround headset. As mentioned in Chapter 3, it is again divided into Travel Tasks.

#### **Exploration**

During exploration, the player should build up spatial knowledge. The player walks around the world without a specific goal to get to know the environment, to find new quests or simply to reach a higher level through battles. Later when looking for special items or quests, the player can remember the surroundings and find his way around better. When playing without the sense of sight, it should be differentiated whether the player wants to explore or is looking for a quest, as the priority is on different things. For this purpose, a mode change can be implemented that reduces the focus to the relevant sounds. When exploring, important landmarks are especially important, for example if the player is in a forest, such a landmark could be a waterfall that is unique.

Items, quests and enemies that appear along the way are also important when exploring. When exploring, more emphasis is placed on the atmosphere in order to achieve the greatest possible immersion. For example, whether the birds chirp in a fight is rather subordinate.

### **Search**

When searching, the goal (quest) is known and the player wants to get there by the fastest route. To achieve this, games usually show the path that leads to the goal or sometimes just the direction to a region in which the goal is located. To make such a path visible to the blind, an audio signal could be placed in the direction in which the player must go. In order to keep the immersion as high as possible, this artificial cue must be embedded in the game as authentically as possible. This can be achieved by introducing a companion, for example in the game *A Blind Legend* [L15] the companion calls in which direction the player should move. Depending on the game setting, the space suit can also talk to the player or a dog can show the player the direction to the goal by barking from one direction. Through the possible spatial knowledge that was acquired while exploring, the player can also use abbreviations that are off the beaten track. When searching, the atmosphere is also relatively important, but it must not distract from the main goal. For this purpose, less important sounds could be faded out, such as items along the way. However, the player should always be able to switch to exploration mode and back again while searching.

### **Maneuvering**

Maneuvering is used when the player has to navigate in narrow buildings or to a quest item. Here, the player has usually already reached the goal and only wants to come to a special position in order to carry out an interaction. With this task, the wider surroundings and the atmosphere are rather uninteresting because the goal is in the immediate vicinity. Here all sounds except those of the target and the obstacles that are up to it can be faded out. It should be possible to activate this mode without a specific goal, for example to find your way around in a house. Here only the sounds should be played in the immediate vicinity with which one can interact. The player can then walk in the direction from which the sound is coming with the surround headset used.

## **8.2. Game World**

The game world in modern story-based action role-playing games is usually huge, very detailed and meticulously decorated with individual objects. Since blind and visually

impaired people cannot see these details, other options are needed to recreate the game experience as authentically as possible. It should also be ensured that the player cannot or may not be allowed to go to any point in the game world, as already explained in the Points of Interest chapter.

### **Areas of Interest**

There are many areas in a game world that the player is not allowed to enter. As an example, there can be abysses that the player can only cross over a bridge. The player must be able to perceive these abysses and should avoid them because he could crash. In order to make such places recognizable for the player, on the one hand a special sound can be played which becomes increasingly intense and louder when one approaches such an area. For example, strong wind noise on steep slopes. In addition, the vibration function of a gamepad can be used to mark such places, the closer to the abyss the more haptic feedback the player gets. For players who play with the keyboard, for example, a smartwatch or a haptic mouse could also be used.

### **The Atmosphere**

The atmosphere in games is an important point that also has to be implemented differently from how it is usually done. While walking through a forest in a game and the sun shines through the trees and a few birds fly by, this scene is not visible to the blind and visually impaired and the whole atmosphere is lost. Here the whole atmosphere has to be reproduced by sound. This can be seen on the one hand through noises that occur in a forest, for example, or on the other hand through the story of a companion who describes in a casual conversation how the environment looks.

### **Sensory Overload**

An important point that should not be neglected is sensory overload. Since only hearing and feeling are used when playing without a sense of sight, there can be an accumulation of different sounds that the player can then no longer differentiate. The whole atmosphere is lost and the game experience is not so good anymore. With the inserted noise sources, it should therefore be ensured that the sounds match the surroundings and only the most important sounds that are nearby are heard. For example, the ambient noise should be reduced during a dialogue so that more can be focused on the spoken or certain sounds are muted completely.

### **Mute Button**

A player can concentrate on certain tasks during the game, such as looking for certain items. He almost ignores all other things. With blind and visually impaired players, this is not so easy because almost exclusively hearing is played and many sounds that are

sometimes more important and sometimes less important can be heard at once. For example, sounds of surrounding objects and also NPCs. It would therefore be an advantage if the player could mute individual categories of sounds at the touch of a button in order to focus even better on those that are relevant to the current task. For example, if the player is looking for an exit door from a pub, it is not so important to hear the background noise of the pub and people who speak to him. In *The Witcher 3: Wild Hunt* [L10] there is a similar approach to the function of the witchcraft sense that attenuates all sounds but makes enemies well and widely audible. In addition, objects that can be interacted with are highlighted.

### 8.3. Fights

The action in story-based action role-playing games is mainly provided by fighting. But since blind and visually impaired people do not see the opponents coming and also do not recognize when they have to block an attack or when the enemy can be hit, a new technique is needed here. In different existing games there are different approaches to this, one of which stands out due to its ease of use. In *A Blind Legend* [L15] a mini game is started during a fight in which the player has to hear from which direction the opponent is coming. Shortly before the enemy attacks, the player hears an attack sound from the direction from which the opponent is coming and can steer in the right direction to block the attack and then attack the confused enemy himself. This technique also works with multiple opponents. With a surround headset, the player can determine the direction and hits on their own avatar can be recognized by vibration. A combat mode could be introduced in which exactly such a technique is used and all other noises are faded out. The player should also be able to change the mode during the fight and, for example, flee to continue a current quest. enemies should be clearly identifiable from a distance in order to avoid a fight if necessary, by sneaking.

### 8.4. Dialogues

In games like *The Witcher 3: Wild Hunt* [L10], the dialogues are spoken and you don't have to read them as subtitles, but this is not the case for all games. Since blind and visually impaired players cannot read the subtitles, a screen reader can be used. However, it is much better for the gaming experience if different characters have different voices and emotions can also be represented using the language. Therefore, any kind of dialog should be spoken and then played back on a headset. The answer options are

usually different choices that the player can choose from. This selection should be made with the arrow keys on the keyboard or with a gamepad, whereby the currently selected answer option should always be heard as a short version. The player can then confirm a possibility and thus respond in a dialog.

## 8.5. Graphical User Interface

Since the graphical user interface is no longer available when playing without the sense of sight and thus all artificial cues that do not have a sound, a replacement must be found. In the following, only suggested solutions are given for part of the graphical user interface. It is important that the newly introduced technologies do not destroy the immersion.

### **Health indicator**

For battles it is important to know how much health the character still has and whether it is necessary to heal them. In most cases, this is implemented by means of a display that can no longer be seen. A heartbeat sound could be introduced here that is either increased in volume or in frequency as the health deteriorates. The former could mask the fighting noise, which is why increasing the frequency is preferable.

### **Ammunition display**

Another point that is usually realized through a display on the screen is the display of the remaining ammunition in a weapon. This can be made visible for the blind by pressing a predefined button and the character says how much ammunition is left. An empty weapon can play a sound that shows that it is empty.

## 8.6. Loot / Crafting

The topic of looting and crafting should of course not be missing in a story-based action role-playing game. Items that can be looted are usually indicated by artificial cues. These notes must now be replaced by unique sounds that can be clearly assigned in the world to make it easier to search for a certain object, a sound library can be built into the menu where the player can listen to the sound he wants to search for. It would also be possible that individual groups of objects such as plants can be hidden or highlighted because the player presses a button. Of course, the immersion should also be

considered when choosing the sounds. The crafting can then be done via the menu, which will be described at a later point.

## **8.7. Interaction**

During the game the player has to interact constantly. Not only with NPCs but also with items to pick them up or doors to open them. To do this, the player must go to the item in a game until an artificial clue is displayed. This can be indicated by lighting up or a message (press X to receive). He must be very close to the item and it must usually be looked at. The player can also see what the item is and whether he wants to interact at all. All of this is not recognizable for the blind and visually impaired, so another technique must be found that makes it clear to the player that he can interact with something at the current position and what it is.

First of all, it is not so important that the player is right in front of the object and he don't have to look at it directly. For example, if the player wants to open a door, it is sufficient to stand nearby and look in the rough direction to be able to open it because the player does not see the door anyway. The interaction radii can thus be kept somewhat larger in order to facilitate the interaction for the player.

Secondly, the object must make itself felt as soon as it can be interacted with. This can be a simple sound that can be heard whenever an interaction is possible. However, it is better if the sound that the player hears fits into the atmosphere of the game. For example, if a door emits a sound that is generated when a key is turned, or a dealer starts talking to the player and says what he has to sell. This means that a distinction can also be made with what is interacting with.

## **8.8. Menu Navigation**

The menu navigation is not only essential in the main menu to make settings or start the game, but also during the game. There it must be possible to change his equipment, find and use items in the inventory or buy items from retailers. In most games there are small pictures of the items in the inventory to recognize them, in addition there is a detailed description with all stats when you select one of these items. Players click on the corresponding field with the mouse to perform an action. Blind and visually impaired people cannot do anything with it. And the widespread screen reader may still be usable in the main menu, but in the game the player would be overwhelmed with the amount of

unnecessary information. For this reason, a basic distinction is made between the menu (main menu) and the inventory because there are different criteria and therefore different techniques are required.

### **Menu**

With regard to the input and output devices, a mouse is rather unusable and a selection should be made with the arrow keys on the keyboard or with a gamepad. The output then takes place using a headset, since this is required for the entire game. In order for blind or visually impaired people to use a menu, they must know which options are available and how they can choose one of these options. For this purpose, a pointer is inserted like on a console, which can be moved up and down with the buttons to navigate through the menu. In addition, other things are added. On the one hand, the currently selected line is now read out so that the player knows where he is. On the other hand, a loop is inserted to get back to the beginning after the last line. These changes make it possible for the blind or visually impaired to navigate through a menu and make a desired selection.

Another possibility that could also be used here is speech recognition, in which the player operates the menu as with a navigation device using defined commands. Since most main menus or setting menus are relatively simple, there was no speech recognition because the implementation effort is much higher and the commands are not recognized 100%.

### **Inventory**

All this is a little more difficult with the inventory because there are many submenus and there are also a lot of items that are in turn described in great detail. In this case, speech recognition is an advantage. A microphone is also required for this. A pure speech recognition would contain a lot of commands, which is why only a rough selection should be made with this technique and the final selection with the same technique as in the main menu. For example, differentiate between weapons, potions, quest items etc. and then again, a finer selection such as firearms and swords. Only then should a relatively small list of objects remain which can then be searched using buttons or a gamepad. However, the detailed information should not always be displayed, but only at the push of a button on selected objects. This display will then be done again using a screen reader.

## 9 Prototype

In the course of this work, a small prototype was also developed which should show that it is possible to differentiate different goals in a room and to navigate to the desired destination.

A PC version was used for the prototype as programming and the support of external hardware is easier to manage. Unity (Unity Technologies) was used as the engine and the associated scripts were written in C Sharp (C #). Mouse and keyboard were used as input media. Since this simple prototype only worked with sound, there was no need for an output device with haptic feedback. In addition, a surround headset was used, which is essential to localize sound sources in the room.

For the prototype, a marketplace was set up on which there are three different dealers who each sell different things. There is a butcher, a blacksmith and an alchemist. The player can recognize which dealers are involved through the different sounds. If the player were to go through the marketplace, they would be alerted to the dealers by shouting if they were in the vicinity. In addition, the ambient sound of a marketplace is used to increase immersion. When the player has decided on a dealer, he can follow the calls and hear even more specific sounds of the dealer's craft as they approach. For example, at the blacksmith, hammer noises are played. When the player has reached the dealer, he stops calling and speaks directly to the player. The prototype was designed in such a way that the player can play it with a completely black screen, but this can also be activated by pressing a button to see where the player is.

If the prototype was used, it could be shown that it is very possible to navigate to certain points with audio only without the sense of sight, which also works relatively well in other existing games.

The resulting prototype was not evaluated and therefore has no significance as to whether the techniques used really work as intended in the desired application area.



## 10 Conclusion

The purpose of this work is to define game design principles that developers can use to enable blind and visually impaired people to play current story-based action role-playing games.

This is possible, at least in theory. By analyzing current games, the most important game elements of such games could be found and then adapted so that they can also be mastered by blind and visually impaired players. If simple tasks such as navigating in a menu were still relatively easy to access, the subject of wayfinding is a bit more complex. This is because the player first has to build up an inner map of the environment in order to be able to find his way around later. Since in this case the player cannot see important waypoints, these must be designed with sound so that the player can recognize them. But there are also game elements that can be made accessible without major changes, including dialogues. These are spoken, for example, in *The Witcher 3: Wild Hunt* [L10] here, only the choice of answers would have to be set to speech. Another point that must not be neglected is that the player only consists of sounds and haptic feedback, so it must be ensured that there is no overlord that negatively affects the gaming experience. Another point that must be observed is that all information that is given on the screen (artificial cues) must now be introduced into the game differently, as these are mostly important for the game but cannot be seen by the blind and visually impaired.

Whether all these game design principles that have been defined also work in practice cannot be confirmed in this thesis, as this requires a user study with blind and visually impaired participants. But since there are already a few games that have been made for the blind and visually impaired, this indicates that it is also feasible to make a current story-based action role-playing game accessible to blind or visually impaired people.

## 11 Outlook

This work has shown that in theory it is possible to expand modern story-based action role-playing games so that it can be made accessible to blind and visually impaired people.

In order to show that these theoretical game design principles can also be implemented in practice, a prototype is needed that takes up all elements of this work. For this prototype, a larger user study should then take place in which the participants predominantly consist of blind and visually impaired people. Such a study can then show where there is still room for improvement. In addition, several approaches were presented in this work for some problems; these can also be tested in a user study in which situations these are best received by the participants.

Furthermore, feedback from people who are blind or visually impaired is of course very important. Also, the game design principles could be improved by using them in a real AAA story-based action role-playing game because of the greater range of players there.

## 12 List of Figures

- 4.1 Dead Space 3. Adapted from <https://steamcommunity.com/sharedfiles/filedetails/?l=german&id=878867490> (24/08/2020)
- 4.2 PUBG. Adapted from [https://www.reddit.com/r/PUBGMobile/comments/8btgd3/cleaner\\_control\\_layout/](https://www.reddit.com/r/PUBGMobile/comments/8btgd3/cleaner_control_layout/) (24/08/2020)
- 5.1 Witcher 3: Wild Hunt. Adapted from [https://www.reddit.com/r/witcher/comments/352zxc/the\\_witcher\\_3s\\_hud\\_explained\\_oc/](https://www.reddit.com/r/witcher/comments/352zxc/the_witcher_3s_hud_explained_oc/) (20/052020)
- 7.1 Witcher 3: Wild Hunt. Screenshot (Felix Borst)
- 7.2 Witcher 3: Wild Hunt. Screenshot edited (Felix Borst)

## 13 Ludography

- [L1] Rogue. 1980. Universität von Berkeley. Computer-Game
- [L2] Darkstone. 1999. Delphine Software International. Computer-Game. Electronic Arts
- [L3] Gothic 1. 2001. Piranha Bytes. Computer-Game. Shoebox
- [L4] Gothic 2. 2002. Piranha Bytes. Computer-Game. JoWood
- [L5] The Elder Scrolls IV. 2006. Bethesda Game Studios. Computer-Game. 2K Games
- [L6] Gothic 3. 2006. Piranha Bytes. Computer-Game. JoWood, Deep Silver
- [L7] The Witcher. 2007. CD Projekt RED. Computer-Game. Atari SA, CD Projekt
- [L8] The Witcher 2: Assassins of Kings. 2011. CD Projekt RED. Computer-Game. CD Projekt, Bandai Namco Games, Atari, 1C
- [L9] The Elder Scrolls V: Skyrim. 2011. Bethesda Game Studios. Computer-Game. Bethesda Softworks
- [L10] The Witcher 3: Wild Hunt. 2015. CD Projekt RED. Computer-Game. Bandai Namco Games, Warner Bros. Interactive, Spike Chunsoft
- [L11] Horizon Zero Dawn. 2017. Guerrilla Games. Computer-Game. Sony Interactive Entertainment
- [L12] PlayerUnknown's Battlegrounds. 2018. PUBG Corporation. Mobile-Game. Tencent Games, VNG Game Publishing
- [L13] Dead Space 3. 2013. Visceral Games. Computer-Game. Electronic Arts
- [L14] Dead-Vision. 2019. WOBE Sound, Wolfgang Beucher. Computer-Game

[L15] A Blind Legend. 2013. Dowino. Computer-Game. Plug In Digital

[L16] Sound of Magic. 2019. Everbyte. Mobile-Game. Google Commerce Ltd.

## 14 Bibliography

- [1] ABSV. Zahlen und Fakten. URL: <https://www.absv.de/zahlen-und-fakten> (visited on 01/05/2020)
- [2] DBSV. Zahlen & Fakten. URL: <https://www.dbsv.org/zahlen-fakten.html> (visited on 01/05/2020)
- [4] DBSV. Smartphone- und Computerspiele. URL: <https://www.dbsv.org/computerspiele.html> (visited on 02/05/2020)
- [5] GAME. Durchschnittsalter der deutschen Gamer steigt weiter. URL: <https://www.game.de/marktdaten/durchschnittsalter-der-deutschen-gamer-steigt-weiter/> (visited on 29/05/2020)
- [6] GAME. Mehr als 34 Millionen Deutsche sind Gamer. URL: <https://www.game.de/marktdaten/mehr-als-34-millionen-deutsche-sind-gamer/> (visited on 29/05/2020)
- [7] newzoo. The Global Games Market Will Generate \$152.1 Billion in 2019 as the U.S. Overtakes China as the Biggest Market. URL: <https://newzoo.com/insights/articles/the-global-games-market-will-generate-152-1-billion-in-2019-as-the-u-s-overtakes-china-as-the-biggest-market/> (visited on 29/05/2020)
- [8] giga. Blinder spielt The Legend of Zelda Ocarina of Time nach 5 Jahren durch!. URL: <https://www.giga.de/spiele/the-legend-of-zelda-ocarina-of-time-3d/news/blinder-spielt-the-legend-of-zelda-ocarina-of-time-nach-5-jahren-durch/> (visited on 29/05/2020)
- [9] World Health Organization. Blindness and vision impairment. 2019. URL: <https://www.who.int/news-room/fact-sheets/detail/blindness-andvisual-impairment> (visited on 29/05/2020)
- [10] Peter Bathge. The Witcher 3, Assassin's Creed Origins und die Krux mit der Genre-Bezeichnung: Eine Kolumne von Peter Bathge. URL: <https://www.pcgames.de/The-Witcher-3-Spiel-38488/Specials/Action-Adventure-vs-Rollenspiel-Wenn-Genre-Grenzen-verwischen-Kolumne-1248633/> (visited on 27/05/2020)

- [11] IGDA-GASIG. Accessibility in games: motivations and approaches. URL: [http://igda-gasig.org/wp-content/uploads/2011/10/igda\\_accessibility\\_whitepaper.pdf](http://igda-gasig.org/wp-content/uploads/2011/10/igda_accessibility_whitepaper.pdf) (visited on 27/05/2020)
- [12] Ossmann, R. and Miesenberger, K. Guidelines for the development of accessible computer games. In: International Conference on Computers for Handicapped Persons. Springer, Berlin, Heidelberg, S. 403-406, 2006.
- [13] Dead Vision. URL: <https://wobesound.com/portfolio/dead-vision/> (visited on 29/05/2020)
- [14] Sound Of Magic. URL: <https://everbytestudio.com/sound-of-magic-immersives-fantasy-audio-adventure-auf-deutsch/> (visited on 29/05/2020)
- [15] A Blind Legend. URL: <http://www.ablindlegend.com/en/home-2/> (visited on 29/05/2020)
- [16] Archambault, D., Olivier, D., & Svensson, H. Computer games that work for visually impaired children. *Interaction et usages des modalités non visuelles, accessibilité des contenus complexes*, 165. Jg, 2005.
- [17] Unterhaltungssoftware Selbstkontrolle. Genres. <https://usk.de/alle-lexikonbegriffe/category/genres/> (visited on 22/06/2020)
- [18] Dix, A., Dix, A. J., Finlay, J., Abowd, G. D., & Beale, R. *Human-computer interaction*, Pearson Education, 2003.
- [19] Bassolino, M., Franza, M., Bello Ruiz, J., Pinardi, M., Schmidlin, T., Stephan, M. A., Solca, M., Serino, A., & Blanke, O. Non-invasive brain stimulation of motor cortex induces embodiment when integrated with virtual reality feedback. *European Journal of Neuroscience*, 47(7), 790-799, 2018.
- [20] Bowman, D., Kruijff, E., LaViola Jr, J. J., & Poupyrev, I. P. *3D User interfaces: theory and practice*, CourseSmart eTextbook. Addison-Wesley, 2004.
- [21] Wiener, J. M., Büchner, S. J., & Hölscher, C. Taxonomy of human wayfinding tasks: A knowledge-based approach. *Spatial Cognition & Computation*, 2009, 9. Jg., Nr. 2, S. 152-165.
- [22] Siegel, A. W., & White, S. H.. The development of spatial representations of large-scale environments. In: *Advances in child development and behavior*. JAI, 1975. S. 9-5