Title	Project Chujing : the use of tactile models in non-visual games
Sub Title	
Author	孙, 一杰(Sun, Yijie) 南澤, 孝太(Minamizawa, Kouta)
Publisher	慶應義塾大学大学院メディアデザイン研究科
Publication year	2023
Jtitle	
JaLC DOI	
Abstract	
Notes	修士学位論文. 2023年度メディアデザイン学 第1026号
Genre	Thesis or Dissertation
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO40001001-00002023-1026

Master's Thesis
Academic Year 2023

Project Chujing:
The Use of Tactile Models in Non-visual Games

Keio University
Graduate School of Media Design

Yijie Sun

A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

Yijie Sun

Master's Thesis Advisory Committee:

Professor Kouta Minamizawa	(Main Research Supervisor)
Professor Kazunori Sugiura	(Sub Research Supervisor)

Master's Thesis Review Committee:

Professor Kouta Minamizawa	(Chair)
Professor Kazunori Sugiura	(Co-Reviewer)
Professor Nanako Ishido	(Co-Reviewer)

Abstract of Master's Thesis of Academic Year 2023

Project Chujing: The Use of Tactile Models in Non-visual Games

Category: Design

Summary

Today, haptic feedback is becoming increasingly popular in next-gen game, with many users receiving haptic feedback from video games via their smartphones or game-pads. However, the majority of non-visual players can only experience a very small number of products. In response to this market demand, this paper presents a prototype game that allows visually impaired gamers to experience non-visual games as well. In this prototype, players can experience non-visual game elements through different haptic modes. Based on player feedback, the prototype allows players to perceive stories and actions in different virtual environments through haptic and auditory senses. The different haptic modalities combined with the different environments can create a unique emotional experience for the player. The prototype mentioned in this paper demonstrates that haptic modalities can enhance non-visual gaming experiences for the visually impaired.

Keywords:

haptic interaction, next-gen games, visually impaired, non-visual games

Keio University Graduate School of Media Design

Yijie Sun

Contents

List of Figures

List of Tables

Acknowledgements

I had a lot of help writing this article. First of all, I would like to thank Professor Kouta for his help during my study. In the most difficult period of my study, he gave me many new research methods, from which I got a lot of inspiration and played an important guiding role in my final completion of this research.

To Professor Pai, Project Senior Assistant Professor. Thank you for sparing your precious time to brainstorm with me. When I first revised the subject, you gave me a lot of methodology based on my situation, which is very helpful for my research. In terms of the novelty of the research and the motivation of the research, I was not very clear in my early exploration, but the conversation with you made me find the direction again.

I would also like to thank giulia, who has inspired me a lot in terms of prototyping and studio design. In particular, thinking about Ability-Based Design really opened my eyes. Without the accumulation of these theories, I could not improve the systematic production of prototypes. Thank you very much for taking the time to discuss my thesis and research direction with me.

Thanks also to my classmates Danyan Peng, Yaokun Wu, Zhou Lu, Kefei Wong, Kiho Lee, Lucas, Yixing Wang, and anyone else I have not mentioned here. You have given me a lot of inspiration and knowledge in different fields during my study in kmd. I sincerely thank you for accompanying me all the way through my journey in kmd.

I am also grateful to my seniors, Maeda, Mark, Kiku, Yan He, Ziyue Wang, Kinga, Taku, Cindy, etc. You have also given me a lot of interesting research methods. Thank you for your company all the time.

Finally, I would like to thank my family for their silent blessings and financial and spiritual support throughout my years of study. Without their support behind me, I could not have successfully completed my study.

Chapter 1
Introduction

1.1. Background

How do blind people play games? Can they take part in e-sports? The truth is that many people have never thought about such questions. Today, in the age of smartphones, computers and mixed reality, which is full of short videos and games, people are used to receiving vast amounts of images on a daily basis. However, few people have thought about how people with visual impairments can access information from the internet as well as play games like sighted people.

As an example, a 2016 report [1] officially states that there are about 13 million people with visual impairment in China. Of this, 95% of the sample showed that the visually impaired were between the ages of approximately 12 and 50, meaning that the vast majority were young people.

In addition to this, 85% of the sample is visually disabled in the first degree, manifesting as no light perception and total blindness.

In addition, 34% of the visually impaired persons had a high school education. Overall, the majority of visually impaired people are highly literate, have good verbal and written skills, and are independent learners. They are able to learn different aspects of knowledge and develop social communication skills.

According to the data in the report, 41% of the visually impaired usually spend more time on the computer than on their mobile phones, and 40% of the visually impaired have been playing games.

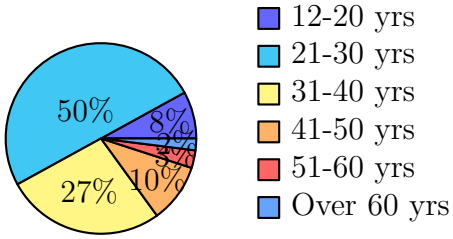


Figure 1.1: Age of the visually impaired in China

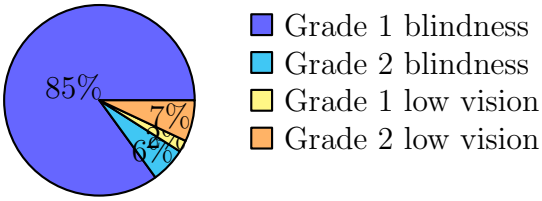


Figure 1.2: Levels of visual disability for the visually impaired

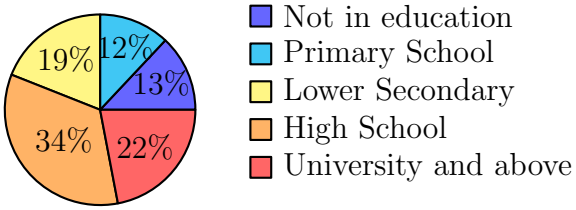


Figure 1.3: Educational attainment of the visually impaired

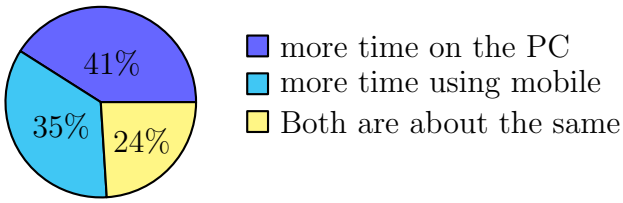


Figure 1.4: Share of time spent on PC/ mobile by visually impaired

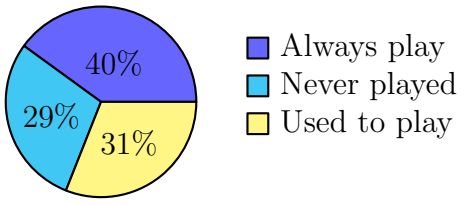


Figure 1.5: Visually impaired have played the game or not

(Source: China Information Accessibility Product Alliance [1])

However, as many gaming software has not been optimised for accessibility, the vast majority of gaming needs of visually impaired are not met.

Moreover, not only the visually impaired, but also the sighted are not satisfied with a single visual and auditory interaction. The vast majority of people, prefer to interact with their mobile phones or other hardware to temporarily escape and be satisfied in virtual cultural entertainment. In fact, short videos and mobile games take up almost all of free time of people. In the gaming sector in particular, in addition to visual and auditory forms of interaction, there is a growing demand for haptic interaction, which has led to the creation of many haptic products. For example, people who have to be away from home for work or other reasons, or who live with strangers, still need to connect with others due to emotional connections and an instinctive desire for touch [2]. Public events such as free hug, for example, can go a long way to alleviating social anxiety. They have been shown to enhance the emotional connection that people have in their daily interactions [3]. Until now, people have focused more on visual and auditory communication and less on tactile communication. Although tactile elements have been shown to enhance the intimacy of communication, the results are often limited by the size of the sample and the age and background of the participants.

1.2. Problem Statement

So how do game designers, help visually impaired players to play games?

In presentation of Karen Stevens [4], it was mentioned that we can use 3D sound design, reactive instructions, audio landmarks, tactile feedback, deterministic menus (where the options and order of the menus are fixed) to help visually impaired players to experience the game. For blind people, it is important that they know where the cursor is located on the menu. One of the cues that can replace audio cues in games is haptic feedback, which can also be called rumble. Take haptic feedback in crossover fighting games as an example, where it can lead to additional information, such as the weight of the attack, at the moment the protagonist makes contact with the enemy. But how should a visually impaired person, in a 3D game, such as the National Football League (NFL), get detailed information about other players? Also, where are the other players located and

what is their behaviour and feedback? Without the ability to turn on the default camera (the default view or camera setting) or auto-navigation, it is difficult for visually impaired players to provide timely feedback on changes in the game.

In addition to this, as the gaming community continues to grow, the rigid needs of non-visual players for experiences remain unmet. These demands include more interaction with other players and the pursuit of a more immersive and rich multi-sensory experience.

Recent party games such as Fall Guys: Ultimate Knockout [1], Eggy Party [2], PlayerUnknown's Battlegrounds (PUBG) [3] and many more. The success of these games exemplifies the need for game designers to provide players with more User-generated content (UGC). Products need to satisfy not only the creative needs of players, but also their strong social desires.

Game designers and community builders need to think about how to break down the limits of interaction scenarios so that users in different locations can convey their mutual happiness through haptic and experience memorable gaming experiences together in virtual environments. In contemporary game design, many works focus on mind flow and art style. For example, masterpiece of Jenova Chen "Journey" [5]. These works present the user with a world that looks like a dream world in a fairy tale, with an emphasis on the overall mind-flow experience and a weakening of competitive elements such as strong confrontation and PVP.

However, whether factors such as tactile feedback, community building and mind-flow experiences are really effective in non-visual gaming experiences still needs to be further explored.

1 Fall Guys: Ultimate Knockout [Video game]. (2020). London, CA: Devolver Digital.

2 Eggy Party [Video game]. (2022). Hangzhou, CA: NetEase Games.

3 PlayerUnknown's Battlegrounds (PUBG) [Video game]. (2016). Seongnam, CA: Krafton .

1.3. Research Goal

The research aims to prototype games for people with visual impairments, combining haptic feedback and audio experiences, using the Unreal Engine 4.27 and PS5 voice coil actuator to achieve this. Questions for this research include:

1. how to enhance the single visual-audio experience for people with visual impairments through multiple haptic modalities such as different tactile cues, warnings and behaviours

2. how to increase accessibility elements in games by optimising the User Interface of game.

3. how to design inclusive and ability-based products to meet the needs of different players.

4. what types of non-visual games are preferred by blind people and why.

5. what the future direction of non-visual games is.

The contribution of this study is to construct a non-visual gaming experience for both the sighted and the blind, and to raise the profile of players to visually impaired players through this research. In addition, the study provides a collation and reflection of haptic modalities for future entry into the visually impaired gaming community and non-visual game production, and explores the importance and richness of combining audio and haptic in the practice of prototyping, combined with theories based on ability design, suggesting a new direction for the future development of multi-modal experience games.

1.4. Paper Structure

This thesis consists of 5 chapters.

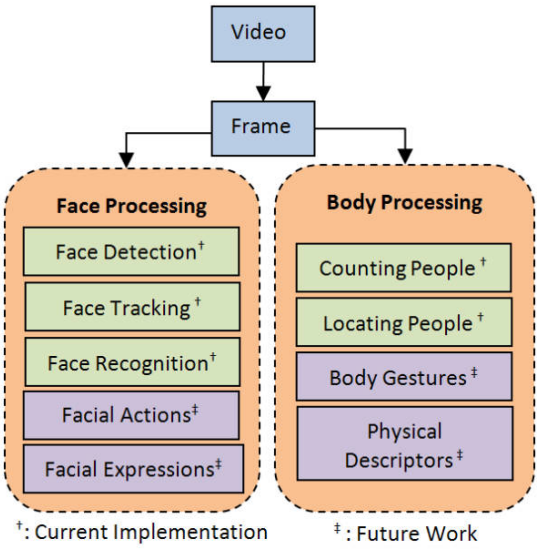
- Chapter 1 introduces 1. background 2. Problem Statement 3. Research Goal 4. Paper structure
- Chapter 2 categories other work related to the research topic. Examples include 1. Visually impaired interactions 2. Accessible Gaming 3. Haptic for Non-Visual Games
- Chapter 3 discusses the prototype design, including 1. Design Proposal 2. Preliminary Survey 3. Initial Prototype
- Chapter 4, the prototype made in Chapter 3 is used to verify the hypothesis. This chapter consists of 1. Pilot Research 2. Experimental iteration
- Chapter 5 summarizes the current research, and discusses the weaknesses and limitations of the research, and puts forward suggestions for future research, exploring the possibility.

Chapter 2
Literature Review

2.1. Visually Impaired Interactions

2.1.1 Converting Visual Information into Audio Cues

In a study by Sreekar Krishna et al [6], they developed an assistive device that can help visually impaired people to enhance their social interaction. In simple terms, it uses a miniature camera and facial detection algorithms to recognise facial expressions of others and converts visual information into audio cues via an audio transmitter, thus helping blind people to better understand their surroundings.



(Source: A systematic requirements analysis and development of an assistive device to enhance the social interaction of people who are blind or visually impaired [6])

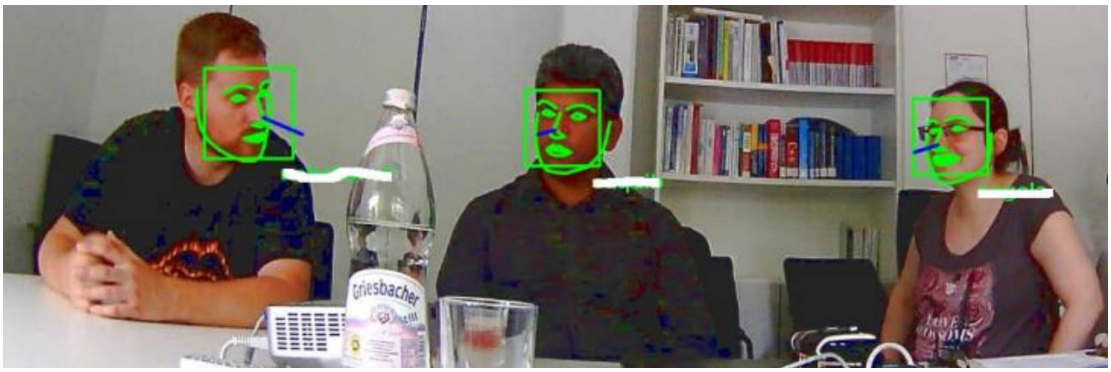
Figure 2.1: Social Interaction Assistant Software

In everyday life, social interaction between people includes a large number of non-verbal behaviours [7], such as facial expressions, posture, eye contact, gestures and so on. These behaviours can convey emotions [8], intentions and inner thoughts. However, as blind people cannot see these non-verbal behaviours, they learn how to infer the emotions and intentions of the other person by listening to the changes in tone and voice during a conversation. And by voicing their questions and thoughts proactively in order to get more information and help. In fact, modern technology can help blind people understand non-verbal behaviour in social interactions. For example, with smartphone AI voice assistants [9], and especially ChatGPT [10] being loaded onto smartphones, the ability of blind people to interact socially can be significantly improved. But a technology-centric approach tends to ignore the needs and experiences of users when developing products. In reality, blind people do not always have access to spatially and visually relevant information in social interaction, as is also evident in 3D games. The spatial perception and non-verbal expression recognition abilities of blind people are difficult to meet their daily needs without the help of any assistive design. Similarly, in the case of facial detection algorithms and identity matching related issues, the prototype had to ensure that the data was used and stored in a way that did not lead to the disclosure of personal information and invasion of privacy. In addition, the sensor may cause a psychological burden to the other person as it reads the micro-expressions of non-verbal behaviour of a sighted person without informing them. In conclusion, although the prototype helps blind people to better perceive their surroundings and improve their quality of life, the prototype may be costly and there are issues of disruption to the lives of those around them, or privacy and ethics.

2.1.2 Multi-Modal Assistive Systems

Firstly, a multi-modal assistive system [11] is a system that is able to assist the user with specific services and goals through multiple sensory modalities, such as vision, hearing and haptic. This type of system is able to use a combination of sensory signals to provide a more comprehensive, accurate and efficient assistance service, depending on the needs of the user and the changing environment. In a study by M. Saquib Sarfraz et al [12], it was demonstrated that multi-modal assistive

systems containing face recognition, voice cues and haptic feedback can allow visually impaired people to better perceive their surroundings in social situations.



(Source: A multi-modal perception based assistive robotic system for the elderly [11])

Figure 2.2: A typical system output overlaid on a frame

Compared to conventional assistive systems, multi-modal assistive systems have significant differences. For example, multi-modal assistive systems can provide additional assistance not only through voice cues, but also through haptic, olfaction and even gustatory sensations. As the different sensory modalities can be adjusted in real time, they can be more flexibly adapted to the needs of the user than conventional assistance systems.

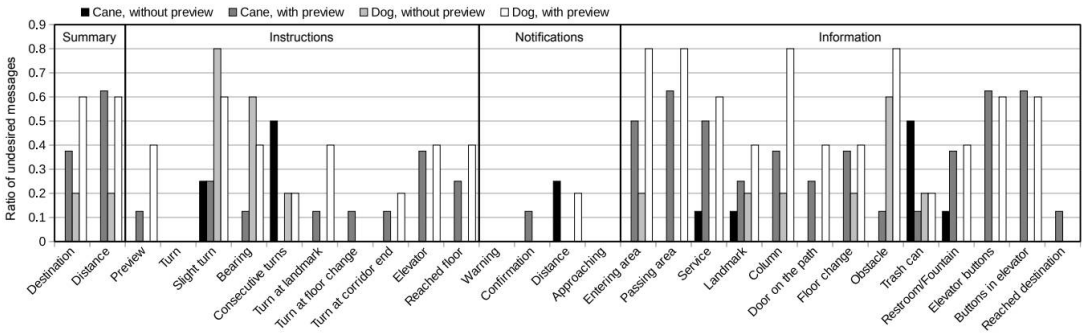
When researching multi-modal assistance systems, care must be taken to avoid counter-intuitive system measures, even when good design solutions are available. These design approaches are often the opposite of what users are used to and think. In visually impaired interaction design, for example, inconspicuous colours or insufficient contrast for the visually impaired [13] may result in the user not being able to clearly identify different elements. A lack of audio cues can leave the visually impaired person unaware of exactly what is happening in the game or story of the experience. Due to the large amount of content that visually impaired people need to remember in their daily lives [14], complex interaction flows can lead directly to the user getting lost in the application. Therefore, the design needs to simplify the interaction flow [15, 16] and allow the user to operate the application with ease. In addition, controls that are difficult to manipulate may also cause problems for the visually impaired. If there are larger buttons or simple

gestures that can be used, this will allow users to operate and interact more easily.

As a common need for visually impaired people in social interaction is to be able to better perceive and understand their surroundings and tasks through multiple sensory modalities, they need to be able to recognise sounds, objects and people more accurately and to understand their position, orientation and movement. Therefore, a multi-modal assistive system may be what visually impaired people need. In addition, such systems need to be scalable and easy to use to facilitate a better response to the needs of different visually impaired people. For example, Microsoft has introduced the Xbox Adaptive Controller [17], which is primarily designed for the physically challenged, but visually impaired people can customise the layout of the buttons to make gaming easier and can also personalise the configuration to suit their needs for a better gaming experience.

2.1.3 Interaction Preferences

In the study by Dragan Ahmetovic et al. [18] it was shown that different interaction preferences exist for different blind users.



(Source: Impact of Expertise on Interaction Preferences for Navigation Assistance of Visually Impaired Individuals [11])

Figure 2.3: Ratio of undesired messages by message type, aggregated by navigation aid used and by route prior knowledge.

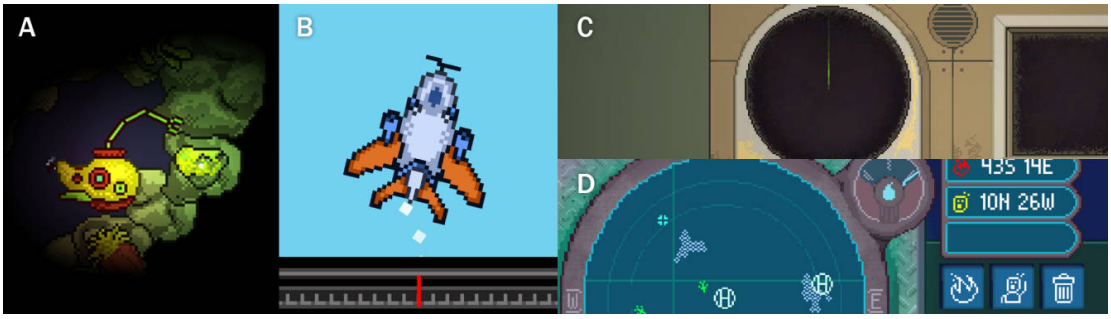
When using different navigation assistance systems, users from different professional backgrounds may choose different technologies, for example, those who come to voice prompts may choose voice navigation, while those who come to

visual information may prefer to use augmented reality technologies, depending on the mental model [19] that the blind user wants to construct. Navigation Assistance Technology (NAT) [20] is a similar technology that combines voice prompts, vibration feedback and directional instructions, while Radio Frequency Identification (RFID) [21] correlates object location information with identification information and detects and tracks its position and movement in real time. In order to provide better services to blind users, the need to differentiate products to suit the level of expertise of different user groups is an aspect of interaction design for the blind that needs to be considered in the future.

2.2. Accessible Gaming

2.2.1 Mixed Ability Games

In the study by David Gonçalves et al [22], it is mentioned that mixed ability games can enhance gaming experience and allow people with different abilities to work together and get a sense of achievement.



(Source: Exploring asymmetric roles in mixed-ability gaming [22])

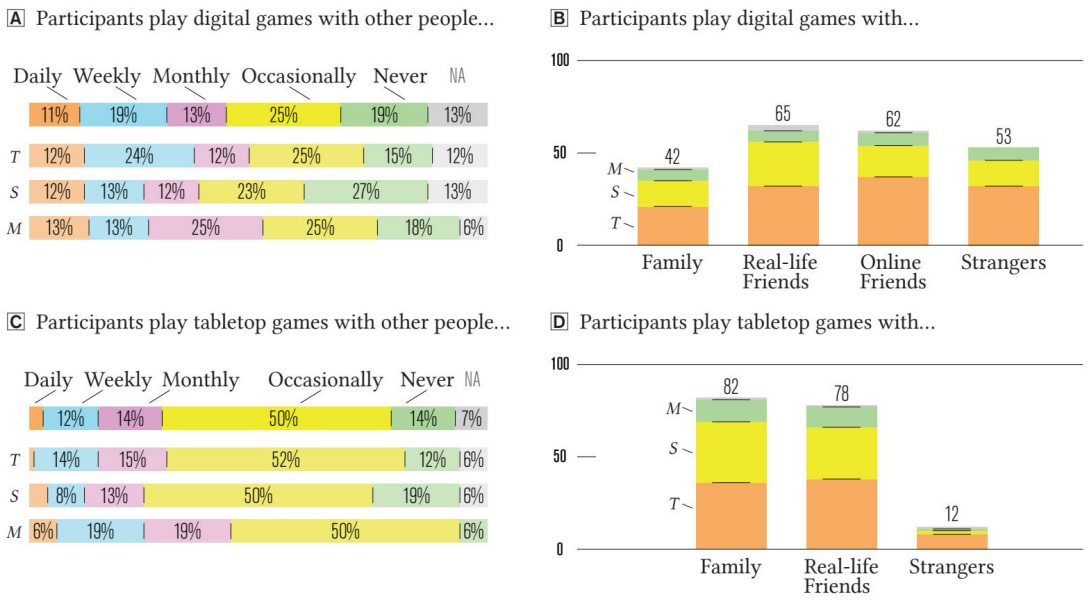
Figure 2.4: Screenshot details presenting the roles in the games

In order to balance the sense of imbalance in mixed ability games, the gaming experience can be enriched by dynamic difficulty adjustment [23], teamwork and diverse game modes. However, the design intent and play experience can vary greatly from game to game, and some games about ability-based design [24] for the blind may be exclusive for the sighted. In games, blind people can equally

experience the game narrative through sound and text descriptions, as well as through markers [25], identifying characters and travelling to locations. Due to the asymmetrical ability character design [26], it indirectly promotes collaboration and interaction between players, a gameplay style that enhances the enjoyment and challenge of the game.

2.2.2 Multiplayer Experience for Visually Impaired

Based on research of David and Rodrigues et al. [27], visually impaired people rely heavily on sound effects in games as they provide narrative and information. Visually impaired people enjoy multiplayer games, but prefer to play with visually impaired people, who are more likely to understand each other considering fairness, similar gaming preferences, communication barriers, and shared experiences.



(Source: Playing with others: Depicting multiplayer gaming experiences of people with visual impairments [27])

Figure 2.5: Gaming habits of respondents to the first survey (Q-VI) particularized by visual impairment of respondents

In addition to this, visually impaired people prefer to promote asynchronous games rather than real-time games, mainly due to the imbalance in difficulty of the

games. Strategy [28] and card games [29] are more popular with visually impaired players due to the length of time that asynchronous games allow players to play in sufficient time without the need to interact with other players to implement them. This is because visually impaired people need more time to perceive what is on the screen through a screen reader [9,19] in order to understand the elements and actions in the game.

2.2.3 Audio Games

Gamers with visual impairment (GVI) [30] are people who need aids to overcome their visual impairment in order to complete their gaming tasks. Among them, audio games [31, 32] are the most played type of games by visually impaired gamers.

(Source: Sound and music in games [31])

Figure 2.6: Rez HD for Microsoft's Xbox 360, remake of original Rez for Sony's Playstation One

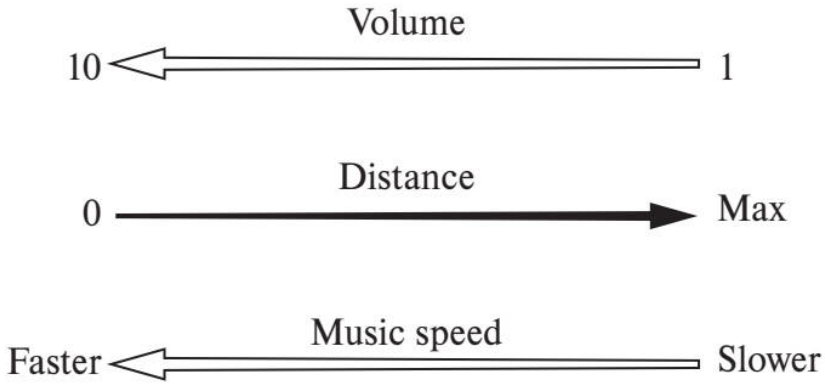
Kirk [33] summarises the characteristics of different types of audio games, such as prompting by voice or text, requiring players to react in time based on timing,

and limiting the player character to move only on a grid of coordinates, in ways that control the difficulty [23] of the game and ensure game balance. In addition, left and right channel and echolocation technologies can enhance the playability and immersion of audio games, with the former simulating a stereo sound effect and allowing players to react accordingly to enemy locations and directions of movement, and the latter allowing players to better determine the source of sounds, such as the location of enemies in the shadows.

2.3. Haptics for Non-Visual Games

2.3.1 Typological Analysis of Sound and Tactile Sensations

In the study by Valente et al. [34] the inclusiveness of non-visual games is explored through the use of sound and haptics instead of images and animations in games. Indeed, systems exist for classifying different sound categories in game design, such as visual lexical semiotics model of triangular sign structures of Charles Peirce [35]. The characteristics of sound can be categorised as the meaning, pitch and rhythm of the sound. In game narratives, the ability to communicate meaning semiotically is essential.



(Source: Turn off the graphics: designing non-visual interfaces for mobile phone games [34])

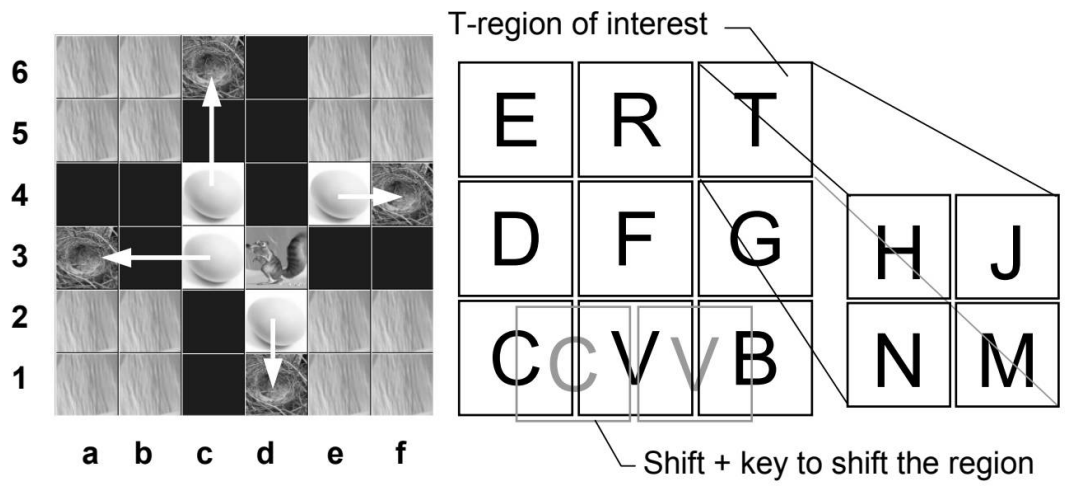
Figure 2.7: Schematic view of the audio radar

Haptic feedback in games can be categorised into a number of types, which Ea Christina Willumsen et al. [36] have reduced to two categories, namely the feedback source and the level of operation. However, this classification is not the same as that of HFX studio [37] and Immersion Corporation [38]. Feedback source include the environment, interaction of objects, User Interface, kinesthetic, physiological, and sixth sense [39] resulting from character actions. Level of operation includes prompts, technical demonstrations, and elements of dramatic narrative.

This classification is inspired by traditional semiotics. Semiotics considers that symbols are made up of two important aspects: the Denotation and the Connotation. In the tactile feedback genre of the game, the Denotation are as important as the connotations. The former provides the specific content and form of the tactile feedback, while the latter conveys the storytelling and drama of the game itself. In game design, therefore, designers seek not only a fluid experience for the player in the game, but also an emotional experience and new perceptions.

2.3.2 Tactile Prompts as an Alternative to Visual Ones

In study of Kuber et al. [40], tactile cues were identified as the key to developing non-visual memory games. In research of Kuber and Yu [41], it was found that users were able to remember multiple tactile messages and could convert tactile stimuli into memories through extensive training. In paper of Evreinova et al. [42] , it was revealed that an egocentric [37] 2D plane orthogonal to the visual axis with a haptic spring effect may better help non-visual players to understand the game space.



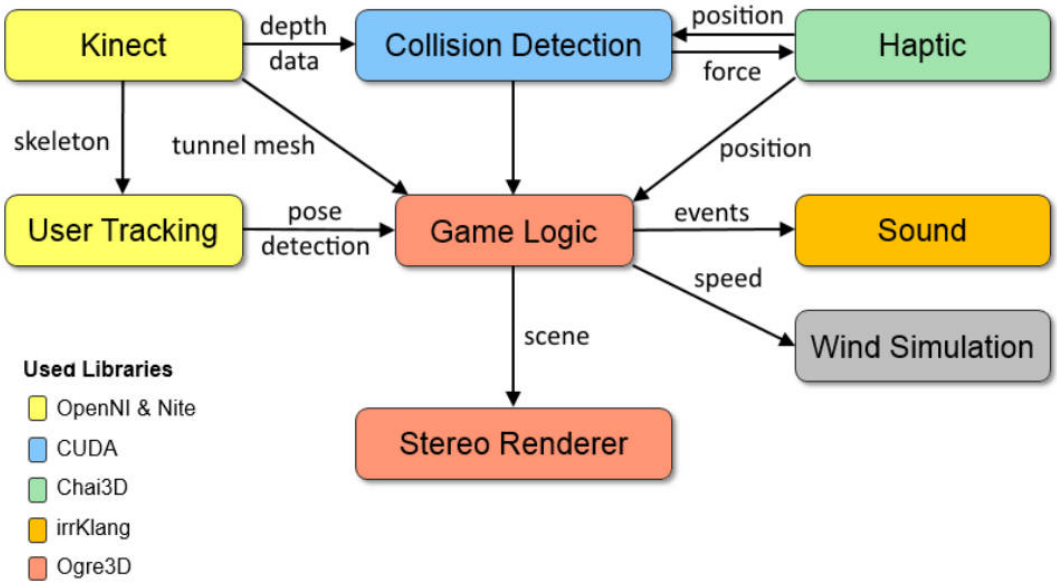
(Source: Non-visual gameplay: Making board games easy and fun [42])

Figure 2.8: Gamespace: 6 by 6 cells, 4 states per cell and the game character Scrat

In analysis of Jaime [43] revealed that haptic cues related to direction, distance and environment can help visually impaired people to improve their spatial awareness. Zulfi Alam [44] argues that different rhythms and intensities can be presented through the rumble of the game controller, allowing players to play more naturally and intuitively, and using tactile channels to maintain brand loyalty and brand awareness. Haptic-audiovisual (HAV) system [45, 46] can also improve the attention of users, sense of presence [47] and emotional engagement [48, 49].

2.3.3 Haptic Feedback Practices in Games

Rich haptic modalities can enhance the gaming experience for visually impaired players. In the work of Grabski et al. [50], haptic devices such as the Phantom were used to help visually impaired players simulate different physical sensations such as force, pressure, vibration and friction in asymmetrical games [22].



(Source: Kinaptic-Techniques and insights for creating competitive accessible 3D games for sighted and visually impaired users [50])

Figure 2.9: System overview

In the study of Youngbo Aram et al. [51], invisible interactions [52] based on physical springs, damper simulations and collision representations can convey information that is difficult to represent visually and auditorily. In the research by Andrade et al. [30] provides a framework for introducing games for visually impaired players by describing the gaming experience for visually impaired players and suggesting that designers and visually impaired players should work together to design tactile gaming experiences. The Immersion Corporation [38] reports that aspects of in-game states, cues and warnings, behaviours and actions can be grouped into one of the categories of haptic feedback in games. These categories are reflected in recent games such as God of War Ragnarök[4] and Horizon

4 God of War Ragnarök [Video game]. (2022). San Mateo, CA: Sony Interactive Entertainment.

2[5], Uncharted 4[6] . The research by Ulrik Söderström et al. [53] also demonstrates vibrational cues such as explosions, shots, and heartbeats [54] in shooter games. These are all types of feedback that can have a positive effect.

2.4. Summary

The following points can be summarised from these studies:

- Not only in social situations, but blind people have the same need for tactile and audio cues in games, as the vast majority of blind people do not have access to visual information.
- A multimodal system that includes haptics is necessary for the use of non-visual games.
- Non-visual games should respond to the interaction preferences of the visually impaired.
- Games with mixed abilities can be considered to increase the multiplayer experience for the visually impaired.
- The results of haptic typology analysis and the practice of haptic feedback can be applied to the design of haptic models for non-visual games.

5 Horizon 2: Forbidden West [Video game]. (2022). Amsterdam, CA: Sony Interactive Entertainment.

6 Uncharted 4: A Thief's End [Video game]. (2016). Santa Monica, CA: Sony Computer Entertainment.

Chapter 3
Concept Design

3.1. Design Proposal

3.1.1 Overview

The project is called Chujing, which is derived from the Chinese idiom, chu jing sheng qing, from the Yuan dynasty sanqu song Gui Yuan [55]. It means that scene which recalls past memories. As chu is also used in Mandarin, it means to haptic. Here, in a double entendre, we want to convey the meaning of allowing visually impaired people to perceive non-visual virtual gaming experiences through the sense of haptics.

The initial goal of the research is to create different scenarios for the visually impaired based on a semiotic haptic model and the results of a questionnaire study. The game engine produced, which will be based on Unreal Engine 4.27 [56], will eventually be exported as software for users to test. The visually impaired will move through the different scenes and feel the changing landscape of forests, deserts, glaciers and fields through their sense of tactile and auditory senses. The hardware for input system to the PC will be the DualSense wireless controller of PlayStation [57]. The game prototype will start with a single-player flow, where the sound of the character stepping on different physical material [58] surfaces, through the sense of touch, will be transmitted to the experience.

(Source: Yijie Sun)

Figure 3.1: forrest concept

3.1.2 Target Users

The target users of the study were visually impaired people, both totally blind and partially sighted. However, before designing the visually impaired workshop, we intend to use preliminary survey to understand the common haptic patterns of users in the current market, and collate the types of haptic expressions in PlayStation games through the typology of haptic [36], and a methodology for recording 1-hour gaming experiences [38], and utilize them into the prototype design. We will first invite sighted people to participate in a pilot study of the prototype, modify the version based on the feedback and invite blind people to participate in the workshop once the modifications are complete.

3.2. Preliminary Survey

3.2.1 Pre-Experiment Questionnaire

The pre-experiment questionnaire was made through the WenJuanXing(WJX) platform, and the number of questions was 38 based on the research direction and theme. The answers to this questionnaire were all from WeChat, and a total of 109 valid questionnaires were received. The main purpose of the pre-experiment questionnaire is to understand the favorite types of games from users and their preference for haptic feedback in different types of games. The goal is to improve the quality of user experience test feedback by inviting the target audience and prioritizing their feedback. Ultimately, content about the game (including haptic feedback design, art style, and game system design) is provided based on the selected goals, preferences, needs, habits, behavior patterns of the user group, and market research. In conclusion, the results of this questionnaire can reduce the cost of prototyping, effectively use resources, and increase the potential for the prototype to resonate in the market. At the same time, through the questionnaire, we can understand the average amount of money spent by different players, and the games they are currently playing or familiar with. The names of the survey participants were kept anonymous.

3.2.2 Survey results

Next, the research results will be analyzed in terms of age, gender, player motivation, response to PVP, value in the game, and expectations of haptic feedback.

Gender

Finding: Among the people who participated in this questionnaire, the male accounted for 49% and the female accounted for 51%. Summary: Male to female ratio is close, there is no obvious gender preference.

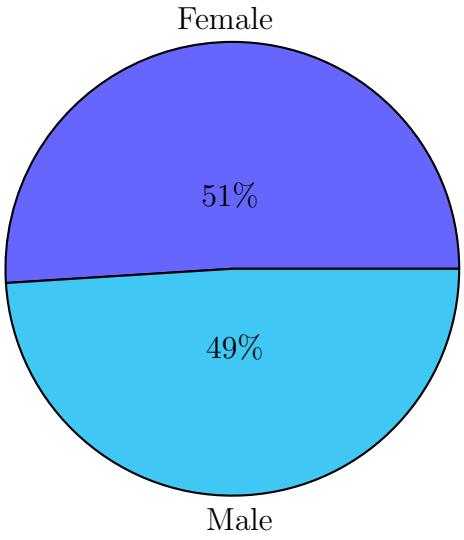


Figure 3.2: Gender

Age

Finding: The number of people aged 31-40 was the largest in this questionnaire, accounting for 23%. Those aged 41 to 50 and 18 to 24 accounted for 23% and 16% respectively. The number of people above 60 years old was the smallest, accounting for 8%. Summary: The age distribution of the people participating in this single topic is balanced, but the young and middle-aged group has a higher participation.

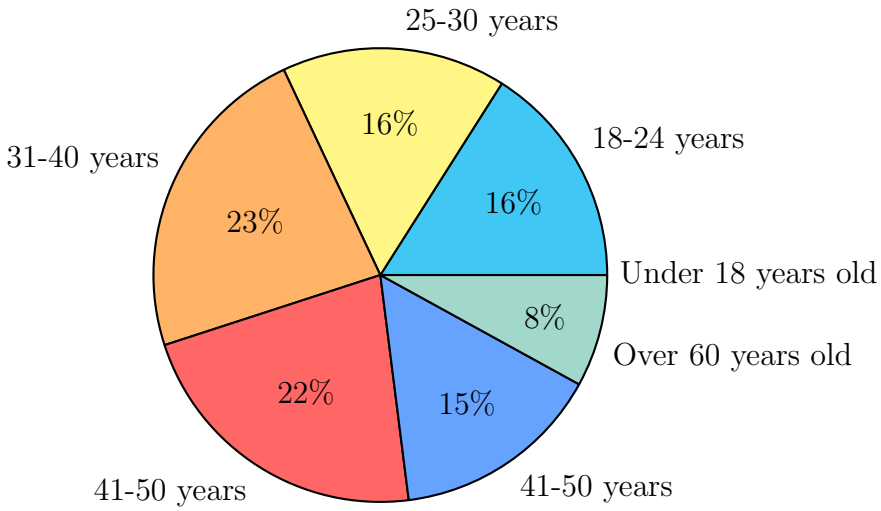


Figure 3.3: Age

PVE mode

Concept: Unmatched matchups are often referred to as PVE matches, which are played against a computer AI. In this case, high scores and rewards can be earned by completing quests, defeating bosses, etc., competing with other players for rankings and achievements. Findings: There are 48% people like or very like the unmatched game, there are 40% people do not like or very dislike the unmatched game. In addition, 12% were neutral. Summary: Some people like PVE, but others may prefer PVP.

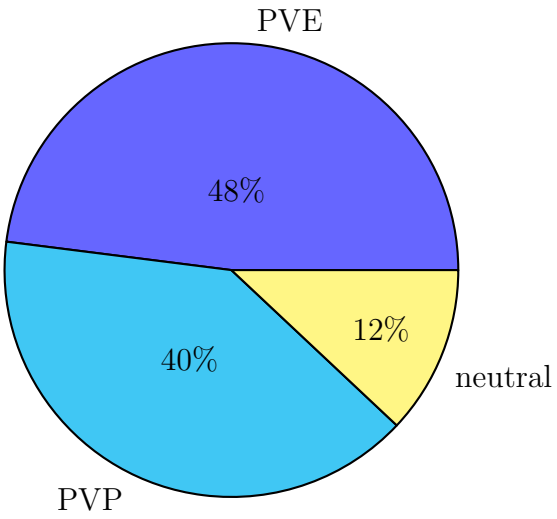


Figure 3.4: PVE Mode

Main Play Platform

Finding: In the last 6 months, the most popular gaming platform was console, followed by PC and mobile. Emulators and consoles have relatively low usage rates, but average scores are higher than other platforms. MR platforms have relatively low usage, but high average scores among those who use them. Summary: The average score across all platforms is around 3.8, indicating that there is no significant correlation between platform choice and satisfaction.

The Popularity of Multiplayer PvP Games

Finding: Over 85% (94 people) prefer multiplayer PvP games. Among them, 46% (50 people) are addicted to it, 40% (44 people) like it, and 14% (15 people) have a general attitude. The number of people who do not like it at all and the number who do not like it is zero. Conclusion: Multiplayer PvP games are quite popular among respondents, with the majority of those who like them excessively and those who like them immensely.

Table 3.1: Main Play Platform(Matrix)

Title or Options	1	2	3	4	5	Average score
PC	8	13	12	40	36	3.76
Console	11	6	9	45	38	3.85
Mobile	9	10	12	36	42	3.84
Simulator	2	18	7	39	43	3.94
Handheld Console	11	8	7	42	41	3.86
MR	5	10	21	40	33	3.79
Total	46	65	68	242	233	3.84

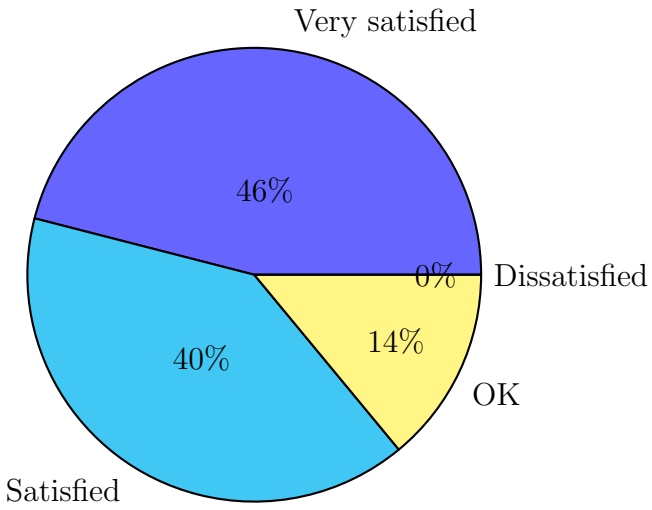


Figure 3.5: The Popularity of Multiplayer PvP Games

Most Played Multiplayer Online Games

Finding: The most popular types of multiplayer online games are MMORPG and FPS, both at 49%. This was followed by Co-op ACT and Battlefield, with 50% and 38%, respectively. Arena games had the lowest percentage at 15%. In addition, the percentages of Cards, Sandbox Survival and Tarkov games were also relatively high at 13%, 12% and 12%, respectively. Diablo games had the lowest percentage at 8%. Summary: Prototypes of MMORPGs and design games are

likely to be more popular with gamers.

Table 3.2: Most Played Multiplayer Online Games(MC)

Options	Total	Proportion
MOBA	34	31%
MMORPG	53	49%
FPS	53	49%
Co-op ACT	55	50%
Battlefield	41	38%
Arena	16	15%
War Simulation	23	21%
Battle Royale	5	5%
Cards	14	13%
RTS	6	6%
Tactical Action	6	5%
Sandbox Survival	13	12%
Tarkov	13	12%
Diablo	9	8%
Total	109	

The Relevant Factors to Consider When Buying Console Games

Finding: Of all the options, the media received the highest rating from players, with an average score of 4.02, indicating that players were more likely to listen to other players to make purchase decisions. Story was the highest, with an average score of 3.87, followed by gameplay and graphics, indicating that players were more focused on story and gameplay. Whether the game is exclusive to the platform and whether it has the highest player rating in the media indicates that players are more concerned about uniqueness and word-of-mouth. The low price score indicates that price is not the most important consideration when buying console games. Summary: The highest scores in the subtotal are for options 5 and

6, indicating that players are more concerned about uniqueness and reputation of the game, as well as whether the game has a local translation.

Table 3.3: The relevant factors to consider when buying console games(Matrix)

Title or Options	1	2	3	4	5	Average score
Visual Quality	7	9	16	37	40	3.86
Storytelling	14	3	5	48	39	3.87
Gameplay	7	6	15	48	33	3.86
Price	5	11	12	38	43	3.94
Media Player Rating	5	10	10	37	47	4.02
Localized Translation	4	13	7	43	42	3.79
exclusive to the platform	14	4	9	36	46	3.88
Total	56	56	74	287	290	3.92

Tactile Feedback in Daily Life

Finding: 67% of the people experienced haptic feedback in computer and mobile devices. This was followed by medical and dental scenarios, with 60% experiencing tactile feedback. Games and entertainment scenes had the fewest tactile feedback, with only 46%. The number of people experiencing tactile feedback in automotive and aviation scenarios was also low, at 46%. Summary: Haptic feedback is most commonly used in computer and mobile device scenarios.

Types of Tactile Feedback Experienced in Games

Findings: The most common type of tactile feedback experienced in games is behavior and action, with 62% choosing this option. This was followed by providing tips and warnings, which was chosen by 60%. Signal status and alarm were also common types of tactile feedback, with 48% choosing this option. For the enhancement of emotion and the creation of atmosphere, relatively few people chose these two options, 49% and 22% respectively. Summary: Actions and behaviors, as well as prompts and warnings, are the types of haptic feedback players

Table 3.4: Tactile feedback in daily life(MC)

Options	Total	Proportion
PC and mobile devices	73	67%
Medical and Dental	65	60%
Games and Entertainment	50	46%
Automotive and Aviation	50	46%
Total	109	

experience the most in games.

Table 3.5: Types of tactile feedback experienced in games(MC)

Options	Total	Proportion
Status and Alerts	52	48%
Tips and Warnings	65	60%
Behaviour and Action	68	62%
Emotions	53	49%
Sense of Atmosphere	24	22%
Total	109	

Tactile Feedback in Action Adventure Games

Findings: According to the data table, the most important haptic feedback was to increase fear, tension, enemy presence alarm, and fatal blow, swordsmanship, other weapons, and explosion. The average haptic feedback score was 3.95 and 3.92, respectively. The average score for haptic feedback was 3.78 for warning when hit or blocked, machine gun strength, recoil, and immediate danger. Next came the collapse of pillars and walls; Fighting back, riding bumps, solving puzzles, editing scenes, fighting. A sixth sense, such as UI hints that users can create a secret base, is also important. The average score for other tactile feedback was

between 3.7 and 3.84, which was relatively low. Summary: Warning of the presence of enemies, different vibrations of weapons, and explosions are some of the most important tactile feedback in action adventure games.

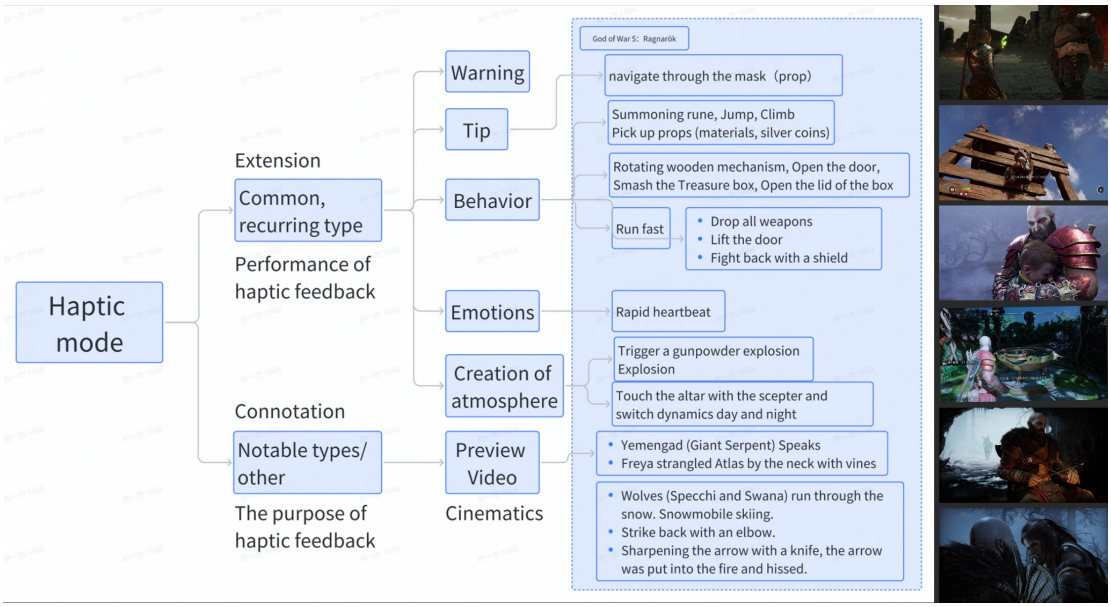
Table 3.6: Tactile feedback in action adventure games(Matrix)

Title or Options	1	2	3	4	5	Average score
Warning	9	10	13	41	36	3.78
Rumble Level	11	9	9	54	29	3.72
Fear	8	8	12	34	47	3.95
Explosion	6	12	6	46	39	3.92
Disaster Weather	10	9	12	51	27	3.7
Building Collapse	5	12	9	46	37	3.9
Carriers	11	8	8	43	39	3.83
Transition Animations	10	10	4	50	35	3.83
Puzzles	9	8	11	46	35	3.83
Walking	7	12	8	46	36	3.84
Sixth Sense	8	11	12	40	38	3.82
Total	94	109	104	494	398	3.83

3.2.3 Haptic Models Solution

Taking “God of War: Ragnarok” as an example, the haptic mode in the game can be roughly divided into Common, recurring type and Notable types. Among them, the Common, recurring type is more of the external manifestation of haptic feedback. The Notable types tactile feedback emphasizes the purpose of tactile feedback. Haptic feedback, for example, can be subdivided into warnings, tips, behaviors, emotions, and atmosphere. In “Ragnarok”, the character Atreus can navigate with haptic through fragments of the mask, and when the green mask is pointed in the right direction, the voice coil actuators on both sides of the gamepad emit a continuous progressively stronger vibration. Away from the correct direction, this vibration will weaken until it stops vibrating. There are more

haptic feedback that represent character behavior. Running, climbing, opening doors, and using props are all different haptic feedback, and they will change the sound channel and alternate vibration of the left and right motors according to the spatial position of the character. Since special haptic feedback emphasizes the purpose of feedback, narrative sound effects, particle effects, audio or action cues, UI interaction, and haptic hardware parameter adjustment can all be included in this category. Specifically, in the early chapters of "Ragnarok", Atreus will feel the natural energy by touching the cedar bark with his hand, and the tactile feedback will gradually pass from the base of the cedar bark to the top of the leaf cluster, spreading out in the form of pulses.



(Source: Yijie Sun)

Figure 3.6: Haptic Model

3.3. Initial Prototype

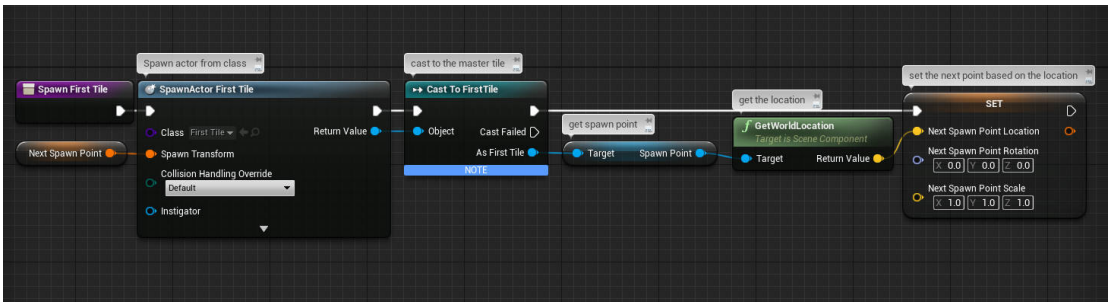
In prototyping, we assume:

- Tactile feedback and auditory can meet the demands of the player and can convey the actions and movements of players.
- The player could play the game mechanics completely without visual cues.
- Basic tactile model methodology could be summarized and new tactile experience could be designed based on the results of previous literature research and questionnaire survey.

The final prototype will be evaluated using the Game User Experience Satisfaction Scale (GUESS-18) [59]. Past user experience satisfaction scales for games have been too lengthy to be applied in practice. The GUESS-18 is relatively easy and convenient to use. It includes game-play, aesthetics and emotions. As the study focuses more on tactile feedback and sound rendering [60], the question template of part of the satisfaction scale will be modified.

3.3.1 Production of Game Prototypes

For the game prototype, Unreal Engine version 4.27 was used in the game Engine section. In the game-play section of the game, it borrows game-play design from early 3D endless games. The player controls an avatar, running through an endlessly generated block of blueprints named Tile. In an earlier design version, Tiles have no physical material and are only filled with regular material materials. Therefore, no physical material distinction was made between the three runways. If the runways are separated by physical material [58], the player can experience completely different auditory and tactile experience in the three tracks. For example, the physical feedback of walking on grass, wood and plastic should be completely different. Due to time, no physical material distinction was added in this prototype.

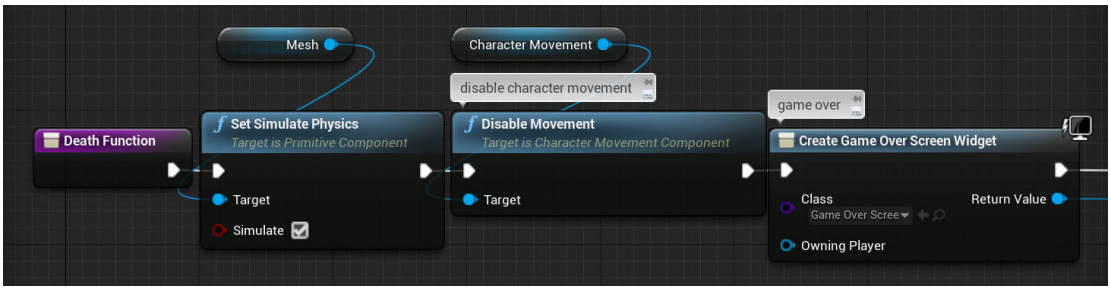


(Source: Yijie Sun)

Figure 3.7: Production of Game Protypes

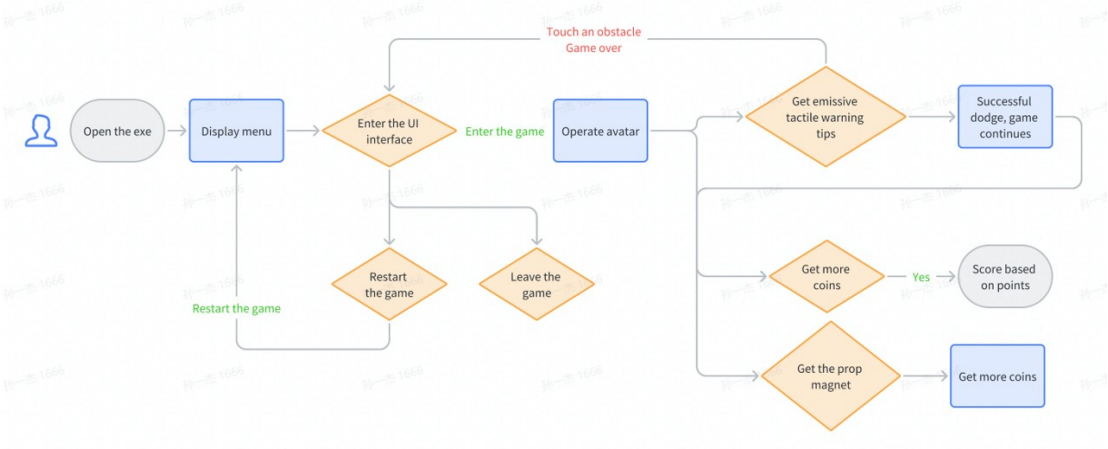
3.3.2 Goals of the Game

The object of the game, in its original design, was to score higher and earn more gold on the run. Based on the theory of game designer Masahiro Sakurai, the essence of games is reward and risk [61]. In this prototype, the reward includes earned gold coins, boots, and magnets. The risks are obstructions, including red water pipes and metal boxes. If the avatar of player is unlucky enough to hit an obstacle, it will trigger a physical collision with the Ragdoll System [62], causing the game to fail, and the screen will return to the User Interface. The player has to choose, on the User Interface, to restart the game or end the game.



(Source: Yijie Sun)

Figure 3.8: Ragdoll Death Function

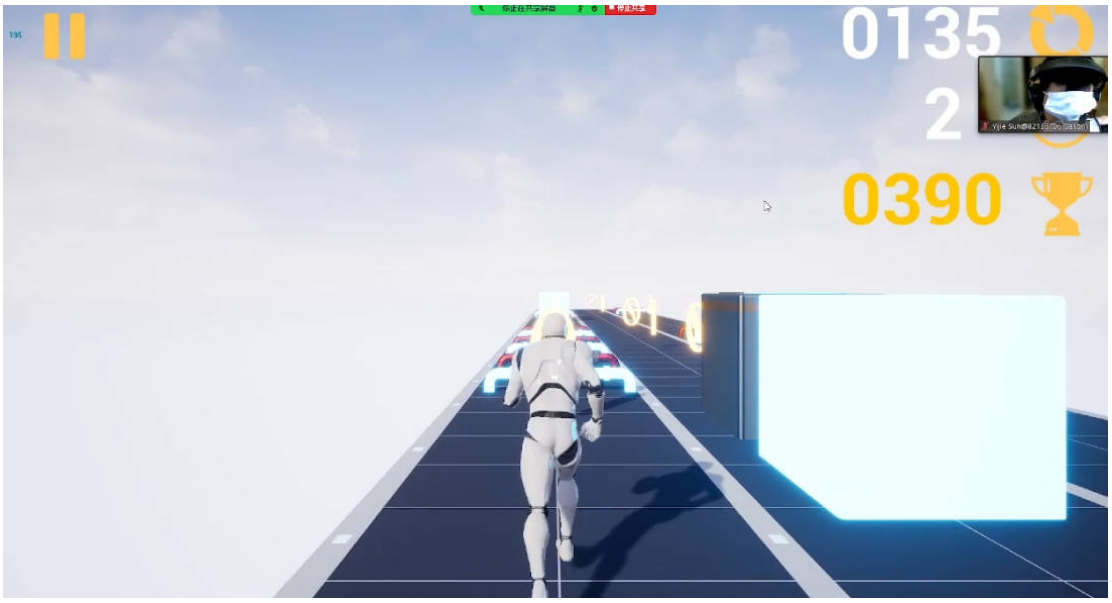


(Source: Yijie Sun)

Figure 3.9: Game Design

3.3.3 Design of Non-Visual Versions of Game Prototypes

After completing the first complete game package, we needed to modify it to a version that could be used by the visually impaired or blindfolded, sighted people. Based on the results of our tests, we artificially reduced the initial speed value from the default of 600 to 300. At the same time, we removed the acceleration because it was difficult to react quickly to the increased level acceleration while playing the game with your eyes closed. Most importantly, we needed to know when the player would encounter an in-game obstacle. Since the presence of obstacles (red water pipes and metal boxes) can indirectly lead to the end of the game, we designed tactile and auditory cues before the player is about to encounter them. In this prototype, therefore, the tactile cues for the obstacles are generated in advance and are represented by emissive materials in order to allow the player to decide and make the correct avoidance action in advance after encountering these pre-generated cues and warnings.



(Source: Yijie Sun)

Figure 3.10: Tactile Cues

3.3.4 Ways to Design Non-Visual Versions of Games

There are many ways to design non-visual versions of games. In a study by David Goncalves et al. [25], they showed how blind people play games. Using channels such as TrueBlindGaming on youtube as a source, the research team analyzed the unique perception of blind people while playing, with the goal of focusing on how blind people experience non-visual experiences in mainstream games. They describe the obstacles players face and what to do about them, inspiring new accessibility practices and more inclusive design. Through online ethnographic research, they analyzed the comments of blind content creators playing digital games, including videos uploaded by content creators. Using the terminology of the game industry, these characteristics can be summarized into the following categories.

Path-Finding

In the aspect of path-finding, the blind can "locate by sound" by swinging a sword and hitting obstacles or walls. The player can use spatial audio to sense the position and direction of elements. Sounds and dialogue [14] are important to convey position and state of the character. The player can construct a map in his mind [19] using various sound elements, such as building torches to increase the possibility of environmental landmarks, so that the player can find the right path through these sound effects. The player may also learn proper path-finding by deliberately returning to the birth point through the death of the avatar.

Precise Interaction

One player was playing God of War IV [7] (SightlessKombat) when the player had to use the R3 key to kill enemies in the game, but was unable to find the right direction by sight. As a result, the player often has to walk around a dying enemy, constantly pressing buttons to interact. As the game becomes more complex, it becomes harder for the player to make real progress. For example, how to dodge enemies and find hidden enemies, in a non-visual game, it is challenging to defeat enemies without automatically tying them down.

Precise localization of sound and interaction within a precise time frame are also extremely effective, as in Anonymous channels, the player experiences The Last of Us [8] in a non-visual way without making timely judgments about the exact spatial location of the level.

---

7 God of War IV [Video game]. (2018). San Mateo, CA: Sony Interactive Entertainment.

8 The Last of Us Part II [Video game]. (2020). Santa Monica, CA: Sony Computer Entertainment.

Automatic Steering

Games like The Last of U [8] and Forza Horizon 5 [9] have auto steering, which greatly reduces the level of interaction and challenge provided by the game, but also reduces the initiative of player.

Tips and Warnings

In multiplayer online games, such as Left 4 Dead 2, non-visual players can interact with each other by "going left" and "turning right." While the speed of interaction would suffer in a first-person game, hints and warnings could be profitable in non-visual gaming experiences.

Sensory Sharing

It is a fun way to play, and it is shown in "eggy party" and "Neverwinter." For example, in "Neverwinter," one player can only judge how to use the skill to kill the enemy, while the other player finds the way and describes what is going on in the game [22].

3.3.5 Seven Design Principles Based on Ability

Wobbrock, J. O et al. [24] mentioned seven design principles based on capability in their research. Many of these principles have implications for prototyping. For example, 2. Responsibility: Designers should take responsibility for the systems they design and for poor performance, rather than letting users take responsibility for the problems themselves. Performance: The design should take user performance into account and monitor, measure, model, or predict that performance in order to continuously improve the design. In the case of non-visual games, there are several ways a game designer can deal with poor performance: Make sure the sound effects and voice prompts are clear and explicit so that blind people can understand the content of the game accurately. Because speech is a requirement

8 The Last of Us Part II [Video game]. (2020). Santa Monica, CA: Sony Computer Entertainment.

9 Forza Horizon 5 [Video game]. (2021). Leamington Spa, CA: Xbox Game Studios.

for interaction and way-finding in non-visual games. Provides a simple operation interface and guide for users to quickly get started. Clear and unambiguous input system can reduce learning costs. Considering the usage habits and needs of blind users, it may be necessary to design dynamic game difficulty adjustment [23] to facilitate their enjoyment of the game. By examining the performance of user and feedback during the game, it is also possible to understand the needs and expectations of the user. The game design can be improved based on post-game feedback. It is also necessary to have an easily accessible and usable feedback system so that users can give feedback to the designer on problems and suggestions in the game.

With regard to the "ability hypothesis", different users may have different levels of ability, and people with low vision and total blindness may face visual or cognitive challenges that can make a product or service difficult to use. The ability level of different users needs to be considered to ensure that products and services can be used by as many people as possible [63].

Design System Based on User Ability

Edwards has developed a visual language that focuses on the capabilities of the user and the matching of the system. The basic idea is to design a system interface suitable for users according to their ability and needs to improve the usability of the system and user satisfaction. For example, in the game "Ting You Jiang Hu" [10] designed for the blind, all the keys have voice prompts because the blind cannot interact with the content in the software through vision. If in some game levels, the blind user is unable to sense the orientation of virtual space through voice prompts, it means that the system is not well matched to his ability. Many games have elements of both ability-based design, universal design and inclusive design, and they use different design methods to meet various user needs and improve game usability and user satisfaction.

10 Ting You Jiang Hu [Audio game]. (2021). Beijing, CA: xinzhihudong.

Ability-Based Design vs. Universal Design

As for the difference between ability-based design, universal design, and inclusive design. [63] For example, the blind mobile games Ting You Jiang Hu [10] and "Rong Yao Zhan Chang" use a ability-based design approach. This is because the developers of these games have taken into account the special needs and abilities of blind people, and designed appropriate auditory game interfaces and modes of operation for them to provide a better experience. The Last of Us and Uncharted 4, which included accessible design, followed a universal design approach. This is because the game developers at Naughty Dog Studios, taking into account the needs and abilities of most players, have designed an easy-to-use game interface and operation mode for players to improve the usability of the game and user satisfaction. At the same time, players can choose to turn on subtitles, so that people with hearing impairments can also understand the dialogue and plot of the game.

Situationally-Induced Impairments and Disabilities (SIID)

SIID can be thought of as a physical and psychological injury that can result in certain situations. Disability is not only a physical condition, but also a sign of social identity [64]. It is relatively difficult for people who have not experienced disability to understand the feelings and experiences of people with disabilities. Instead of focusing on a flaws and inadequacies of people, we should identify their strengths and potential, especially in specific circumstances. Some physical limitations may interfere with our daily lives, but technology and innovation can help us overcome these physical barriers. For example, blind users can not see the images on the game interface, but can use voice and haptic feedback instead of visual feedback. Specifically, sound and haptic feedback can be used to indicate locations and actions within the game, while in-game text and sound cues can be used to convey in-game information. In addition, smartphones can be equipped with voice recognition technology and gesture recognition technology, allowing blind users to operate games by voice and gesture. These technologies can help ssid people enjoy the fun of the game.

10 Ting You Jiang Hu [Audio game]. (2021). Beijing, CA: xinzhihudong.

3.4. Summary

The software required for this experiment is almost complete, including the blueprints for the game created and packaged using Unreal Engine 4.27. We have made a clear distinction between the visual and non-visual versions, through acceleration, tactile cues, and auditory cues. In addition, we were able to smoothly transmit signals from the video game-pad to the input system of game engine. Players are able to feel different haptic feedback when collecting props in a mobile game, manipulating buttons in the user interface or colliding with obstacles leading to the end of the game. Next, we will conduct experimental studies and workshops for the blind to test our hypothesis.

Chapter 4
Proof of Concept

4.1. Pilot Research

4.1.1 Overview

For the pilot study, we need to gather feedback from other game designers, especially insights on accessibility design. We will record the issues they point out in the initial non-visual version for further analysis.

4.1.2 Participant

We invited two colleagues, Liu and Lu, aged between 22 and 24 years old, who work for a gaming company. The test took place on Saturday 27 May 2023 at 4pm, with Liu taking part in the offline test and Lu taking part in the online test via microphone due to time constraints. The game was relatively long, lasting 1 hour, with about 5 minutes spent explaining the game upfront and between 15 and 20 minutes spent on the game itself. After the test, we spent about 5 minutes filling out a questionnaire and discussing issues related to the non-visual version of the game prototype.

(Source: Yijie Sun)

Figure 4.1: Participant

4.1.3 Method

In the experiment, participants were first asked to play the first version of the game prototype with their eyes open to get a rough idea of the game mechanics. The second version of the game prototype, the non-visual version, will then be played with a blindfold on and the participants will be asked to play with their eyes closed. At the end of the game, the players will be invited to complete a questionnaire on WeChat. The questionnaire is based on a reworked GUESS-18 questionnaire, which takes the satisfaction of players with the game and analyses the shortcomings and limitations of the non-visual version of the prototype.

4.1.4 Result

Playability

The results of the player tests show that the game itself is playable.

Voice Prompts

However, in the non-visual version of the prototype game, players inevitably ran into obstacles during testing due to a lack of adequate audio descriptions and prompts. Therefore, more audio prompts for actions are needed in the non-visual version of the prototype game. In addition, in the non-visual version it may be difficult for visually impaired gamers to understand whether or not the progress of the game has ended because of the lack of audio cues for the ending sound, only sound effects.

Introduction of Game Mechanics

As it was not possible for visually impaired gamers to understand the game mechanics through the first visual version in the subsequent workshop for the blind, additional audio files for the introduction to the actions of game were required.

Game Difficulty

Colleague Liu suggested that the acceleration could be increased. In the visual version of the prototype, the difficulty of the game is increased due to the acceleration. In the non-visual version, however, the difficulty becomes less because of the removal of acceleration. In the obstacle generation mechanism, there are cases where boxes and pipes are generated in the same row, so the generation parameters and random values need to be dealt with when generating game objects, and good constraints need to be put in place.

Motivation to Keep Playing

A good game needs to keep the player motivated to keep playing. Lu suggests that this can be improved through the design of in-game rewards. For example,

the coins collected during the game and the time spent alive in the game can be converted by an algorithm into a score for the game result.

Questionnaires

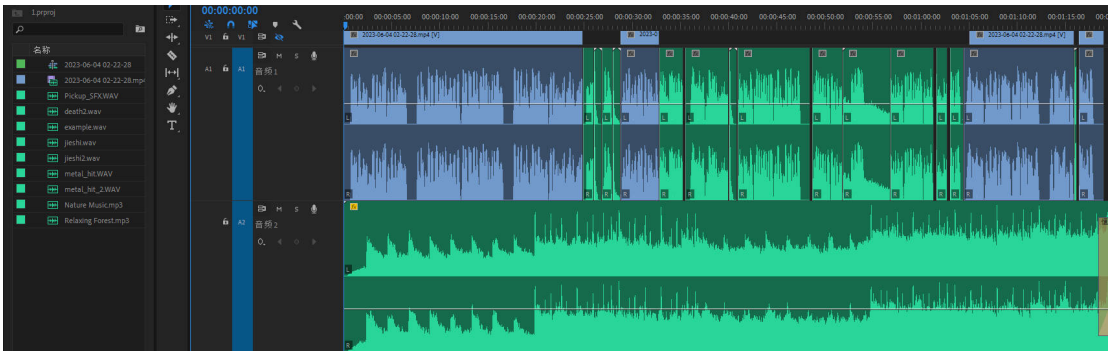
Some of the questions in the questionnaire were repetitive.

4.2. Experimental Iteration

4.2.1 Overview

In this version we have added an audio version of the introduction to the game mechanics, a distinction between sound cues in the user interface, and footsteps based on physical materials. The entire workshop will take place at the front desk of a blind massage therapy.

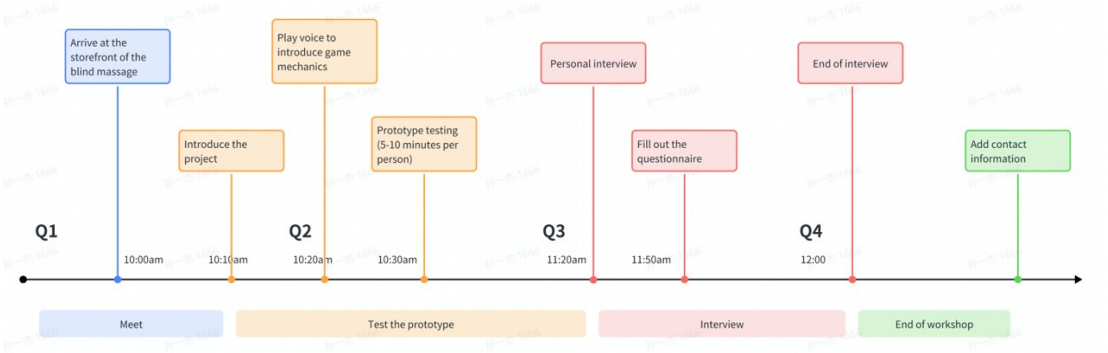
Based on a 2016 report by the China Information Accessible Products Alliance [1], the majority of visually impaired people are engaged in blind massage therapist, at 63%, while only 7% of the sample are school students. Therefore, the workshop chose to find blind massage therapists to test the non-visual version of the prototype.



(Source: Yijie Sun)

Figure 4.2: Introduction to game mechanics

4.2.2 Participant



(Source: Yijie Sun)

Figure 4.3: Process of Testing

The participants of the workshop were eight masters of massage for the blind. We made an appointment for the next day the day before the workshop and negotiated with the blind masseurs to avoid delaying their work. As a result, we scheduled the workshop in the morning. At the same time, we reached a price agreement with the blind masters. At 10am on 4 June 2023, we arrived at the designated blind massage therapy. At around 10.10am, we introduced the project to the participants and played the recorded introduction of the game. Afterwards, we conducted a 5 to 10 minute test with each blind master. At around 11.30am, we conducted individual interviews and filled in questionnaires. At around 12 o'clock, we exchanged contact details and concluded the workshop.

(Source: Yijie Sun)

Figure 4.4: participant

4.2.3 Method

Participants were asked to hold the game-pad, dodge and collect according to the elements mentioned in the audio introducing the game mechanics, and follow the voice prompts they were given during the game. Before the game started, the player was introduced to how to use the buttons on the joystick and which ones would be used. During the designated play period, the player can experience the non-visual version of the prototype an unlimited number of times and feel the tactile and auditory elements of the game. During the game it is possible to discuss and promptly ask for in-game situations and action tips. Before the game starts, we do not tell the player what tactile feedback they will feel, only what sounds they will hear and how to distinguish them and act accordingly to continue the game.

4.2.4 Result

According to the experimental data, six participants were relatively satisfied with their experience of the game. Of these, four members felt challenged during the experience. Seven players found no difficulty in navigating with the tactile and auditory cues in the game. Four found the game itself to be fun. Three liked the sounds in the game. Four participants felt that the tactile and auditory aspects of the game enhanced the play experience. Three users found themselves focused while playing the non-visual version of the game. Four participants would like the game to support more social interaction, such as chatting, in the future.

4.2.5 Discussion

Dynamic Game Difficulty

Blind massage therapist suggests adding dynamic difficulty adjustments to the game, for example, starting the game with one path and gradually increasing the number of paths to eventually three as the non-visual player becomes more familiar with the game mechanics.

Table 4.1: Related analysis

OPT	AVG	STD	Diff	Tactile	PLY	XP	SNS
Diff	4.50	2.07	1				
Tactile	4.63	1.06	-0.62	1			
PLY	4.13	1.89	0.09	0.17	1		
XP	4.38	1.85	0.47	-0.79*	-0.22	1	
SNS	3.88	2.03	0.39	-0.69	-0.22	0.24	1
$p \leq 0.05$	$p \leq 0.01$						

Sound effects

The sound effects in the game, the warnings could be more defined, for example they could be changed to sirens or a more defined sound. Even though the non-visual version of the prototype has more and clearer voice cues compared to the last test, there is a lack of clarity in the alerts and hazard cues, especially for water pipes and metal boxes, and a clearer distinction needs to be made.

Game Sound Atmosphere

Some blind masters would like to experience more, differentiated characters with rich sounds. Regarding the creation of sound. The perception of left and right channels and spatial ambience needs to be enriched.

Boundary collision cues

In the visual version, the sighted player can clearly know the boundaries of the three paths. In the non-visual version, however, the blind player cannot perceive, through the sound effects, the border between the left and right side of the road, and so cannot judge the presence of the border.

Types of game

In terms of game genres, some players do not like racing games, but prefer strategy, card and first-person shooter games, which do not require timely perception of acceleration and direction.

Haptic feedback

Three to four masters were interested in haptic feedback and felt that current games for the blind rely too much on hearing and would like to experience more haptic experiences.

4.2.6 Summary

Mobile gaming remains the most common gaming device used by blind players. In the non-visual versions of the games, haptic feedback plays a large role in adding to the gaming experience and bringing some novelty to the participants. Auditory games such as RongYaoZhanChang Game for Peace, Dou Dizhu, MingJiangSan-Guo ,ShouHuRongGuang, and TingYouJiangHu are popular with blind players. The sound design in all these games is excellent, but there is little tactile feedback or visual support.

In fact, the screen reader [9, 19] is faster than I would have expected. Most blind players have a screen reader speed of 9x, while the average visual player has a maximum sound speed of 2x. In addition, while the visually impaired were using the screen reader to read the screen, in-game UI interaction sounds or character voices were also played. The difference is that the character sound effects and voices are played at double speed. In other words, for blind players, the doubled speed sounds are what needs to be played at the normal rate for the gaming experience, while the game voice prompts, even if played at several times the speed, they can still easily catch the auditory information they need.

Chapter 5
Conclusion

Main Findings

The final prototype of Project Chujing presents an attempt at a non-visual game. We inducted a haptic model through typology to enhance the experience of gaming for the visually impaired through sound cues and tactile cues.

The purpose of this research is to create games for visually impaired people using tactile and auditory information. And through this study to awaken the awareness of other players to the visually impaired.

In the literature review in chapter 2, we found out that, games using tactile and audio cues are already available in the market. Designers have created games with mixed abilities for the visually impaired through multimodal interaction. Visually impaired players are able to change the interaction to their preferences through hardware and software. However, it is still possible to create diverse types of games for the visually impaired based on typological models. And through the innovation of interaction, we could develop tactile games based on ability design for visually impaired players.

From the experimental results, the enjoyment of the game is positively correlated with the haptic feedback, and the difficulty of the game is negatively correlated with the haptic feedback.

Sighted players can experience the game mechanics in their entirety without visual cues. These hypotheses were tested on a relatively small scale with a non-visual game prototype produced through the Unreal Engine 4.27 environment. However, many other factors, such as the richness of the audio and haptic combination, still need to be considered to fully validate the ability of the haptic model to give visually impaired people more enjoyment of the game. Due to time and human resource constraints, there are still many possibilities to be explored.

Future Work

Possible directions for future research include experimentation with massively multiplayer online games with multiple modes of PVE and PVP for the visually impaired. Visually impaired people need more social possibilities. Existing social circles for the blind do not meet the social needs of the visually impaired in general. Customisation with audio and tactile feedback, card games for the visually impaired and strategy games could also be tried. Turn-based games are probably what most visually impaired people would like to experience, as there is no need for real-time feedback. Visually impaired people may want more sound ambience and tactile experiences, so more ambience switching could also be added. Mixed ability gaming is also a possible direction, based on auditory haptic abilities, allowing players with different abilities to experience different sensory gaming experiences and collaborate to complete game tasks is also one of the future directions of gaming. Finally, by optimising the user interface of the game, a more accessible interactive experience can be brought to visually impaired players.

References

[1] China Information Accessibility Product Alliance. Basic information report on visually impaired internet users in china, 2016.

[2] Phyllis R. Davis. *The Power Of Touch*. Hay House Inc.

[3] Adrian David Cheok. An instrument for remote kissing and engineering measurement of its communication effects including modified turing test. *IEEE Open Journal of the Computer Society*, 1:107–120, 2020.

[4] Karen Stevens. Aaa gaming while blind. Game Developers Conference, 2018. URL: `https://www.gdcvault.com/play/1025025/AAA-Gaming-While`.

[5] Thatgamecompany. Journey. URL: `https://thatgamecompany.com/journey/`.

[6] Sreekar Krishna, Dirk Colbry, John Black, Vineeth Balasubramanian, and Sethuraman Panchanathan. A systematic requirements analysis and development of an assistive device to enhance the social interaction of people who are blind or visually impaired. In *Workshop on Computer Vision Applications for the Visually Impaired*, 2008.

[7] Troy McDaniel, Sreekar Krishna, Vineeth Balasubramanian, Dirk Colbry, and Sethuraman Panchanathan. Using a haptic belt to convey non-verbal communication cues during social interactions to individuals who are blind. In *2008 IEEE international workshop on haptic audio visual environments and games*, pages 13–18. IEEE, 2008.

[8] Heyongyan He and Kōta Minamizawa. Project corvus: A virtual reality horror tool for improving self-efficacy, 2023.

[9] Ali Abdolrahmani, Ravi Kuber, and Stacy M Branham. " siri talks at you" an empirical investigation of voice-activated personal assistant (vapa) usage by individuals who are blind. In *Proceedings of the 20th International ACM SIGACCESS Conference on Computers and Accessibility*, pages 249–258, 2018.

[10] Kadir Uludag. How chatgpt can help visually impaired individuals? *Available at SSRN 4401285*, 2023.

[11] Christophe Mollaret, Alhayat Ali Mekonnen, Frédéric Lerasle, Isabelle Ferrané, Julien Pinquier, Blandine Boudet, and Pierre Rumeau. A multi-modal perception based assistive robotic system for the elderly. *Computer Vision and Image Understanding*, 149:78–97, 2016.

[12] M Saquib Sarfraz, Angela Constantinescu, Melanie Zuzej, and Rainer Stiefelhagen. A multimodal assistive system for helping visually impaired in social interactions. *Informatik-Spektrum*, 40:540–545, 2017.

[13] Vivek Pradeep, Gerard Medioni, and James Weiland. Robot vision for the visually impaired. In *2010 IEEE Computer Society Conference on Computer Vision and Pattern Recognition-Workshops*, pages 15–22. IEEE, 2010.

[14] Hyun K Kim, Sung H Han, Jaehyun Park, and Joohwan Park. The interaction experiences of visually impaired people with assistive technology: A case study of smartphones. *International Journal of Industrial Ergonomics*, 55:22–33, 2016.

[15] Jenova Chen. Flow in games (and everything else). *Communications of the ACM*, 50(4):31–34, 2007.

[16] Mihaly Csikszentmihalyi. *Flow: The psychology of optimal experience*. Harper Perennial, 1990.

[17] Camille Godineau. The new xbox adaptive controller, another step towards digital inclusion. *Masters of Media*, 2018.

[18] Dragan Ahmetovic, João Guerreiro, Eshed Ohn-Bar, Kris M Kitani, and Chieko Asakawa. Impact of expertise on interaction preferences for navigation assistance of visually impaired individuals. In *Proceedings of the 16th International Web for All Conference*, pages 1–9, 2019.

[19] Doug Griffith. Computer access for persons who are blind or visually impaired: Human factors issues. *Human factors*, 32(4):467–475, 1990.

[20] Mohamed Dhiaeddine Messaoudi, Bob-Antoine J Menelas, and Hamid Mcheick. Review of navigation assistive tools and technologies for the visually impaired. *Sensors*, 22(20):7888, 2022.

[21] Mohsin Murad, Abdullah Rehman, Arif Ali Shah, Salim Ullah, Muhammad Fahad, and Khawaja M Yahya. Rfaide—an rfid based navigation and object recognition assistant for visually impaired people. In *2011 7th International Conference on Emerging Technologies*, pages 1–4. IEEE, 2011.

[22] David Gonçalves, André Rodrigues, Mike L Richardson, Alexandra A de Sousa, Michael J Proulx, and Tiago Guerreiro. Exploring asymmetric roles in mixed-ability gaming. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, pages 1–14, 2021.

[23] Ziyue Wang and Kouta Minamizawa. Developing players' sense of agency by physiological sensor in game-play : design approaches of dynamic difficulty adjustment, 2021.

[24] Jacob O Wobbrock, Shaun K Kane, Krzysztof Z Gajos, Susumu Harada, and Jon Froehlich. Ability-based design: Concept, principles and examples. *ACM Transactions on Accessible Computing (TACCESS)*, 3(3):1–27, 2011.

[25] David Gonçalves, Manuel Piçarra, Pedro Pais, João Guerreiro, and André Rodrigues. My zelda cane: Strategies used by blind players to play visual-centric digital games. *arXiv preprint arXiv:2301.08031*, 2023.

[26] Lisa Rauch. Designing mechanics for asymmetric cooperation in hybrid co-located social games, 2017.

[27] David Gonçalves, André Rodrigues, and Tiago Guerreiro. Playing with others: Depicting multiplayer gaming experiences of people with visual impairments. In *Proceedings of the 22nd International ACM SIGACCESS Conference on Computers and Accessibility*, pages 1–12, 2020.

[28] Manuel López Ibáñez, Alejandro Romero Hernández, Borja Manero, and María Guijarro Mata-García. Computer entertainment technologies for the visually impaired: an overview. *IJIMAI*, 7(4):53–68, 2022.

[29] Haruna Miyakawa, Noko Kuratomo, Hisham E Bilal Salih, and Keiichi Zempo. Auditory uta-karuta: Development and evaluation of an accessible card game system using audible cards for the visually impaired. *Electronics*, 10(6):750, 2021.

[30] Ronny Andrade, Melissa J Rogerson, Jenny Waycott, Steven Baker, and Frank Vetere. Playing blind: Revealing the world of gamers with visual impairment. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, pages 1–14, 2019.

[31] Peter Peerdeman. Sound and music in games. *Amsterdam: VrijeUniversiteit*, pages 2–3, 2010.

[32] `https://audiogame.center/`, 2016.

[33] Alexis Kirke. When the soundtrack is the game: From audio-games to gaming the music. *Emotion in Video Game Soundtracking*, pages 65–83, 2018.

[34] Luis Valente, Clarisse Sieckenius de Souza, and Bruno Feijó. Turn off the graphics: designing non-visual interfaces for mobile phone games. *Journal of the Brazilian Computer Society*, 15:45–58, 2009.

[35] Charles Sanders Peirce. *The Essential Peirce: Selected Philosophical Writings. 1893-1913. Volume 2*, volume 2. Indiana University Press, 1998.

[36] Ea Christina Willumsen and Milan Jacevic. A typology of rumble. In *DiGRA Conference*, 2019.

[37] Fabien Danieau, Philippe Guillotel, Olivier Dumas, Thomas Lopez, Bertrand Leroy, and Nicolas Mollet. Hfx studio: haptic editor for full-body immersive experiences. pages 1–9, 11 2018. doi:10.1145/3281505.3281518.

[38] Immersion Corporation. Best practices for use of vibration feedback in console games, 2010.

[39] Lev Poretski and Anthony Tang. Press a to jump: Design strategies for video game learnability. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, pages 1–26, 2022.

[40] Ravi Kuber, Matthew Tretter, and Emma Murphy. Developing and evaluating a non-visual memory game. In *Human-Computer Interaction–INTERACT 2011: 13th IFIP TC 13 International Conference, Lisbon, Portugal, September 5-9, 2011, Proceedings, Part II 13*, pages 541–553. Springer, 2011.

[41] Ravi Kuber and Wai Yu. Feasibility study of tactile-based authentication. *International Journal of Human-Computer Studies*, 68(3):158–181, 2010.

[42] Tatiana V Evreinova, Grigori Evreinov, and Roope Raisamo. Non-visual gameplay: Making board games easy and fun. In *Computers Helping People with Special Needs: 11th International Conference, ICCHP 2008, Linz, Austria, July 9-11, 2008. Proceedings 11*, pages 561–568. Springer, 2008.

[43] Jaime Sánchez. Development of navigation skills through audio haptic videogaming in learners who are blind. *Procedia Computer Science*, 14:102–110, 2012.

[44] David Parisi. A counterrevolution in the hands: The console controller as an ergonomic branding mechanism. *Journal of Games Criticism*, 2(1):1–23, 2015.

[45] Fabien Danieau, Anatole Lécuyer, Philippe Guillotel, Julien Fleureau, Nicolas Mollet, and Marc Christie. Enhancing audiovisual experience with haptic feedback: A survey on hav. *IEEE Transactions on Haptics*, 6:193–205, 04 2013. doi:10.1109/TOH.2012.70.

[46] Stefanie Gertrud Schaack and Kazunori Sugiura. Design guidelines for a non-visual ar gaming application using haptic feedback, 2018.

[47] Tadeusz Stach and T.C. Graham. Exploring haptic feedback in exergames. pages 18–35, 08 2011. doi:10.1007/978-3-642-23771-3_2.

[48] Hasti Seifi, Kailun Zhang, and Karon E. MacLean. Vibviz: Organizing, visualizing and navigating vibration libraries. In *2015 IEEE World Haptics Conference (WHC)*, pages 254–259, 2015. doi:10.1109/WHC.2015.7177722.

[49] Yulan Ju and Kouta Minamizawa. Haptic empathy : embodying emotions for children with autism, 2021.

[50] Andreas Grabski, Toni Toni, Tom Zigrand, Rene Weller, and Gabriel Zachmann. Kinaptic-techniques and insights for creating competitive accessible 3d games for sighted and visually impaired users. In *2016 IEEE Haptics Symposium (HAPTICS)*, pages 325–331. IEEE, 2016.

[51] Youngbo Aram Shim, Keunwoo Park, Sangyoon Lee, Jeongmin Son, Taeyun Woo, and Geehyuk Lee. Fs-pad: Video game interactions using force feedback gamepad. In *Proceedings of the 33rd Annual ACM Symposium on User Interface Software and Technology*, pages 938–950, 2020.

[52] Carolin Stellmacher. Haptic-enabled buttons through adaptive trigger resistance. In *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, pages 201–204. IEEE, 2021.

[53] Ulrik SöDerströM, William Larsson, Max Lundqvist, Ole Norberg, Mattias Andersson, and Thomas Mejtoft. Haptic feedback in first person shooter video games. In *Proceedings of the 33rd European Conference on Cognitive Ergonomics*, pages 1–6, 2022.

[54] Yizhen Zhou, Aiko Murata, and Junji Watanabe. The calming effect of heartbeat vibration. In *2020 IEEE Haptics Symposium (HAPTICS)*, pages 677–683. IEEE, 2020.

[55] Patricia Sieber. The protean world of sanqu songs, 2021.

[56] Tristan King, Kyle Davis, Bradley Saunders, Ryan Zuber, Priya Rajasagi, Christina Lukaszczyk, Anita Komlodi, and Lee Boot. Immersive visualization of open geospatial data in unreal engine. In *2023 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, pages 709–710. IEEE, 2023.

[57] Yannan Niu. Swot analysis on sony's playstation under covid-19. In *2021 International Conference on Modern Educational Technology and Social Sciences (ICMETSS 2021)*, pages 5–8. Atlantis Press, 2021.

[58] Katax Emperore and Devin Sherry. *Unreal engine physics essentials*. Packt Publishing Ltd, 2015.

[59] Joseph R Keebler, William J Shelstad, Dustin C Smith, Barbara S Chaparro, and Mikki H Phan. Validation of the guess-18: a short version of the game user experience satisfaction scale (guess). *Journal of Usability Studies*, 16(1):49, 2020.

[60] Jeffrey N Chadwick, Changxi Zheng, and Doug L James. Precomputed acceleration noise for improved rigid-body sound. *ACM Transactions on Graphics (TOG)*, 31(4):1–9, 2012.

[61] Mikael Jakobsson, Olli Sotamaa, C Moore, J Begy, M Consalvo, A Gazzard, et al. game reward systems. *Game Stud*, 11(1), 2011.

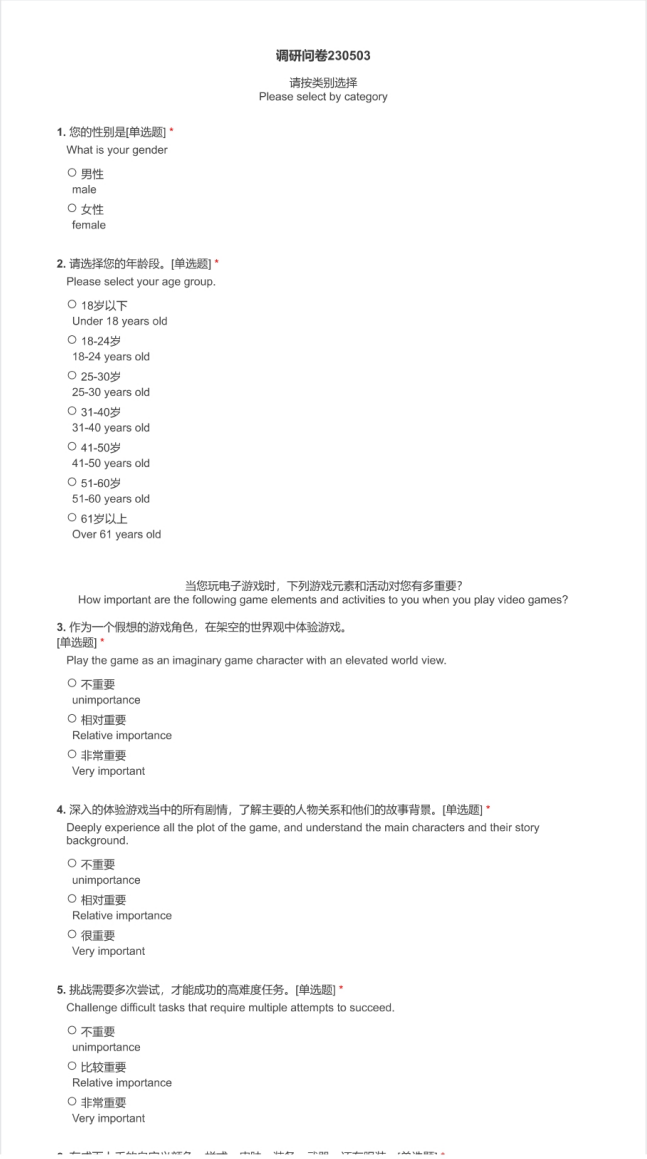
[62] Johan Gästrin. Physically based character simulation–rag doll behaviour in computer games. *Royal Institute of Technology, Stockholm*, 2004.

[63] Jacob O Wobbrock, Krzysztof Z Gajos, Shaun K Kane, and Gregg C Vanderheiden. Ability-based design. *Communications of the ACM*, 61(6):62–71, 2018.

[64] Jacob O Wobbrock. Situationally aware mobile devices for overcoming situational impairments. In *Proceedings of the ACM SIGCHI Symposium on Engineering Interactive Computing Systems*, pages 1–18, 2019.

Appendices

A. Haptic Feedback Conceptual Design Preliminary Questionnaire



调研问卷230503

请按类别选择
Please select by category

1. 您的性别是[单选题] *
What is your gender

- ○ 男性
  male
- ○ 女性
  female

2. 请选择您的年龄段。[单选题] *
Please select your age group.

- ○ 18岁以下
  Under 18 years old
- ○ 18-24岁
  18-24 years old
- ○ 25-30岁
  25-30 years old
- ○ 31-40岁
  31-40 years old
- ○ 41-50岁
  41-50 years old
- ○ 51-60岁
  51-60 years old
- ○ 61岁以上
  Over 61 years old

当您玩电子游戏时，下列游戏元素和活动对您有多重要?
How important are the following game elements and activities to you when you play video games?

3. 作为一个假想的游戏角色，在架空的世界观中体验游戏。
[单选题] *
Play the game as an imaginary game character with an elevated world view.

- ○ 不重要
  unimportance
- ○ 相对重要
  Relative importance
- ○ 非常重要
  Very important

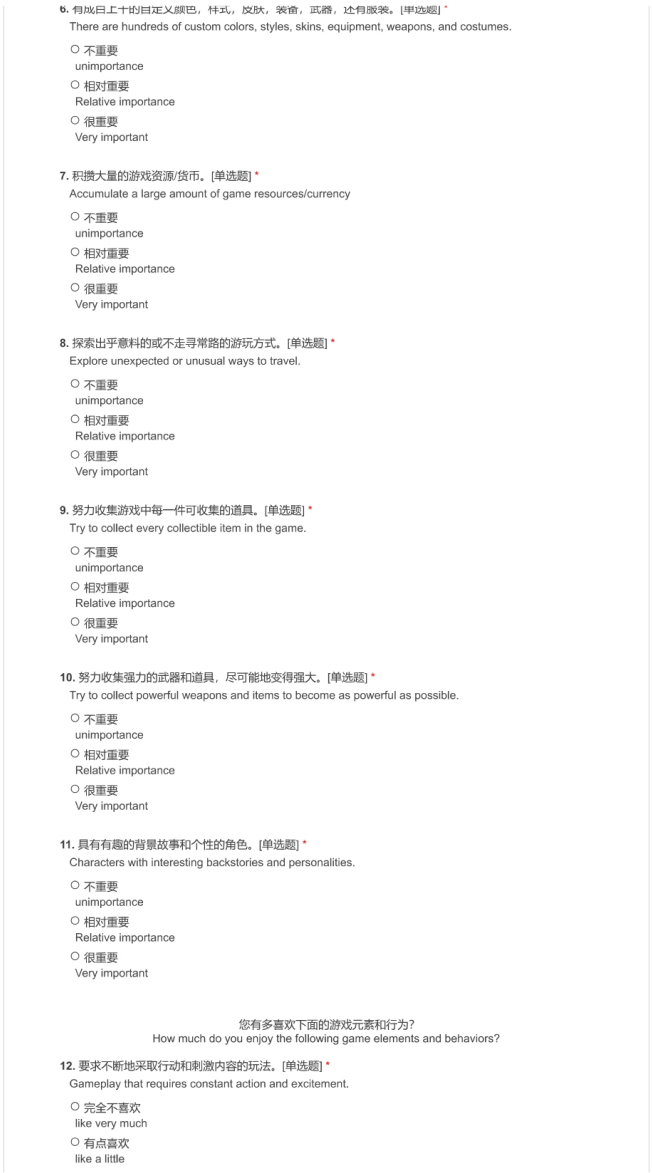
4. 深入的体验游戏当中的所有剧情，了解主要的人物关系和他们的故事背景。[单选题] *
Deeply experience all the plot of the game, and understand the main characters and their story background.

- ○ 不重要
  unimportance
- ○ 相对重要
  Relative importance
- ○ 很重要
  Very important

5. 挑战需要多次尝试，才能成功的高难度任务。[单选题] *
Challenge difficult tasks that require multiple attempts to succeed.

- ○ 不重要
  unimportance
- ○ 比较重要
  Relative importance
- ○ 非常重要
  Very important

Figure A.1: survey a 01



6. 有成百上千的自定义颜色，样式，皮肤，装备，武器，还有服装。[单选题] *
There are hundreds of custom colors, styles, skins, equipment, weapons, and costumes.

○ 不重要
unimportance
○ 相对重要
Relative importance
○ 很重要
Very important

7. 积攒大量的游戏资源/货币。[单选题] *
Accumulate a large amount of game resources/currency

○ 不重要
unimportance
○ 相对重要
Relative importance
○ 很重要
Very important

8. 探索出乎意料的或不走寻常路的游玩方式。[单选题] *
Explore unexpected or unusual ways to travel.

○ 不重要
unimportance
○ 相对重要
Relative importance
○ 很重要
Very important

9. 努力收集游戏中每一件可收集的道具。[单选题] *
Try to collect every collectible item in the game.

○ 不重要
unimportance
○ 相对重要
Relative importance
○ 很重要
Very important

10. 努力收集强力的武器和道具，尽可能地变得强大。[单选题] *
Try to collect powerful weapons and items to become as powerful as possible.

○ 不重要
unimportance
○ 相对重要
Relative importance
○ 很重要
Very important

11. 具有有趣的背景故事和个性的角色。[单选题] *
Characters with interesting backstories and personalities.

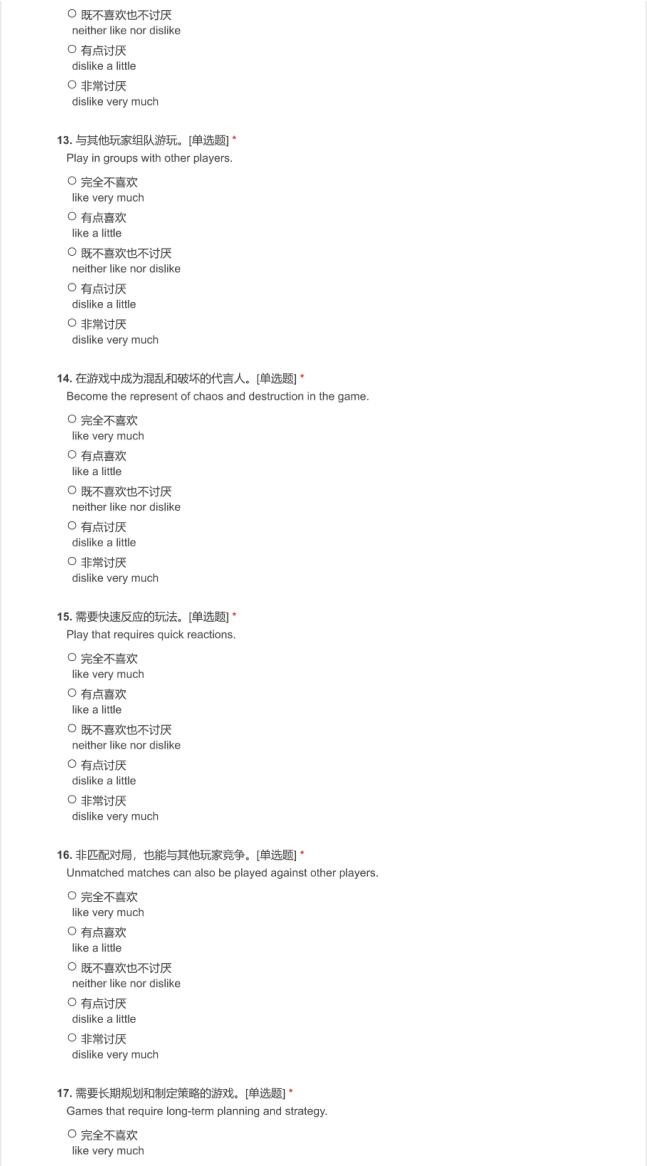
○ 不重要
unimportance
○ 相对重要
Relative importance
○ 很重要
Very important

您有多喜欢下面的游戏元素和行为?
How much do you enjoy the following game elements and behaviors?

12. 要求不断地采取行动和刺激内容的玩法。[单选题] *
Gameplay that requires constant action and excitement.

○ 完全不喜欢
like very much
○ 有点喜欢
like a little

Figure A.2: survey a 02



○ 既不喜欢也不讨厌
neither like nor dislike
○ 有点讨厌
dislike a little
○ 非常讨厌
dislike very much

13. 与其他玩家组队游玩。[单选题] *
Play in groups with other players.
○ 完全不喜欢
like very much
○ 有点喜欢
like a little
○ 既不喜欢也不讨厌
neither like nor dislike
○ 有点讨厌
dislike a little
○ 非常讨厌
dislike very much

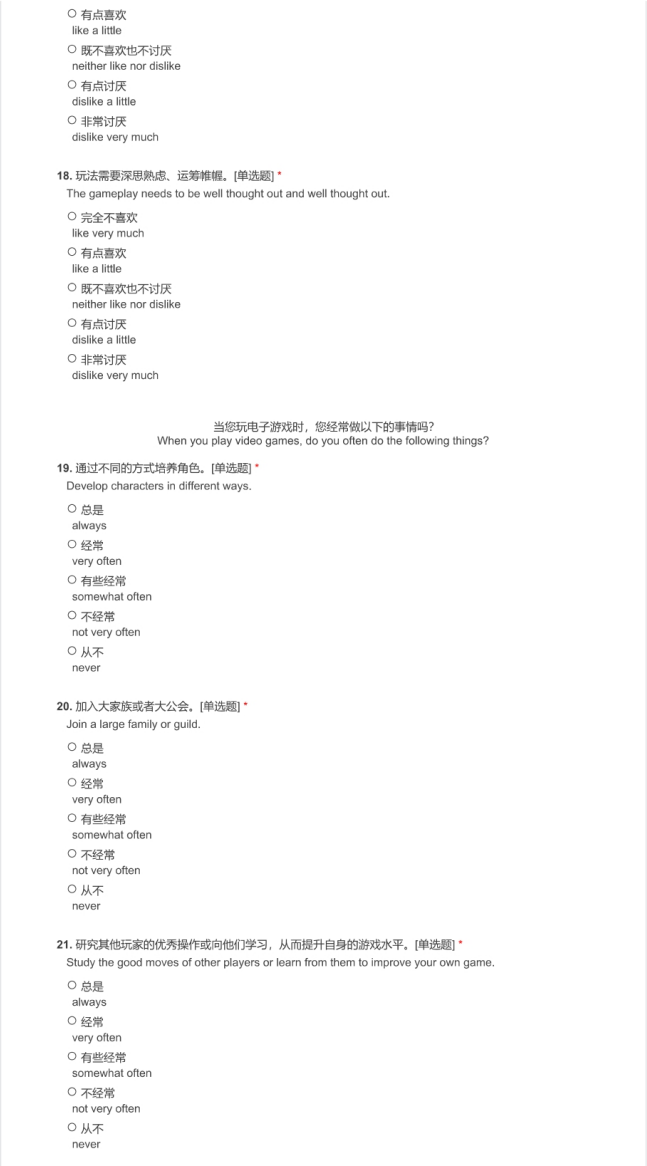
14. 在游戏中成为混乱和破坏的代言人。[单选题] *
Become the represent of chaos and destruction in the game.
○ 完全不喜欢
like very much
○ 有点喜欢
like a little
○ 既不喜欢也不讨厌
neither like nor dislike
○ 有点讨厌
dislike a little
○ 非常讨厌
dislike very much

15. 需要快速反应的玩法。[单选题] *
Play that requires quick reactions.
○ 完全不喜欢
like very much
○ 有点喜欢
like a little
○ 既不喜欢也不讨厌
neither like nor dislike
○ 有点讨厌
dislike a little
○ 非常讨厌
dislike very much

16. 非匹配对局，也能与其他玩家竞争。[单选题] *
Unmatched matches can also be played against other players.
○ 完全不喜欢
like very much
○ 有点喜欢
like a little
○ 既不喜欢也不讨厌
neither like nor dislike
○ 有点讨厌
dislike a little
○ 非常讨厌
dislike very much

17. 需要长期规划和制定策略的游戏。[单选题] *
Games that require long-term planning and strategy.
○ 完全不喜欢
like very much

Figure A.3: survey a 03



○ 有点喜欢
like a little
○ 既不喜欢也不讨厌
neither like nor dislike
○ 有点讨厌
dislike a little
○ 非常讨厌
dislike very much

18. 玩法需要深思熟虑、运筹帷幄。[单选题] *
The gameplay needs to be well thought out and well thought out.
○ 完全不喜欢
like very much
○ 有点喜欢
like a little
○ 既不喜欢也不讨厌
neither like nor dislike
○ 有点讨厌
dislike a little
○ 非常讨厌
dislike very much

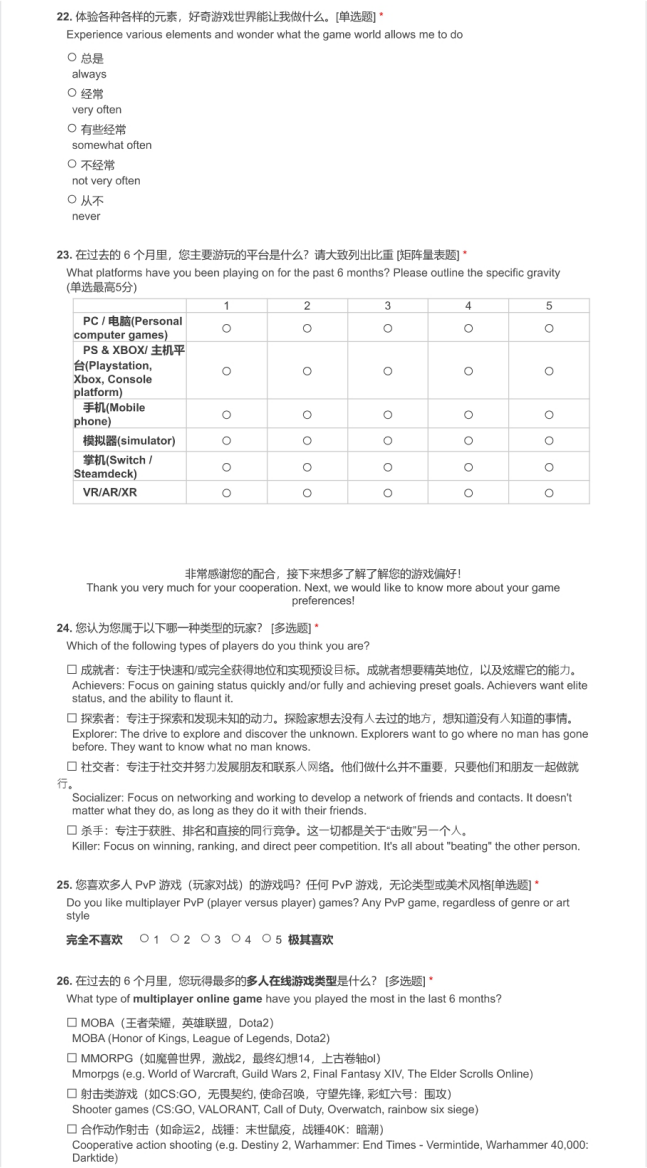
当您玩电子游戏时，您经常做以下的事情吗?
When you play video games, do you often do the following things?

19. 通过不同的方式培养角色。[单选题] *
Develop characters in different ways.
○ 总是
always
○ 经常
very often
○ 有些经常
somewhat often
○ 不经常
not very often
○ 从不
never

20. 加入大家族或者大公会。[单选题] *
Join a large family or guild.
○ 总是
always
○ 经常
very often
○ 有些经常
somewhat often
○ 不经常
not very often
○ 从不
never

21. 研究其他玩家的优秀操作或向他们学习，从而提升自身的游戏水平。[单选题] *
Study the good moves of other players or learn from them to improve your own game.
○ 总是
always
○ 经常
very often
○ 有些经常
somewhat often
○ 不经常
not very often
○ 从不
never

Figure A.4: survey a 04



22. 体验各种各样的元素，好奇游戏世界能让我做什么。[单选题] *

Experience various elements and wonder what the game world allows me to do

- ○ 总是 always
- ○ 经常 very often
- ○ 有些经常 somewhat often
- ○ 不经常 not very often
- ○ 从不 never

23. 在过去的 6 个月里，您主要游玩的平台是什么？请大致列出比重 [矩阵量表题] *

What platforms have you been playing on for the past 6 months? Please outline the specific gravity (单选最高5分)

	1	2	3	4	5
PC / 电脑(Personal computer games)	○	○	○	○	○
PS & XBOX/ 主机平台(Playstation, Xbox, Console platform)	○	○	○	○	○
手机(Mobile phone)	○	○	○	○	○
模拟器(simulator)	○	○	○	○	○
掌机(Switch / Steamdeck)	○	○	○	○	○
VR/AR/XR	○	○	○	○	○

非常感谢您的配合，接下来想多了解了解您的游戏偏好!
Thank you very much for your cooperation. Next, we would like to know more about your game preferences!

24. 您认为您属于以下哪一种类型的玩家？ [多选题] *

Which of the following types of players do you think you are?

☐ 成就者：专注于快速和/或完全获得地位和实现预设目标。成就者想要精英地位，以及炫耀它的能力。
Achievers: Focus on gaining status quickly and/or fully and achieving preset goals. Achievers want elite status, and the ability to flaunt it.

☐ 探索者：专注于探索和发现未知的动力。探险家想去没有人去过的地方，想知道没有人知道的事情。
Explorer: The drive to explore and discover the unknown. Explorers want to go where no man has gone before. They want to know what no man knows.

☐ 社交者：专注于社交并努力发展朋友和联系人网络。他们做什么并不重要，只要他们和朋友一起做就行。
Socializer: Focus on networking and working to develop a network of friends and contacts. It doesn't matter what they do, as long as they do it with their friends.

☐ 杀手：专注于获胜、排名和直接的同行竞争。这一切都是关于"击败"另一个人。
Killer: Focus on winning, ranking, and direct peer competition. It's all about "beating" the other person.

25. 您喜欢多人 PvP 游戏（玩家对战）的游戏吗？任何 PvP 游戏，无论类型或美术风格[单选题] *

Do you like multiplayer PvP (player versus player) games? Any PvP game, regardless of genre or art style

完全不喜欢 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 **极其喜欢**

26. 在过去的 6 个月里，您玩得最多的**多人在线游戏类型**是什么？ [多选题] *

What type of **multiplayer online game** have you played the most in the last 6 months?

☐ MOBA（王者荣耀，英雄联盟，Dota2）
MOBA (Honor of Kings, League of Legends, Dota2)

☐ MMORPG（如魔兽世界，激战2，最终幻想14，上古卷轴ol）
Mmorpgs (e.g. World of Warcraft, Guild Wars 2, Final Fantasy XIV, The Elder Scrolls Online)

☐ 射击类游戏（如CS:GO，无畏契约, 使命召唤，守望先锋, 彩虹六号：围攻）
Shooter games (CS:GO, VALORANT, Call of Duty, Overwatch, rainbow six siege)

☐ 合作动作射击（如命运2，战锤：末世鼠疫，战锤40K：暗潮）
Cooperative action shooting (e.g. Destiny 2, Warhammer: End Times - Vermintide, Warhammer 40,000: Darktide)

Figure A.5: survey a 05

☐ 大战场射击类（如战地，人间地狱，战术小队）
Big battlefield shooting class (Battlefield, Hell let loose, Squad)

☐ 竞技场类（如骑士精神2，荣耀战魂）
battle arena (e.g. Chivalry 2, For honor)

☐ 战争模拟类（如坦克世界，战争雷霆）
Tactical role-playing game (e.g. World of Tanks, War Thunder)

☐ 大逃杀类（如绝地求生, 永劫无间，Apex, 使命召唤：战区）
Battle royale game (e.g. Pubg, Naraka：Bladepoint, Apex, Call of Duty: Warzone)

☐ 卡牌类（如炉石传说，巫师之昆特牌）
Cards (Hearthstone, Thronebreaker: The Witcher Tales)

☐ RTS (如星际争霸2，全面战争：竞技场）
RTS (e.g. Starcraft 2, Total War: Arena)

☐ 战术动作类 （如战意、铁甲雄兵）
Real-Time Tactics (e.g., Conqueror's Blade, Blood of Steel)

☐ 沙盒生存类 （如森林之子、方舟：生存、腐蚀）
Sandbox game (e.g. Sons of the Forest, Ark: Survival Evolved)

☐ 塔科夫类（如逃离塔克夫、猎杀：对决、Dark and Darker
Tarkov (e.g.Escape from Tarkov, Hunt：Showdown, Dark and Darker

☐ 暗黑破坏神类（如暗黑破坏神、失落方舟、流亡黯道）
Diablo (e.g. Diablo, Lost Ark, Path of Exile)

27. 您玩电子游戏的频率是?[单选题] *
How often do you play video games?

○ 几乎不玩
Barely play games

○ 偶尔玩(每月几次)
Play games occasionally (several times a month)

○ 经常玩(每周几次)
Play games regularly (several times a week)

○ 几乎天天玩
Play games almost every day

28. 您喜欢玩（或者看主播玩）哪些PS/Xbox主机平台的游戏类型? [多选题] *
What kind of games do you like to play (or watch streamers play) on playstation /Xbox?

☐ 近战动作类：卧龙:苍天陨落、仁王12、黑暗之魂3、血源诅咒、只狼、机甲狂潮2、艾尔登法环
Melee Action: Wo Long：Fallen Dynasty，Nioh: Complete Edition 1-2, Demon's Souls 3, bloodborne, Sekiro: Shadows Die Twice, The Surge 2, Elden Ring

☐ 动作类：血源:诅咒 战神4-5、 怪物猎人:世界、 最后的生还者:重置版、 神秘海域4、 生化危机7、 恶名昭著:次子、 瑞奇与叮当、 往日不再、 编蝠侠:阿卡姆骑士、死亡搁浅。
Action game：Bloodline: Curse, God of War 4-5,Monster Hunter: World, The Last of Us: The Reset, Uncharted 4: A Thief's End, Resident Evil 7,Notorious: Second Son, Ricky and Tinker Bell, The past is no more, Batman: Arkham Knight，Death Stranding.

☐ 线性剧情类：美国末日12、暴雨、超凡双生、瘟疫传说、如龙0：誓约的场所、十三机兵防卫圈、恶灵附身12、奇异人生前传，奇异人生1，古墓丽影崛起，神秘海域4
Linear Drama: US Doomsday 12, Rainstorm, Extraordinary Twins, Plague Legend, Yakuza Zero , Thirteen Machines Defense Circle, Evil Possession 12, Strange Life Prequel, Strange Life 1，Tomb Raider: Rise, Uncharted 4: A Thief's End

☐ 射击类：原子之心、德军总部2：新巨像、泰坦陨落2、战地1、无主之地3、先驱者outriders、狂怒2
Shooting: Heart of the atom，Wolfenstein II: The New Colossus, Titanfall 2, Battlefield 1, Borderlands 3, Pioneer outriders, Fury 2

☐ 开放世界：地平线零之曙光、地平线2：西部禁区，荒野大镖客2、巫师3、GTA5、赛博朋克2077、原神、对马岛之魂
Open World: Horizon Zero Dawn, Horizon 2: Western Forbidden Zone, Red Dead Redemption 2, The Witcher 3, GTA5, Cyberpunk 2077、Genshin Impact、Ghost of Tsushima.

☐ 小游戏动作类：死亡细胞、钢铁鼠、迷雾征程、无人（无名氏）拯救世界
Mini-game action: Death Cells, Iron Rats, Misty Journey, No One (Anonymous) Saves the World

☐ 球类：2K欢乐竞技场（篮球）
Balls: 2K Happy Arena (basketball)

☐ 开放世界动作冒险犯罪类：GTA5侠盗猎车手5
Open world action adventure crime: GTA5 Grand Theft Auto 5

☐ 电影式:底特律:变人
Movie Style: Detroit: Become Human

☐ 格斗:真人快打10
Fighting: Mortal Kombat 10

☐ 潜行类游戏：刺客信条

Figure A.6: survey a 06

Stealth Games: Assassin's Creed

29. 您购买主机游戏时的相关因素考虑程度是 [矩阵量表题] *

How much of a factor do you consider when buying console games
（单选最高5分）

	1	2	3	4	5
画面（Visual quality）	○	○	○	○	○
剧情（storytelling）	○	○	○	○	○
游戏性（gameplay）	○	○	○	○	○
价格（price）	○	○	○	○	○
媒体上的玩家评价（Media player rating）	○	○	○	○	○
是否有中文版（Whether there is localized translation）	○	○	○	○	○
是否为该平台独占游戏（Whether the game is exclusive to the platform）	○	○	○	○	○

30. 在最近的6个月，您平均每月在游戏上的花费多少？[单选题] *

In the last 6 months, how much did you spend on games per month on average?

○ 50元以内
Up to $7

○ 51-100 元
$7 to $15

○ 101-200元
$15 to $30

○ 201-500元
$30 to $70

○ 501-1000元
$70 to $150

○ 1001-2000元
$150 to $300

○ 2000元以上
More than $300

31. 您可能会对以下的哪些游戏内容付费？[多选题] *

Which of the following are you likely to pay for?

☐ 游戏本体（拷贝）
Game ontology (copy)

☐ 角色皮肤
Character skin

☐ 点卡
Dot card

☐ 新角色
New Character

☐ 新地图
New map

☐ 数值向内容（提升等级、装备等）
Value oriented content (leveling, equipment, etc.)

☐ 头像、语音等自定义内容
Custom content such as profile picture and voice

您是否有感受过游戏的触觉反馈？最后想和您探讨一下游戏当中的3C元素。

32. 您在生活中的以下哪些场景中，感受过触觉反馈？[多选题] *

In which of the following situations in your life have you experienced haptic feedback?

☐ 汽车和航空（警告，通信，汽车部件：方向盘，安全带，踏板，座椅，驾驶员的服饰）

Figure A.7: survey a 07

Automotive and aviation (warning, communication, auto parts: steering wheel, seat belt, pedals, seats, driver's clothing)

☐ 医学和牙科（微创手术，腹腔镜工具，医学教育特定的虚拟现实模型）
Medicine and dentistry (minimally invasive surgery, laparoscopic tools, medical education specific virtual reality models)

☐ 计算机和移动设备（台式电脑、笔记本电脑、平板电脑、手机等3D触控）
Computers and mobile devices (desktop computers, laptops, tablets, mobile phones, etc.)

☐ 游戏和娱乐（操纵杆、游戏手柄、方向盘、带力或电触觉反馈的喷气座椅）
Games and entertainment (joystick, joystick, steering wheel, jet seat with force or electro-tactile feedback)

33. 您在游戏中感受过以下哪些类型的触觉反馈？（可选择填空，补充未包含的内容） [多选题] *
Which of the following types of haptic feedback have you experienced in your game?

☐ 信号状态和警报（生命值下降，受伤，攻击状态，保持专注，检查游戏进度，继续体验）
_____
Signal status and alerts (health point drop, injury, attack status, stay focused, check game progress, continue the experience)

☐ 提供提示和警告（发现隐藏的敌人或目标，枪声，爆炸，判断与敌人的距离，判断敌人的大小，发现隐藏的物体，物品，路径）_____
Provide tips and warnings (find hidden enemies or targets, gunshots, explosions, judge the distance from the enemy, judge the size of the enemy, find hidden objects, items, paths)

☐ 行为和动作（车子的震动感，武器是否命中敌人，防御是否成功）_____
Behavior and movement (the vibration of the car, whether the weapon hit the enemy, whether the defense was successful)

☐ 情绪的强化（害怕，紧张，兴奋，惊喜，强烈地对抗，预期被提高，迷失了方向，得到了奖励很满意）_____
Emotional reinforcement (fear, nervousness, excitement, surprise, intense confrontation, raised expectations, disorientation, rewarded satisfaction)

☐ 氛围感的营造氛围感的营造（毛骨悚然的幽灵，戏剧性的战斗背景，悬念，心跳加速）
_____
Atmosphere creation (creepy ghosts, dramatic battle backgrounds, suspense, heart racing)

34. 您觉得在动作冒险游戏中，以下哪些触觉反馈是最重要的？ [多选题] *
Which of the following haptic feedback do you think is most important in action adventure games?

☐ 被击中或被阻挡时发出警报；机枪强度、后坐力；紧急危险时的警告
Alerts when hit or blocked；Machine gun intensity, recoil；Warnings when in imminent danger

☐ 不同武器的不同震感
Different rumble levels for different weapons

☐ 加剧恐惧、紧张；敌人存在警报
Intensify fear, tension; the enemy is on the alert

☐ 致命一击；剑术、其他武器；爆炸
Fatal blow; swordplay, other weapons; explosion

☐ 选项173

35. 您觉得在动作冒险游戏中，以下哪些触觉反馈是最重要的？ [矩阵量表题] *
Which of the following haptic feedback do you think is most important in action adventure games?
（单选最高5分）

	1	2	3	4	5
被击中或被阻挡时发出警报；机枪强度、后坐力；紧急危险时的警告 (Alerts when hit or blocked；Machine gun intensity, recoil；Warnings when in imminent danger)	○	○	○	○	○
不同武器的不同震感 Different rumble levels for different weapons	○	○	○	○	○
加剧恐惧、紧张；敌人存在警报 Intensify fear, tension; the enemy is on the alert	○	○	○	○	○
致命一击；剑术、其他武器；爆炸 Fatal blow;	○	○	○	○	○

Figure A.8: survey a 08

	1	2	3	4	5
swordplay, other weapons; explosion					
命中警报;惯性、碰撞;雷暴;空气湍流。 (Hit warning; inertia, collision; thunderstorm; air turbulence.)	○	○	○	○	○
柱子倒塌，墙壁倒塌；反击 Pillars collapse, walls collapse; counterattack	○	○	○	○	○
直升机、飞机、摩托车 Helicopters, planes, motorcycles	○	○	○	○	○
剪辑场景、战斗 Editing scenes, battles	○	○	○	○	○
解谜 Solve puzzles	○	○	○	○	○
骑马的颠簸 The bumps of riding	○	○	○	○	○
第六感 （比如UI提示可以新建秘密基地） Sixth sense (such as UI prompts to create a new secret base)	○	○	○	○	○

36. 您觉得在格斗游戏中，以下哪些触觉反馈是最重要的？ [矩阵量表题] *

Which of the following haptic feedback do you think is the most important in a fighting game?

（单选最高5分）

	1	2	3	4	5
表示出拳和受拳的强度 Indicates the intensity of the punch and the punch	○	○	○	○	○
玩家被挡住或击中时的警报和强度感；需要躲闪的警报；落地重拳和强度感；动物从后面攻击时的警报 Alarm and sense of intensity when the player is blocked or hit; alarm that needs to be dodged; landing punch and sense of intensity; alarm when an animal attacks from behind	○	○	○	○	○
玩家受阻时发出警报；拳击及其严重程度	○	○	○	○	○
Marking, fighting, lock picking; need to rob people and break into stores	○	○	○	○	○

37. 您觉得在赛车游戏中，以下哪些触觉反馈是最重要的？ [矩阵量表题] *

Which of the following haptic feedback do you think is the most important in racing games?

（单选最高5分）

	1	2	3	4	5
独立于视觉和声音提示的游戏状态信息；崩溃和碰撞；越野地形 Game state information independent of	○	○	○	○	○

Figure A.9: survey a 09

	1	2	3	4	5
visual and acoustic cues; crashes and collisions; off-road terrain					
转弯时轻微振动；撞到其他汽车；路缘、颠簸、碰撞；地形差异,更容易判断抓地力和稳定性；牵引力和失去牵引力；车轮摆动,提供有关玩家何时将车辆推得太用力的信息 Slight vibration when cornering; bumping into other cars; curbs, bumps, bumps; terrain differences, making it easier to judge grip and stability; traction and loss of traction; wheel wobble, providing information about when the player is pushing the vehicle too hard	○	○	○	○	○
汽车加速、换档、速度,提供玩家拥有多少控制权的感觉；该地区的警察警报；撞车和障碍物,指示撞击的严重程度； Cars accelerate, shift gears, speed, providing a sense of how much control the player has; police alerts for the area; crashes and obstacles, indicating the severity of the impact;	○	○	○	○	○

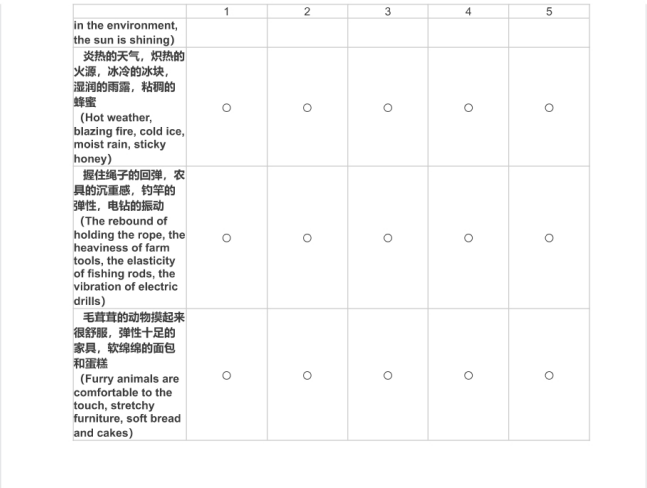
38. 您觉得在未来的悠闲类社交游戏中，以下哪些触觉反馈是最重要的？ [矩阵量表题] *

Which of the following haptic feedback do you think is the most important in future leisurely social games?

（单选最高5分）

	1	2	3	4	5
握手，拥抱等社交礼仪 Social etiquette such as shaking hands, hugging	○	○	○	○	○
协同制作设计时的振动传递，触觉同步（Vibration transmission, tactile synchronization during co-production design）	○	○	○	○	○
界面交互，升级，获得道具和装备的UI提示（UI prompts for interface interaction, upgrades, getting props and equipment）	○	○	○	○	○
走过麦浪，聆听鸟鸣，风的吹拂，感受环境中的天气变化，阳光明媚（Walk through the wheat waves, listen to the birdsong, the wind blowing, feel the weather changes	○	○	○	○	○

Figure A.10: survey a 10



	1	2	3	4	5
in the environment, the sun is shining)					
炎热的天气，炽热的火源，冰冷的冰块，湿润的雨露，粘稠的蜂蜜 (Hot weather, blazing fire, cold ice, moist rain, sticky honey)	○	○	○	○	○
握住绳子的回弹，农具的沉重感，钓竿的弹性，电钻的振动 (The rebound of holding the rope, the heaviness of farm tools, the elasticity of fishing rods, the vibration of electric drills)	○	○	○	○	○
毛茸茸的动物摸起来很舒服，弹性十足的家具，软绵绵的面包和蛋糕 (Furry animals are comfortable to the touch, stretchy furniture, soft bread and cakes)	○	○	○	○	○

Figure A.11: survey a 11