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Author	徐, 聡(Xu, Cong) 杉浦, 一徳(Sugiura, Kazunori)
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Master's Thesis
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A Knight's Oath: A Mobile Game for Immersive Gaming Experience Using Environmental Data

Keio University
Graduate School of Media Design

Cong Xu

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

Cong Xu

Master's Thesis Advisory Committee:

Professor Kazunori Sugiura	(Main Research Supervisor)
Professor Kai Kunze	(Sub Research Supervisor)

Master's Thesis Review Committee:

Professor Kazunori Sugiura	(Chair)
Professor Kai Kunze	(Co-Reviewer)
Project Senior Assistant Professor Masato Yamanouchi	(Co-Reviewer)

Abstract of Master's Thesis of Academic Year 2019

A Knight's Oath: A Mobile Game for Immersive Gaming Experience Using Environmental Data

Category: Design

Summary

Many games have been pursuing "immersion" since the early days of video games. With VR technology, some games try to bring a more realistic game world before the eyes of players. Whereas, some games also try the opposite way: involving the real world as a part of the game, as known as "breaking the fourth wall."

Smartphones are now becoming more and more powerful and functional. They usually carry a lot of sensors, which allow the smartphone easily to collect information about the environment around the user. With these sensors, it has been easier to involve the real world in the game. In other words, to create a bi-directional connection between the game world and the real world.

In this paper, we describe the design process of an environment-aware mobile platforming game. We detail some previous games which have already used sensors in the gameplay. We introduce how *A Knight's Oath* uses sensors to detect the real-world environment data and map these data into the game scene.

To measure the effectiveness of this design, we conducted a user test which uses an immersion and presence questionnaire to evaluate the prototype game. The result of the user test has collected positive data, which showed that an environment-aware mobile game could provide players more immersive gaming experience.

Keywords:

Smartphone, Sensor, Mobile Game, Immersion, The Fourth Wall

Keio University Graduate School of Media Design

Cong Xu

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Chapter 1
Introduction

Many games have been pursuing "immersion" since the early days of video games. Many of them are trying to offer more realistic graphics to players. In 1994, 3DO Interactive Multiplayer was released. It is considered as the first influential and widespread fifth-generation game console. In the next decade, many consoles which players are familiar with were released, including PlayStation, Nintendo 64, and Sega Saturn. The fifth-generation game consoles change the appearance of games significantly. It provides the function to produce 3D graphics. Since the era of the fifth-generation game consoles, 3D games have a great share in video games. Comparing to those 2D games which used to dominate the game market, 3D graphics give us a more vivid game world. In the last two decades, the graphics quality of 3D games keep evolving, and we can experience much more realistic and vivid game worlds than anytime before.

In 1995, Nintendo released its new game console, Virtual Boy. It is the first commercial attempt of virtual reality game consoles. However, due to its high price, monochrome display, unimpressive 3D effect, and most importantly, lack of high-quality games, it was a commercial failure. In recent years, almost 20 years later, benefit from the rapid growth of the power of computers and video game consoles, virtual reality game is finally an option for game creators. With VR technology and high-performance devices, more and more high-quality VR games have been made. Players now can have another choice to immerse themselves in the game world. Some studies have shown that compared to traditional video games, players usually feel more immersive while they are playing a VR game. And many creators think that VR game is the first step of developing a truly immersive experience for the player to enjoy.

Whereas, some game creators and designers believe that more realistic graphics quality or VR game contents are not the only way to provide an immersive gaming

experience. In a VR game, We can make the game world more similar to the real world, which is so realistic that players may believe that they themselves are in the game world. This is also Thus, we can see these creators try the opposite way: involving the real world as a part of the game. Sometimes this idea is as known as "breaking the fourth wall".

Smartphones are now becoming more and more powerful and functional. They usually carry a lot of sensors, which allow smartphones easily to collect the information about the environment around the user, which makes them an ideal media to connect the game content to the real-world context. With these sensors, it has been easier to involve the real world in the game. Smartphones have also become an important platform in the game industry. In 2018, mobile revenues accounted for more than 50% of the global games market as it reaches 137.9 billion USD [1]. If some creators want their games can be played by more people, choosing the mobile platform could be a good decision.

Comparing to many other game platforms, such as personal computers or video game consoles, smartphones have it uniqueness which other platforms do not carry. Its portability, capability of detecting the environment with sensors, all-time internet connection have provided the possibility of creating a lot of unique games on this mobile platform.

This research will focus on how to use the capability and functions of smartphones to design a game which can give players a more immersive gaming experience than normal games. Besides, how to use sensors in the smartphone to involve the real world as a part of the game and how to design gameplay based on these sensors will also be studied.

1.1. Motivation

Although the VR technology has developed a lot recently, still only a few players have experienced VR games. For now, there are many factors that limit the spread of VR games. The first factor is the VR device itself. If players want to play a VR game, the first thing they will need is VR devices in addition to their PCs or consoles, which cost quite an amount of money. Therefore, the VR devices are not very widespread so far. According to the investigation, about 8.9 million VR

headset units will be sold by 2019. [2] It looks like that a great number of VR units have been sold, but if we compare this number to other game devices in the game market, such as smartphones, video game console, and PCs, "8.9 million" is still a very little number.

The second factor which limits the VR game is virtual reality sickness. Due to technological limitations, many users will suffer virtual reality sickness while using a head mount display (HMD), which is a common display device among VR devices [3]. Similar to motion sickness symptoms, players might suffer a series of symptoms including general discomfort, headache, stomach awareness, nausea, vomiting, pallor, sweating, fatigue, drowsiness, disorientation, and apathy [4]. If creators insist on using virtual reality devices to realize the immersive gaming experience, many players who suffer from virtual reality sickness might not be able to enjoy the game. The author believes that VR devices are not the only solution to realize a deeply immersive gaming experience. If we can find a method to realize this kind of immersive gaming experience on other platforms, it could be a solution of providing more players more immersive gaming experience.

1.2. Hypothesis

The hypothesis of this research is defined as such:

Players will feel more immersive if the real-world context and the game content are connected. In other words, the real world is (partially) mapped to the virtual world.

When we talk about immersion, it usually means that the player is having a sense of being in the game world. If we could turn the real world into a part of the game world, then it might make the gaming experience more immersive, since the real world is now also the game world. The hypothesis is also based on this concept.

1.3. Contribution

This research aims to establish and evaluate new ways for the immersive gaming experience, which could create a bi-directional connection between the real world

and the game world. There are some games which have already used sensors to interact with the game; however, they usually only use it as merely an input method. Thus, we will focus the research on how to use these sensors to create this bi-directional connection between two worlds. If the hypothesis could be proved, then this research could offer a solution for creating immersive games on the mobile platform.

Moreover, this research will also research how this design could affect experienced players and those who do not often play games. We would like to see if the design could have a positive effect on both players and non-players.

1.4. Thesis Structure

- **Chapter 1: Introduction** This chapter will mainly introduce the background, motivation hypothesis, and contribution of this research. After these, it gives the structure of the whole thesis.
- **Chapter 2: Related Works** This chapter will mainly discuss literature review and related works. We will first explain the definition of "immersion" and what is "the fourth wall". Then we will discuss the relationship between the game and immersion. Next, introduce some games which already use the idea of "breaking the fourth wall" in their design. And at the end of this chapter, related researches and thesis will be reviewed. Finally, some typical games which have already used sensors as an input method or interaction method will be introduced. We will introduce what kind of sensors these games use and the way how they use these sensors.
- **Chapter 3: Design Approach** This chapter, we will first explain the concept and approach to this environment-aware game design. The reason why the smartphone is chosen as the game platform. What kinds of environmental elements are involved and how to use these environmental elements in the game. Further, some sensors which are not used in the prototype game will be mentioned as well and explain the reason why they are not used in the final prototype game.
- **Chapter 4: The Final Prototype game: *A Knight's Oath*** This

chapter, the game design, and the game mechanism will be introduced. The entire prototype game flow will be explained in detail, including the game premise, the game controls, use of sensors, the game story, the game scene, and the gameplay.

- **Chapter 5: Evaluation** This chapter will introduce the design iteration, the user test of the prototype game, and analyze the feedback from participants. The design of the questionnaire, the procedures of the user test, users' behavior in the user test, and the results of the user test will be introduced one by one.
- **Chapter 6: Conclusion** This chapter, which is also the last chapter, we will have a conclusion of this research. The limitation of this research and what is needed to do in the future research will be discussed as well.

Chapter 2
Related Works

In order to design a game which could involve the real-world context and provide a more immersive gaming experience, several points must be understood. First, it is essential to understand the relation between the game and the immersion. We need to learn about what is immersion and how to create a feeling of immersion. Second, it is very important to learn how games can interact with the real world as well. Those games which have already used sensors to interact with the real world will be discussed. This chapter will mention the current researches and studies about immersion, immersion in games, and game with sensors.

2.1. Games and Immersion

Most successful games all have one element in common: they have an ability to draw people in, which is usually referred to as "immersion". Immersion in games involves a lack of awareness of time, a loss of awareness of the real world, involvement, and a sense of being in the task environment. [5]

2.1.1 The Definition of "Immersion"

The definition of what is immersion might vary from person to person. So far, the most accepted definition is made by Janet H. Murray. In his book, he defines:

> A stirring narrative in any medium can be experienced as a virtual reality because our brains are programmed to tune into stories with an intensity that can obliterate the world around us. The experience of being transported to an elaborately simulated place is pleasurable in itself, regardless of the fantasy content. We refer to this experience

> as immersion. Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool:the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus, in a participatory medium, immersion implies learning to swim, to do the things that the new environment makes possible...the enjoyment of immersion as a participatory activity [6].

When discussing immersion, another term is usually related as well, presence. Although immersion and presence are different concepts, they are not separated, and there is even a grey zone between them. J. Steuer has defined that presence refers to the mediated perception of an environment. This environment can be either a temporally or spatially distance "real" environment or virtual environment created by a computer [7]. M. Slater argued that if immersion is analogous to wavelength distribution in the description of color, then "presence" is analogous to the perception of color. In other words, presence is a human reaction to immersion [8]. It could be possible to use the level of presence to measure immersion. B. G. Witmer and M. J. Singer pointed out that a virtual environment which produces a greater sense of immersion will produce higher levels of presence [9].

2.2. Immersion, the Game and the Fourth Wall

2.2.1 Breaking the fourth wall

The fourth wall is a performance convention in which an invisible, imagined wall separates actors from the audience. While the audience can see through this "wall", the convention assumes, the actors act as if they cannot [10].

The idea of breaking the fourth wall is originally used in the theater. "Breaking the fourth wall" is any instance in which this performance convention is violated. And it is also possible in other media, such as books and video games. D. M. Davis and P. J. Auter pointed out that people like to be included in the context of their media and audiences prefer comedy breaks the fourth wall to comedy that

does not [11]. Comparing to many traditional media such as books or TV, games have way more interaction methods than those traditional media.

2.2.2 How to Increase Immersion in a Game

"Immersion" as a concept of gameplay is often discussed in terms of "presence", the feeling of immersed "in the game". K. Collins argued that rather than view the game as a separate space into which we may become immersed, we may more accurately speak of the player being immersed "in the gameplay". Immersion can also occur in the narrative-what we might refer to as "presence"-and immersion in the experience-what we might refer to as "engagement". When a player creates something in the real world and then incorporates these things into the virtual space, the player holds a position between the actor and audience in a virtual world. At this moment, the fourth wall that divides the virtual world from the real is broken as the virtual-real dichotomies are destroyed. In this situation, the player may become immersed in the experience of co-creation and play [12].

In *A Circular War? Reformulating the Fourth Wall for Video Games* [13] the author presented the idea that relocating the fourth wall entirely behind the player, as a tool of immersion, is something quite unique, and actually in complete opposition to the motivation of breaking the fourth wall in the first instance. But this method can also give the player an immersive game experience.

2.2.3 Break the Fourth Wall in Games

Many scholars seem to agree that total visual-realism or audio-realism is not necessary for a virtual reality environment to produce a sense of immersion [14]. Virtual reality and some other similar technology are not essential to create an immersive gaming experience. There are other ways to create this kind of feeling and experience.

For example, there are some games using a very unique interaction method in recent years. One typical game is *Doki Doki Literature Club!* [15] (Figure 2.1). This game looks like a common visual novel style adventure game. However, it contains a unique core game design. The play needs to manipulate the game files in their computers to push forward the game story. This kind of game is usually

called meta-game, which means the game which breaks the fourth wall. The core idea of a meta-game is to break the fourth wall between the real world and the game. Through this method, to give players a more immersive gaming experience. These games use several different methods to break the fourth wall and interact with players.

Figure 2.1 Doki Doki Literature Club!

In most of the games, players are able to change something within the framework of games. In this case, these meta games expand the game content to the real world. Game files, something that players usually not allowed to change, are now becoming a part of the gameplay. Players must delete some specific game files in order to solve the puzzle and continue the game. In addition to *Doki Doki Literature Club!*, some other games also use this method to enhance the gaming experience and the immersion, such as *Kimi to Kanojo to Kanojo no Koi*. And the narrative of these games is also different from normal games. Characters in these games usually recognize themselves as game characters and directly communicate with players. This method is similar to breaking the fourth in a theatre or in a TV drama. When characters recognize the existence of the audience by speaking directly to them, the fourth wall is "broken" [16].

Among these games which use the narrative to break to fourth wall, one typical game is *Stanley's Parable* (Figure 2.2) [17]. In the game *Stanley's Parable*, the player uses the first-person perspective to move around and interact with certain elements of the environment, such as pressing buttons or opening doors. The game story is primarily presented to the player through the voiceover of the game's

narrator. The key design of this game is that when the player makes choices, the narrator directly comments on player's choices, which makes it feel like that the narrator is "talking" to the player.

Figure 2.2 The Stanley's Parable

Another quite famous example of this kind of game is *Undertale* (Figure 2.3) [18]. In most time, this game looks like a normal indie role-playing game. But in some scenes, the characters in the game recognize themselves as in-game characters and speak directly to the player.

Figure 2.3 Undertale

2.3. Game with Sensors

In order to get information from the real world, sensors on game devices are very useful tools. In fact, there have been already some games which use sensors as

an interaction method. Most of them are mobile games due to the easy use of sensors in the smartphone and the huge market of mobile games. Some examples are listed below.

2.3.1 Game with Sensors in Early Days

Someone might think that playing a video game with sensors is a quite new idea. In fact, this kind of game was realized a long time ago. In the 1980s, there have already been some games which use sensors to play. Some games on Famicom use the microphone in Famicom to create a unique gameplay. For example, *Takeshi no Chōsenjō* [19], *Raid on Bungeling Bay* [20], and the famous *The Legend of Zelda* [21] (Figure 2.4).

Figure 2.4 Boktai: The Legend of Zelda

2.3.2 Boktai: The Sun Is in Your Hand

Video game creators kept trying making more interesting games. Almost 20 years after the first attempt of using sensors to play the game, another game tried this idea. Boktai: The Sun is in Your Hand [22] (Figure 2.5) is a game released in 2003 on Game Boy Advance, created by Hideo Kojima. It is a unique game, once the players see the game cartridge, they can tell the difference immediately: the photometric light sensor is attached to the game cartridge.

In this game, the player is going to control the main character. A boy called Django, who turned out to be an heir of vampire hunters and a weapon called Gun Del Sol. This weapon can be charged by the sunlight in the real world, and

Figure 2.5 Boktai: The Sun Is in Your Hand

with the power of the sunlight, it can kill enemies, which are similar to vampires, in the game. In order to do that, the player must take their Game Boy Advance outside in the daytime and expose the photometric light sensor to the sunlight.

Besides, before the player starts the game, the player is prompted to set their current time and time zone. Based on the time and location information, the game can simulate the position of the sun in the game and a day-night cycle.

2.3.3 Racing Games on Mobile Devices

Recently, we can see many racing games on mobile devices which use the accelerometer on smartphones to play, such as *Real Racing 3* [23] and *F1 Mobile Racing* [24]. In these mobile racing games, basically, players rotate their mobile devices to turn the corner. It makes them feel that they are using their mobile devices as steering wheels to control the car in the game.

2.3.4 Scream Hero

The game *Scream Hero* [25] is another example of using sensors to play (Figure 2.6). This game looks like a common "endless runner" game. However, what makes the game different from other runner games is the use of the microphone.

In this game, players can use their voice to move and jump between platforms. The microphone in the smartphone will detect the loudness of the player's sound and use the sound to control the character in the game, a little ninja. Soft voice and scream can have different effects. The player is expected to control the volume of their voice carefully in order to avoid obstacles and keep the ninja running on the platform.

Figure 2.6 Scream Hero

2.3.5 Fitflap

This game is another example. **Fitflap** [26] is a bit different from other game which uses sensors to play. This game uses the front camera of smartphones or tablets to capture players' gestures. It was presented at Google I/O 2015, due to its adoption of the Google Cast Remote Display API.

2.3.6 Pokemon Go

Pokemon Go (Figure 2.7) [27] is a famous title developed and published by Niantic for iOS and Android devices. This is an augmented reality game based on player's real-world location. The game is the result of a collaboration between Niantic and Nintendo by way of The Pokemon Company. The game uses the GPS in players'

mobile devices to locate, capture, battle, and train Pokemon which appears as if they are in the player's real-world location.

Figure 2.7 Pokemon Go

Chapter 3
Design Approach

3.1. Design Concept

As mentioned in previous chapters, the concept is using sensors to create a bi-directional connection between the game and the physical world, and through this bi-directional connection, to provide players more immersive gaming experience. The game can detect and react to the environmental changes in the physical world with sensors; players can also manipulate the game by changing the environment around them.

There are many games which have already use sensors to play, such as those games mentioned in Chapter 2. However, most of them only use sensors as merely input methods. In those games, we can use the accelerometer to turn the corner; use our voice or even our body gestures to control the movement of the game character. But we can hardly say that these games create a solid connection between the game world or the real world. We have to admit that many of these games are interesting, the change of the input method can bring fun and happiness to players and provide them a new gaming experience. However, the change of the input method does not change the nature of these games.

In recent years, smartphones have become more and more powerful, most of us have at least one smartphone and using it almost every day. Smartphones usually carry a lot of sensors, which allow smartphones easily to collect information about the environment around the user, which makes them an ideal media to connect the game content to the real-world context. With these sensors, it has been easier to involve the real world in the game. Sensors on other game devices, such as personal computer and game consoles, they usually only carry a few kinds of sensors, which could limit the game design, since only one or two environmental

factors can be involved in the game depending on what kind of sensors the game devices carry. The design concept is involving as many environmental elements as possible in the game. We assume that the more elements in the real world are included in the game world, the stronger the connection between two worlds could be.

In this research, sensors are used as an input method, game environment projector, and scenario brancher.

- **Input Method**

  First, the player can use the sensor as an input method. For example, the speed of the character will be affected by the environment, such as the brightness around the player. The player can control the speed by changing the light intensity in the real world; the enemies' behavior will change depending on environmental data, the player can avoid or defeat enemies by changing the environment. In addition to the enemies, game items can be affected in a similar way.

- **Environment Projector**

  The sensor can be used as an environment projector. Sensors can detect the environmental information in the real world and map it to the game. Moreover, it will keep detecting so that the environmental data can be updated in real-time. By this method, to create a continuous, stable, long-term connection between the real-world and the game-world.

- **Scenario Brancher**

  Further, the game could be led to different branches depending on environmental data. Both short-term and long-term environmental data will affect the game scenario. In short-term case, the environmental state when the players activate a trigger decides what will happen after the trigger has been activated. In long-term cases, the sensor is used to detect if the player has stayed in a specific environment long enough, for example, a noisy environment or bright environment.

3.2. Design Process

As mentioned in Chapter 2, there have been some games which use sensors as an interaction method. However, most of them only use these sensors as an input method. It is hard to say that these games have created a connection between the game content and the real-world context. *Pokemon GO* and *Boktai: The Sun Is in Your Hand* are a bit different among all these games which use sensors. Both of them use the sensor to create a link between the game world and the real world. *Pokemon GO* and other games which use the technology of Niantic, they have turned the real world into a playground. Players can use their mobile devices with GPS to observe the real world in a different way. Through the screen of mobile devices, players seem to interact with a world which is hidden behind the real world.

Boktai: The Sun Is in Your Hand uses the sunlight in the real world as the energy in the game. Players use the sunlight to charge the weapon in the game. Further, the time in the game is related to the time in the real world. Before the game starts, players need to choose their location and the day-night change in the game is exactly the same as the day-night change at the player's location.

Can we create a stronger connection between the real world and the game world with more elements? Can sound volume, gravity, and other elements be also involved in the game? Then we tried these elements one by one, to see how these sensors could be fitted in a mobile environment-aware game.

3.3. Use of sensors

In order to create a stronger connection between the real world and the game world, it is necessary to connect more elements between the two world. Multiple sensors in the smartphone can be used to involve more real-world elements into the game. The more elements in both worlds (game and real) are related, the deeper and stronger the connection could be. This section will explain how these sensors are used in detail.

3.3.1 Light Sensor

The light sensor is a very common and important sensor in most modern smartphones. It can detect the light intensity around the device. And the accurate value of the real-time light intensity of an Android device can be acquired easily. The prototype game will be made with Unity 3D Engine, with a couple of lines of codes, the game can get the value of light intensity through these codes and use them to affect other parts of the game (Figure 3.1).

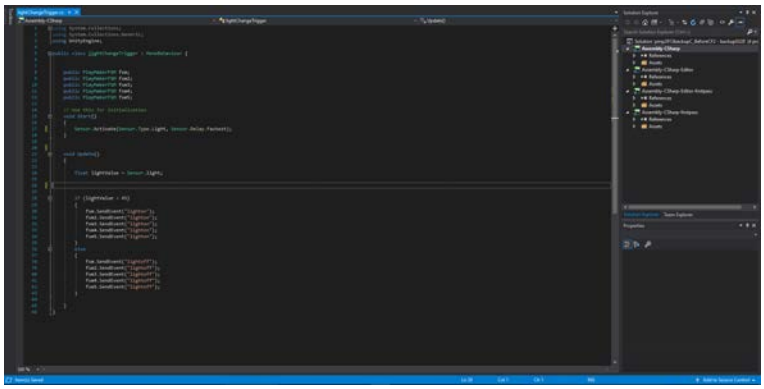

Figure 3.1 Get the Lux Value

In this design, the lux value detected through the light sensor is used to affect enemies' behavior as well as the brightness in the game. The brightness in the game is related to the brightness around the player in the real world. Enemies in this final prototype game react to the light as well. They will be very aggressive in the darkness. The following pictures (Figure 3.2 and 3.3) show the difference. The first one is how the game looks like in a bright environment. The skeleton soldiers are paralyzed by the light and the game environment is bright. On the other hand, the second picture shows the way of darkness.

In addition to the enemies behavior, the brightness around the player can affect the game ending as well. There will be several triggers in the game. If the player activates the trigger in different situations, the game could be led to different endings. There will be an ending for the light as well as an ending for the darkness.

Moreover, the game will be led to different branches or endings based on relatively long-term environment situation (in this case, the brightness) rather than

Figure 3.2 The Game in the Light

Figure 3.3 The Game in the Dark

only the situation when the player triggers the event (salutes to the king). More specifically, if the time that the player stays in the light is longer than the time the player stays, the game will be led to an "ending of the light". On the contrary, if the player stays in the dark longer, then it will be an "ending of the dark".

To realize this function, a time count system was added to the game to detect the time that the player has spent in a bright environment or in a dark environment. When the character arrives the trigger area, in this case, when the character salutes to the king, the system will compare the time that the character has spent in the light and the darkness and decide which ending the player will be led to. The following figure shows this counting system which is made with PLAYMAKER in Unity 3D engine (Figure 3.4).

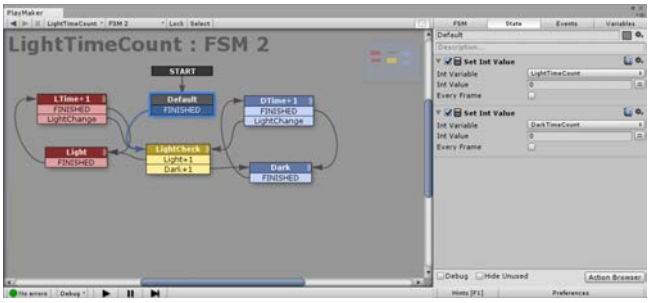

Figure 3.4 The System to Count How Long Players Stay in Light or Dark

3.3.2 Microphone

After the brightness, the second environmental element which is used in the game is sound. The microphone is always very important input equipment in a mobile device. The most basic function of a mobile phone: making a phone call, relies on microphone and speaker (or headphone) installed on the smartphone. The microphone on most mobile devices can also detect the loudness which detected by it. It enables us to detect the loudness around the player with the microphone in the smartphone. Through the microphone, the game will detect the loudness around the player and react to it. Some codes are used to get the value of the loudness and it is used to control other game objects. Similar to the light sensor, some codes are used to get the loudness value in the Unity 3D engine (Figure 3.5).

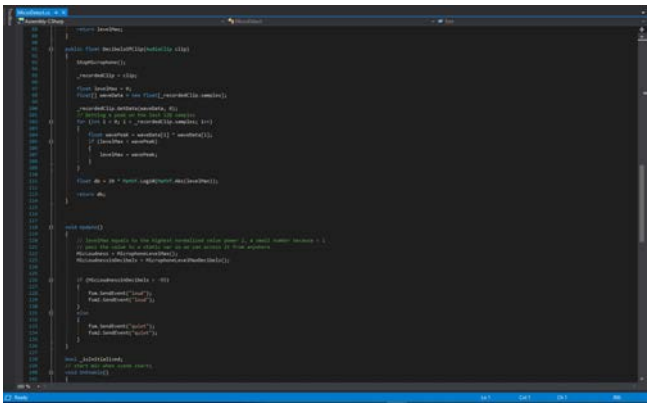

Figure 3.5 Get the Loudness Value

The items in the game and the game environment can be affected by the change of the loudness around the player. For example, the flame on torches, the flame of the fire barriers (trap) will be faint if the player is in a noisy environment. Otherwise, it will burn brightly in a quiet environment.

Further, as mentioned above, the key concept of this design is to create a strong and continuous connection between the game world and the real world. If only the fire is affected by the sound, it might not be an enough strong connection. Thus, the main character controlled by the player is going to be affected by the sound in the real world as well. The idea is that the sound can make the game world unstable, as a result, the character will not be able to run fast in a noisy condition. Some items in the game scene will look different in a noisy environment, comparing to how they look in a quiet environment.

3.3.3 Accelerometer

The accelerometer is used to detect the rotation of the smartphone. When the player rotates the smartphone, the accelerometer in the smartphone will detect this change and make some changes in the game. Some codes are used to get the inclination value in the Unity 3D engine. (Figure 3.6) Depending on the inclination of the smartphone, some items in the game scene can be moved. For example, if the player rotates the smartphone to the left side, some game objects can roll down towards the left side. The player can use this gameplay to remove obstacles on the path or bring down something from high places in the game scene.

3.3.4 Others

- **GPS**

  There are also some other sensors have been considered but they are not applied in this final prototype game. The first one is the GPS. GPS can easily attach geographic information to the game but the challenge is how to use this information. The original design is to use user's geographic location data and weather API, to make the weather in the game the same as the weather at player's location. But the challenge is that the prototype game does not last for a long time. The game length is around 5 to 10

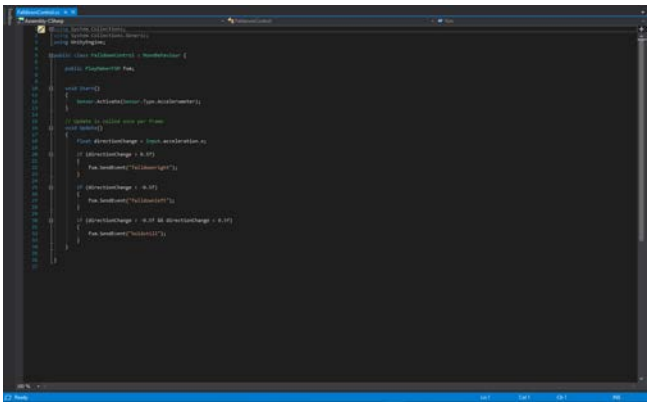

Figure 3.6 Detect the Inclination

minutes. This length is too short to observe any weather change in the real world. The player must be very lucky so that the player can see this weather change in the game. Otherwise, they are very unlikely to find out that the weather in the game is related to the weather in the real world. Due to this reason, this gameplay is not going to be involved in the final prototype game.

- **Time**

  The next one is time. Time is also an element which can be shared between the real world and the game world. If both worlds share the same time and have the same day-night cycle, it could make players feel that the connection between the two worlds is stronger. In fact, the time system which is related to the real world has been created. However, due to the game length of the prototype game, which only last around 5 to 10 minutes, it could be very hard for players to find out that the time in the game is the same as the time in the real world. So, this function is removed in the final prototype game.

3.4. Story and Narrative

Some researches argued that story and gameplay in a game are not isolated. There is a connection between them, in a certain point of view, they work as one. J. Schell concluded that many experiments proved that experiences could be created that had elements of both story and gameplay. It questions the assumption that stories and games are governed by a different set of rules. In fact, we can find common principles that underlie both story and game based entertainment [28].

The narrative is often used to define the conventions of the virtual world and to help the user align their expectations and the logic of the world. [14] To convey the idea that the game world and the real world are connected better, the story and narrative are also related to the sensors.

To contain a story in a game, the best genre could be the adventure game. The prototype game will also be made into an adventure game. In the prototype game, the main character is not only a game object which is controlled by the player, but also a media between the game world and the real world. The character is designed to "speak" to the player.

There is also a narrative system in the game. The narrative also plays an important role in the immersion of video games. According to H. Qin, P. Rau and G. Salvendy, player immersion in the computer game narrative can be divided into three stages: antecedents, experiences, and effects. Further, the factors which affect the immersion in the computer game narrative includes curiosity, concentration, comprehension, control, challenge, and empathy [29]. The character controlled by the player will "speak" to the player through the subtitles in the middle of the screen. These words will explain the game story to the player and also serve as a tutorial of the game.

3.5. Design Summary

This design uses the sensor in the smartphone as an input method, environment projector, and scenario brancher.

The player can change the environment around them, "input" this change into the game, and interact with the game. The environment around the player will

change by itself, and this change will also be detected by sensors and affect the game. When this happens, sensors are used as an environment projector. Depending on the data collected by sensors, both short-term and long-term environmental data, the game could be led to different branches.

Multiple sensors are used in order to create a stronger connection between the game world and the real world. Also, the game design should pay more attention to the gameplay, story, and characters design. The author thinks that gameplay and the story are the most important part. In order to contain these elements in a game, the adventure game is the best choice. It fits the design concept the best.

In the next chapter, it will explain how these designs are applied in the final prototype game and the complete mechanism of the game.

Chapter 4

The Final Prototype Game: A Knight's Oath

4.1. Overview

This chapter will introduce the final prototype game *A Knight's Oath* in detail. The following figures (Figure 4.1 and Figure 4.2) are an overview of the final prototype game scene.

The red line is the route that the player is expected to travel. The player controls the character, a knight, who lies on the ground at the position of the blue star. The target of the first part of the scene is that the player needs to control the knight to go towards the throne of the skeleton king, who is located at the edge of the space on the right side. In the middle of this part, the player will enter an alert zone of the skeleton soldiers (the green box), which are aggressive to the player. The player has several methods to avoid or kill these enemies. The method of how to interact with these enemies will be introduced later in this chapter. Once the player has passed through this area, the player will arrive the throne and salute to the skeleton king.

After having saluted to the skeleton king, the player needs to go back to the chamber on the left side of the game scene. The yellow line is the path that the player is going to travel. If the player chooses the ending of the light, the alert zone will be deactivated, the player can go through this zone safely. If the player chooses the ending of the dark, the alert zone is still active, the player must be careful. After the alert zone, the player will face a fire barrier zone. In this area, there will be two fire barriers and one pillar on the ground. The player needs to find a way to pass them safely.

Finally, the player will enter the chamber on the left side. If the player chooses

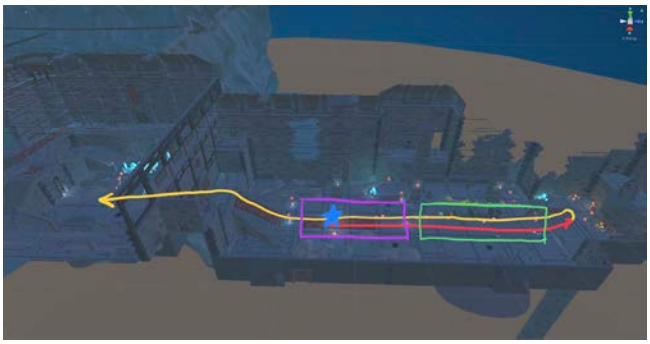

Figure 4.1 Overview 1

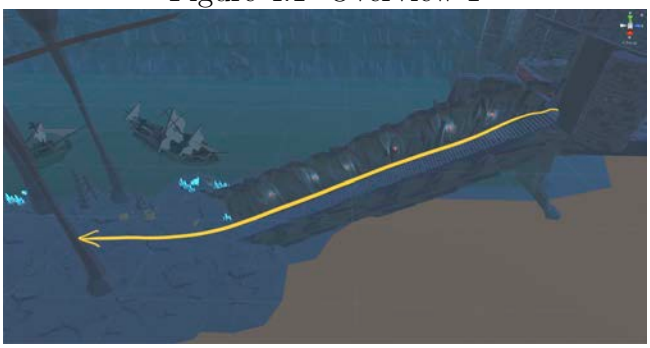

Figure 4.2 Overview 2

the ending of the light, the game will end in this chamber. If the player chooses the ending of the dark, a secret path will be revealed, and the player can enter the secret underworld through this path. (Figure 4.2)

4.2. Development Environment

This final prototype game used assets which are listed below. Both free and purchased assets are included. (annex in Appendix Section A)

- PLAYMAKER (Appendix A.1)
- GyroDroid (Appendix A.2)
- POLYGON - Dungeons Pack (Appendix A.4)

- POLYGON - Pirates Pack (Appendix A.5)
- POLYGON - Nature Pack (Appendix A.6)
- POLYGON - Knights Pack (Appendix A.7)
- Control Freak 2 - Touch Input Made Easy! (Appendix A.8)
- Hero General Animation Collection (Appendix A.9)
- Simple Waypoint System (Appendix A.10)
- Simple Sky - Cartoon assets (Appendix A.11)
- 500 Skill icons (Appendix A.12)

4.3. Game Premise and Aesthetics

According to the feedback of the first user test, the final prototype game will be made into a 2D platforming game.

In this prototype game, the main character (the character the player is going to control) is a knight (Figure 4.3) who lost his memory. He lies in a ruin of a cathedral before the player starts the game. Once the player touches the screen, the knight will wake up and speak to the player. The knight tells the player that his world (the game world) and player's world (real world) are connected. Although the knight has lost his memory, he still remembers he has a mission to fulfill, and he asks the player to help him.

The game uses 3D low poly art style materials to create. Models using the low poly art style usually require fewer polygons and consume fewer system resources, which makes it possible to contain more contents in a game scene.

4.4. Controls

4.4.1 Movement

Although the game is created by 3D materials, the game control is more similar to a 2D platforming game. On the left side of the smartphone screen, there is

Figure 4.3 The Knight

a virtual joystick which allows the player to move the character, the knight, in horizontal and vertical (jump). The virtual joystick is not located in a specific place but anywhere the player touches as long as in the left side of the screen. The player can touch anywhere on the left side screens makes him/her comfortable to control the game. Further, since most games use left joystick or WASD keys, which are also on the left side of input devices (keyboards), we believe that it would be better to put the virtual joystick on the left side so that players can be more used to this controlling method.

4.4.2 Sensors

Other than the main character itself, the environment in the game scene is the other thing that the player can control. The prototype game detects the environment around the player with sensors, and the player can interact with the game

by changing something around them, for example, turn off the light.

- **Light Sensor** The brightness in the game is related to the brightness around the player in the real world. Enemies in this final prototype game react to the light as well. The game environment will be bright if it is bright around the player in the real world. On the contrary, the game environment will be dark. (Figure 4.4 and 4.5) Enemies will be very aggressive in the darkness, whereas they will hold still in the light.

Figure 4.4 The Game in the Light

Figure 4.5 The Game in the Dark

If the game environment is dark, the skeleton soldiers will be active and patrolling. Once they find the player, they will chase the player and will not stop until either they die or the player is killed (Figure 4.6). If skeleton soldiers find the player, the player needs to move the smartphone to somewhere as soon as possible, which will paralyze skeleton soldiers and the player can move safely in the light. This design is similar to what was done

in the preliminary prototype game. The idea of this design is urging the player to change the environment around them and interact with the game.

Figure 4.6 The Player is Chased by Skeleton Soldiers

In the following scene, when the player salutes to the king who is sitting on his throne, there will be two results depending on the brightness around the player. If the player salutes to the king in a bright environment, we can see a ghost comes out of king and tells the player what to do next (Figure 4.7).

Figure 4.7 The Player Salutes to the King in the Light

On the other hand, if the player salutes to the king in a dark environment, there will not be anything comes out of the king, but there will be a whisper which also indicates the player what to do next.

- **Microphone** The flame on torches, the flame of the fire barriers (trap) will be faint if the player is in a noisy environment. Otherwise, it will burn brightly in a quiet environment. The idea of this design is that there will

be several fire barriers in the game and the fire is fatal to the player. The player will be killed once they touch the flame (Figure 4.8).

Figure 4.8 The Player is Killed by the Flame

To pass the fire gate safely, the player needs to move their smartphones to somewhere noisy or simply blow at the smartphones: to blow out the fire. Since the sound produced by the action "blowing" will be loud enough to activate the trigger and put out those burning fire gates, players would be able to feel like that they are blowing out the burning fire (Figure 4.9).

Figure 4.9 The Fire is Blown Off

- **Accelerometer**

  In this prototype game, there is one more way to defeat enemies rather than use the light or salute to the king in the light: rotate the smartphone and pull down the pillar near the enemies in a right position. In this case, the

player is expected to rotate the smartphone to the right side and the pillar will fall down and crush the skeleton soldiers (Figure 4.10).

The player also will meet some obstacles in the game, for example, a pillar which falls down to the pass of the character. It will block the path before the character, and the character will not be able to pass unless the fallen pillar is removed. What the player is expected to do is rotating the smartphone and remove the obstacle with the gravity.

Figure 4.10 The Pillar is Falling Down

4.5. Game Scenes

In the following subsections, the mechanism of the whole prototype as well as how the design concept is integrated into the prototype game will be explained.

4.5.1 Scene Part 1

When the player enters the game, the player will see a knight, which is also the character the player is going to control, lies in the middle of the screen (Figure 4.11). When the player touches the screen, the knight will wake up and the game starts. When the knight wakes, he will tell the player some information about the game world and himself, which will be the guide and tutorial of the game. The knight's words imply that the game world and the real world are connected. After the knight finishes his speaking, the game will start and the player can move the character by using the virtual joystick on the left side of the screen.

Figure 4.11 Before the Game Starts

The player can go either the left side or the right side but the right side is the correct direction. If the player goes to the left side, the player will find that the gate on the left side is closed (Figure). The player can push the gate, but the door will not open until the player activates the trigger of opening the gate.

If the player moves towards the right side, after a few steps, the player will enter the alert zone where skeleton soldiers are patrolling in the dark. Then the knight will speak to the player once again in order to tell the player to notice that the enemies are sensitive to the light and some items in the game scene are sensitive to the gravity (Figure 4.12). In this alert zone, if the player is spotted by active skeleton soldiers (in other words in the darkness), they will start to chase the player until the player is down. To prevent this from happening, the player can rotate the smartphone to pull down the pillar and make the pillar fall on the heads of the skeleton soldiers. In this scene, the player should rotate the smartphone to the right side in order to make sure that the pillar will fall to the heads of the skeleton soldiers. But if the player pulls the pillar in a wrong direction which will not touch the enemies, the player will not have a second chance to use the pillar to kill skeleton soldiers. And if the player is detected by the skeleton soldiers before they can pull down the pillar, the player will not have the chance to use the pillar to kill the skeleton soldiers either.

In this case, what the player needs to do is moving the smartphone to somewhere bright to paralyze those skeleton soldiers, so that skeleton soldiers will stop chasing and the player can have a chance to move to the next stage of the game. Meanwhile, the smartphone must be kept in a bright environment; otherwise, the

Figure 4.12 The Alert Zone

skeleton soldiers will be activated again and continue to chase the player. This area is designed to enforce players using the real-world environment around them to interact with the game. The game pushed them to make the change but it is still not that fast which will make some players have to focus on the main character himself and ignore the other environmental elements.

If the player passes the skeleton soldiers' alert zone, he/she will face the Skeleton King, who is used to be the king of the main character. The knight tells the player that he will salute to the king (Figure 4.13). If the knight salutes to the king in a bright condition (which means the player is playing the game in a bright environment at this moment), a ghost will come out of the king's skeleton and tell the player something. At the same time, the skeleton soldiers will be killed by the shock wave which is created by the ghost, no matter the skeleton soldiers are activated or not. Otherwise, if the knight salutes to the skeleton king in a dark condition, there will not be a ghost which comes out of the king, and it seems nothing has happened. But there will be a whisper which tells the player what to do next. And the game is going to the second part.

4.5.2 Scene Part 2

After having saluted to the king, the game might be led to two different major endings. The first one is the ending of the light. If the time the player stays in the light is longer than the time the player has spent in the darkness, then the ending will be this "ending of the light". On the other hand, the game will be led

Figure 4.13 Salute to the King

to the end of the darkness. Players will find out which ending they have entered after they enter the chamber on the left side, whose gate is closed when the game begins. Depending on the condition when the knight saluted to the skeleton king, the gates will be either opened or blew away due to the shock wave created by the ghost.

Then players will leave the throne of the king and head for the chamber on the left side. If the skeleton soldiers have been killed by pillars or the shock wave created by the ghost, players can pass the alert zone without any concern. But if the skeleton soldiers are still alive, players must be careful just as how they did on the way came to the throne.

Once players passed the alert zone, they will enter another zone which is designed to enforce the player to interact with the game by doing something in the real world. There will be two fire barriers and a fallen pillar which lies on the path (Figure 4.14). Players are expected to do something in the real world to solve this puzzle. To pass the fire barriers, players must blow or shouts towards the smartphone, or they can also move the smartphone to somewhere noisy to put out the fire. To remove the pillar lies before the player, the player needs to rotate the smartphone and remove the pillar with the gravity.

After having passed this area, the player can finally enter the chamber on the left side, which the player can not enter at the beginning of the game. The chamber will be in different conditions depending on player's decision before. As mentioned above, there will be two different major endings. If the player chooses the "ending of the light", the sword on the ground will shine brightly with strong

Figure 4.14 Fire Barriers and Pillar on the Ground

cyan light. The knight will stare at the sword for a while and the game scene will end here (Figure 4.15).

Figure 4.15 The Ending of Light

The other major ending is the "ending of the darkness". In this ending, instead of the shining sword, the player can see a female ghost standing in the middle of the chamber. Once the player enters the chamber and stands before the ghost, she will wave at the character and ask the player to follow her (Figure 4.16).

The female ghost will walk towards a statue which is located at the end of the chamber. The statue will move under the ground and a hidden path will be revealed. There is one more fire barrier lies at the hidden path (Figure 4.17). As before, the player needs to blow at the smartphone or make some noise to put out the fire in order to pass this secret gate safely. Otherwise, the knight controlled by the player will be killed just like those fire barriers the player has met before. There is a long stair after the player has passed the hidden gate and it leads to

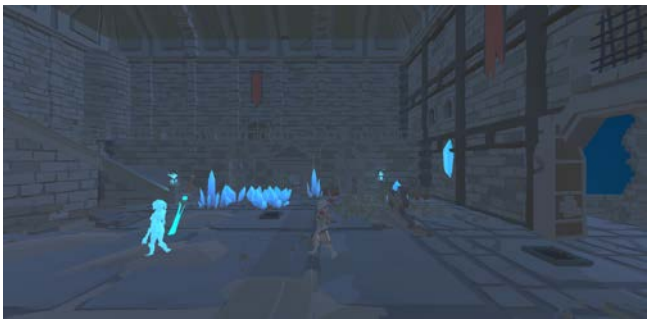

Figure 4.16 The Ending of Darkenss

a hidden underground space. The player can go downstairs and enter this hidden underworld. This will lead to the end of this scene as the "ending of the darkness" (Figure 4.18).

Figure 4.17 The Hidden Path

After the ending of either the light or the darkness, the prototype scene will come to an end.

Figure 4.18 The Underworld

Chapter 5
Evaluation

5.1. Design Iteration: First User Test

Before design and test the final prototype, a preliminary user test was conducted. This user test was conducted to revise the design concept. The target of this first user test is finding out if the design works as expected and which part of the design needs to be revised.

5.1.1 Development Environment

To realize the first prototype game, the following tools, software, or devices are used.

- Personal Computer
- Android Smartphones (Samsung Galaxy S9 Plus and Sony Xperia XZ Premium)
- Unity Personal edition Version 2018.1.8f1
- Materials from Unity Asset Store

5.1.2 User Test Design

The first attempt to implement the design of the game was almost completely different from the final implementation of the game. As the first stage of implementation of the prototype game, this prototype game is made to test only one sensor in the smartphone: the light sensor. Thus, the brightness around the player is the only environmental element that the game can detect. The players

are expected to change the light intensity around them to interact with the game. For example, move the smartphone to somewhere bright or dark to manipulate the game. Also, a survey was conducted to find out what kind of elements in a game that players would find most engaging. After this first user test, the design concept will be revised and improved based on the result of the user and feedback from participants. In this first user test of the research, we made a 2.5D top-down tank shooting game based on Unity 3D engine and materials from Unity Asset Store. This prototype game used assets which are listed below. Both free and purchased assets are included. (annex in Appendix Section A)

- PLAYMAKER
- GyroDroid
- Top Down Shooter Toolkit (TDS-TK)

The gameplay and the rule of this game are very simple: control your tank to shoot and destroy your enemies as well as doge bullets from enemies or enemies which try to crush your tank in order to keep your tank alive. This prototype game uses the light sensors in smartphones to detect the brightness around the player and react to the brightness change which happens in the real world around the player. The brightness in the game is related to the brightness in the real world. If the player is in a bright environment, the game will be bright as well. On the contrary, if the player is in the dark, the environment in the game will be dark. The following picture (Figure 5.1) shows the outlook of this game and the difference between the bright and dark environment. In this prototype game, new waves of enemies will be generated every 15 seconds. There are two kinds of enemies, one is the tank, which moves fast in the dark; the other is the drone, which moves fast in the light. If the player is surrounded by tanks, the player is expected to move the smartphone to some bright places to slow these tanks down. On the contrary, if the player is surrounded by drones, the player should move the smartphone to some dark places to slow down these drones.

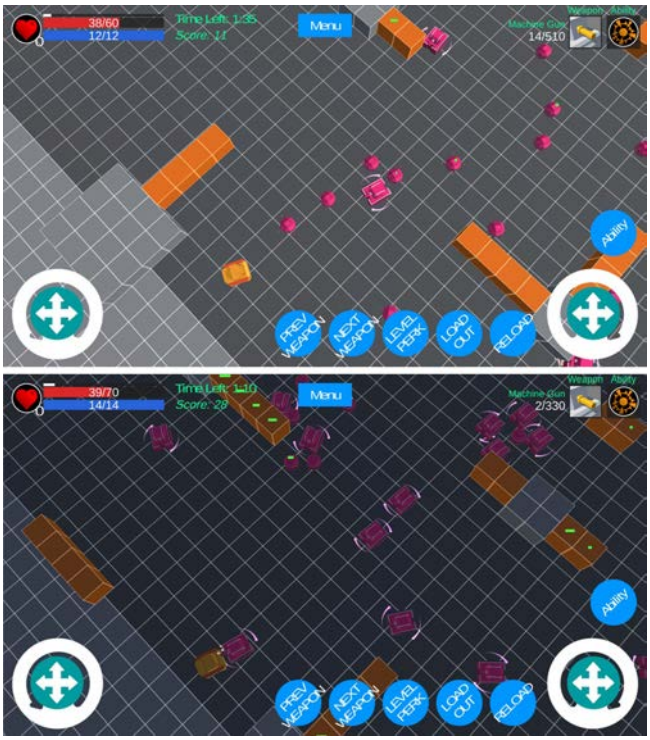

Figure 5.1 The Prototype Game in the Light and in the Dark

5.1.3 Survey Before the User Test

There are 10 participants, who are graduate students of Keio University Graduate School of Media Design. Participants were asked two questions before the test as a pre-test survey. Two questions are listed here:

- Question 1: Assume that there is a puzzle game, you must change something in the real world to solve the puzzle (for example, the path only shows in the dark), do you think that it is a more immersive gaming experience?
- Question 2: Among graphics, gameplay, story, soundtrack, characters, multiplayer and achievements, what do you find more engaging in a game (multiple choice)? The following figures (Figure 5.2 and 5.3) show the result.

This time, participants also gave positive feedback to the puzzle game idea. The average rate of this question is 8.1 (Figure 5.2), which is higher than the

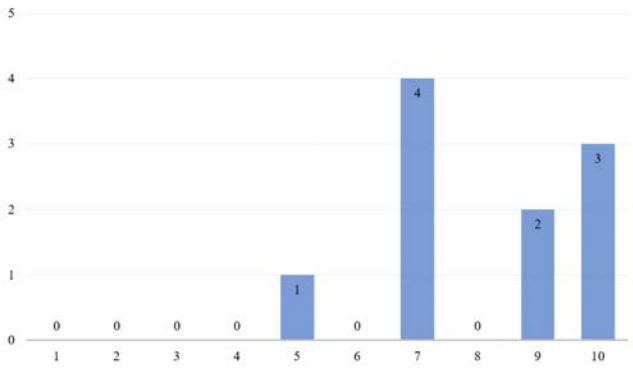

Figure 5.2 Survey: Question 1

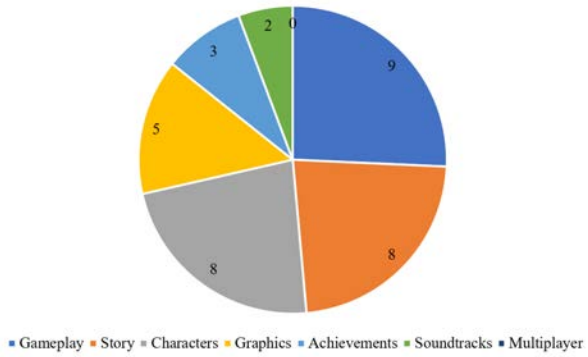

Figure 5.3 Survey: Question 2

average rate of Question 1 (6.5). This result might imply that relatively slow pace games, for example, puzzle games, fit the proposal better. Participants found "gameplay", "story", and "characters" most engaging in a game. We think if the sensor can be combined with these factors, for example, use the sensor to affect the storytelling, the gaming experience could be more immersive.

5.1.4 User Test and Feedback

To test the game, I prepared two versions. One version uses the light sensor on the smartphone to control the brightness in the game. The other version uses buttons to control the brightness. If the player presses the button, the game will

be switched to light or dark. I asked ten participants to play this game and then to fill in a questionnaire, which contains two questions: Question1 (this question was asked before the test). Will you feel more immersive if the game is controlled or affected by manipulating something in the real world (1 for not immersive and 10 for very immersive)? Question2 (this question was asked after the test). Which one gives you more immersive gaming experience? The button one or the sensor one (1 for the button one and 10 for the sensor one)?

The following graph (Figure 5.5 and Figure 5.4) shows the result of the questionnaire.

Figure 5.4 Question 1

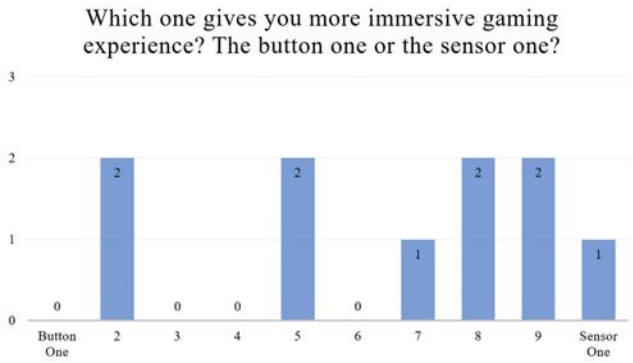

Figure 5.5 Question 2

As we can see, The average rate of Question 1 is 7.8, which indicates that most

of my participants agreed with the idea that controlling the game with sensors could be more immersive. And in the prototype game test, 6 out of 10 participants thought that the gaming experience was more immersive with the sensor (a rate above 5) and the average rate of Question 1 is 6.5. 9 out of 10 participants gave positive answers (a rate above 5) to the idea of controlling or affecting the game with manipulating something in the real world. In addition, I also got some other interesting feedback from participants. Some participants said that sometimes moving the smartphone to change the light intensity distracted them form such a fast pace game. Some participants found the way to cheat: cover the light sensor with their fingers.

Most of the participants gave a positive answer to my idea in the test. But the average rate of Question 2 is lower than Question 1, which means that the prototype game might not fit this idea the best. Then what kind of games fit the idea better? Since some of the participants complained that moving the smartphone sometimes distracted them from this fast pace game, how about a relatively slow pace game? For example, puzzle games. And in which part of a game should a sensor be applied?

According to the feedback from this preliminary prototype game test, we found that 60% of participants felt that the prototype game with light sensor gave them more immersive gaming experience. 90% of participants gave positive answers to the idea of controlling or affecting the game with manipulating something in the real world. And the interaction method design should stay focus on gameplay, story, and characters, which players find most engaging in a game. These results were used to revise the game design and the final user test.

5.2. Questionnaire Design

It is not easy to measure the level of immersion. Some studies have researched how to measure immersion or presence while players are playing the game. The Igroup Presence Questionnaire (IPQ) [30] is a well-developed scale for measuring the sense of presence experienced in a virtual environment. The questionnaire of the research is also based on the Igroup Presence Questionnaire.

Although it was designed 20 years ago, IPQ is still a reliable test for measuring

presence or immersion level. V. Shwind et al. proved its reliability again in a recent research [31]. IPQ has also been used in many researches to measuring presence or immersion level as well. For example, M. Krijn et al. used IPQ to measure presence and immersion in *Treatment of Acrophobia in Virtual Reality: The Role of Immersion and Presence* [32]. F. Aardema et al. used IPQ to measure presence in *Virtual Reality Induces Dissociation and Lowers Sense of Presence in Objective Reality* [33]. H. M. Peperkorn et al. used IPQ to measure presence in *Temporal Dynamics in the Relation Between Presence and Fear in Virtual Reality* [34].

Before playing the game, participants are also required to fill in a questionnaire in order to investigate their gaming experience. According to the findings in the preliminary prototype, participants with different gaming experience might have different feedback after playing the game. Those experienced game players among participants never complaint about the difficulty of the game. However, some of the participants who did not usually play video games said that the game was too difficult for them. They have to focus on the game object they are controlling and controlling itself, so that they could not pay much attention to other game elements. Thus, we believe that we must have a questionnaire about participants gaming experience as well in order to see if participants' gaming experience will affect the result of the test.

The questionnaire to evaluate immersion and presence consists of 14 questions and these questions can be divided into four different types. In general, these 14 questions demand participants to rate from 1 (the most negative)to 9 (the most positive). Question 1 is designed to evaluate participants' general presence level. Question 2 to 6 are designed to evaluate participants' spatial presence level. Question 7 to 10 are designed to rate participants' involvement level. And finally, Question 11 to 14 are designed to evaluate participants' experienced realism.

After acquiring data from participants, these data will be analyzed. Firstly, we will calculate the average rating of a total of 14 questions for each participant. The rate of the questionnaire could indicate the immersion and presence level of the players while they are playing the game. The higher the rate is, the more immersive the player feels.

Next, we would analyze the data in detail. We will discuss the data separately. As mentioned above, the questions in the questionnaire are divided into four

sections, the result of each section will be reviewed, compared, and analyzed.

5.3. Methodology

We chose to conduct this user test in several different places, including the classrooms or the Project Room of Collaboration Complex in Keio University, Hiyoshi Campus, and their homes. These places are chosen because participants are used to these places and the environment, so that they would feel easy to change the environment around them such as turning on/off the light or moving to somewhere quiet or noisy. Since participants are expected to interact with the game through changing something in the real world, it would be important that the participants are in a comfortable condition so that they will not feel stressed about changing the environment around them.

To test how the prototype game works, another version of the prototype game which is controlled with buttons instead of sensors was made. The control scripts are removed from the original prototype game and a set of icons are added to the game and serve as the game environment controller (Figure 5.6). The button version is similar to many mobile games on the market, that a few skill icons are attached on the UI panel, and players can cast these skills by clicking the icons of the skills.

Figure 5.6 The Button Version Prototype Game

This game is used as a control group. Participants are going to play two versions of the game, both the button version and the sensor version. After playing the game, we are going to use the questionnaire mentioned above to evaluate players'

immersion and presence level. And after that, the results of two versions of the game will be analyzed and discussed, to see what we can find through this user test.

After the user test, the general results will be discussed first, to see if the general immersion rate of the prototype game (sensor version) is higher than the control version (traditional button version), which could imply if the hypothesis is correct. The higher the rate is, the more immersive the player feels. So, if the average rate of the sensor version is higher than the button version, then it proves the hypothesis is correct.

Then these results will be analyzed in a detailed view. As mentioned above, these 14 questions in the questionnaire can be divided into four sections, general presence, spatial presence, involvement, and experienced realism. So, the data will also be analyzed separately in 4 groups.

5.4. User Test

14 participants undertook the user test, 11 female and 4 male between the ages of 23 and 29. 9 of them are Chinese, 3 Indonesians, 1 Japanese, and 1 Canadian. All of them are students of Keio University Graduate School of Media Design. The user test will be conducted in the following steps.

- **Step 1**: Gaming Experience Survey (annex in Appendix Section D)

  Before the test starts, participants will be asked to fill in a questionnaire in order to find out if they usually play video games.

- **Step 2**: Playing the Prototype Game (Random Version)

  The participants will be asked to play one version of the prototype game. They will play the button version or the sensor version randomly.

- **Step 3**: Questionnaire of the Prototype Game (annex in Appendix Section E)

  After playing the prototype game, participants will be asked to fill in a 14-question-long questionnaire. The questionnaire will evaluate how immersive they feel while they are playing the prototype game.

- **Step 4**: Playing the Prototype Game (The Other Version)

  The participants will be asked to play the prototype game once again. This time they are going to play the other version of the game depending on which version they have played before.

- **Step 5**: Questionnaire of the Other Version Prototype Game (annex in Appendix Section E)

  After playing the other version prototype game, participants will be asked to fill in another questionnaire. The questionnaire will evaluate how immersive they feel while they are playing this version of the prototype game. The questions in this questionnaire are the same as those questions in the previous questionnaire (Figure 5.7).

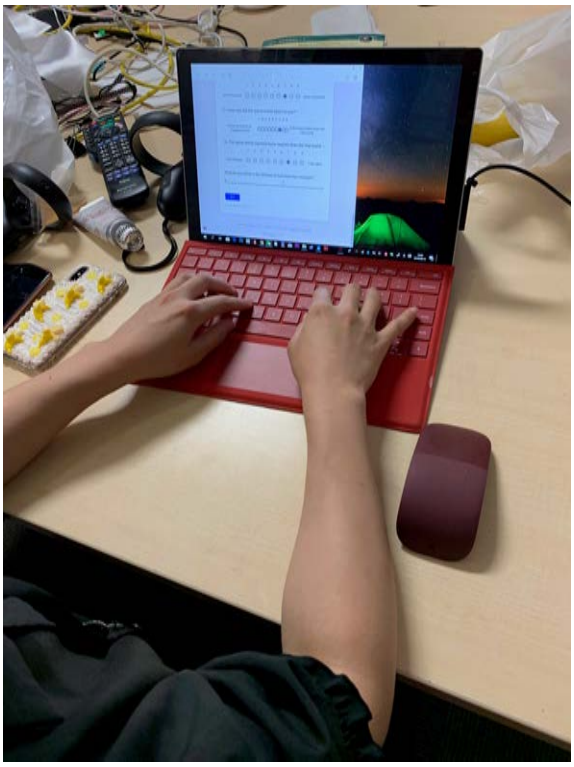

Figure 5.7 Participant 12 was Filling in the Questionnaire

- **Step 6**: Interview

Interview participants and ask them if they have any advice or opinion about the prototype game. Answers from participants will be recorded and these answers, advice, or opinion will be discussed as well in the latter part of this section.

5.5. User Feedback & User Behavior During the Test

In addition to the data collected from the participants' questionnaire answers, participants also did something interesting during the test, which needs to be marked as well. They interacted with the game in some ways which beyond expectations.

5.5.1 Light Sensor

Firstly, there is some interesting behavior about using the light sensor. When participants were playing the sensor version prototype game, most participants moved the smartphone under the table in order to reduce the light intensity the smartphone can detect. The following picture shows what Participant 12 did while she was playing with the light sensor (Figure 5.8). It was observed in more than half the participants.

Participant 8 did something else. Participant 8 turned off the light. He was the only one who turned off the light to turn the game environment into the dark. He switched the light a few times to see what would happen to the game. Although the intention of the original design is asking the player to turn on or turn off the light to change the light intensity in the room in order to change the brightness in the game, few participants did as how it designed.

Meanwhile, Participant 5 also did something different from others. When he was playing the sensor version of the game, he went beneath the desk of the room in order to put the smartphone in a really dark place. It seems that the light intensity of the classroom was too strong, even if he put the smartphone beneath the desk, it was still quite bright that the game did not turn into a dark environment.

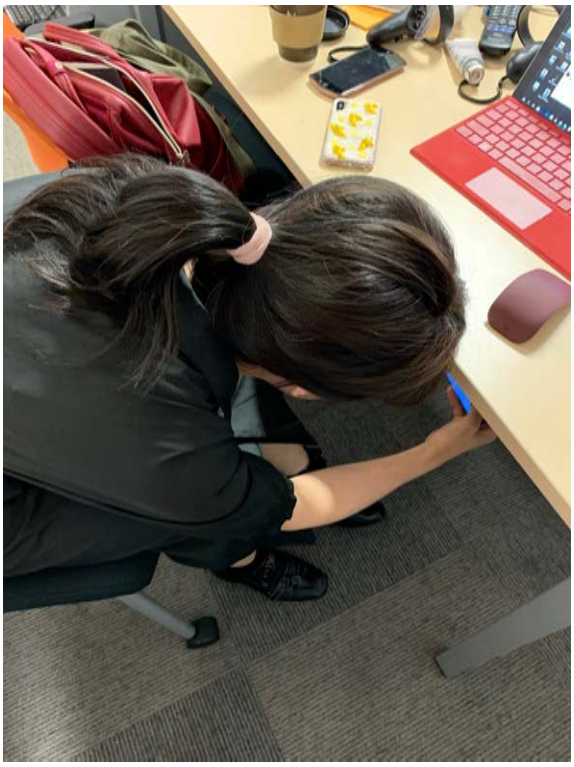

Figure 5.8 Participant 12 was Moving the Phone Under the Table

5.5.2 Microphone

Secondly, the microphone. The microphone in this prototype game is designed to detect the loudness around the player. If the surrounding environment is quiet, then the fire will burn brightly. On the other hand, if it is noisy around the player, the fire will burn faint and there will be an extra effect that the main character controlled by the player, the knight, will be slowed down. He will not be able to run as fast as he does in a quiet environment.

It turned out the "blowing at the screen" in the sensor version game was the most favored gameplay in the user test. Many participants liked this gameplay, and some they tried many times to put off the fire with their blowing.

When Participant 4 (Figure 5.9) played the sensor version of the game, he tried twice when he faced the fire barrier. For the first time, he did not blow strong enough so that when the character moved to the position right on the fire barrier,

the fire started burning again. The character controlled by him was killed by this time. The game restarted after the character's death. In fact, Participant 4 found out that he could just shout at the microphone in order to put out the fire. However, he did not choose to do so. He insisted blowing at the screen. This time Participant 4 succeeded and reached the end of the stage.

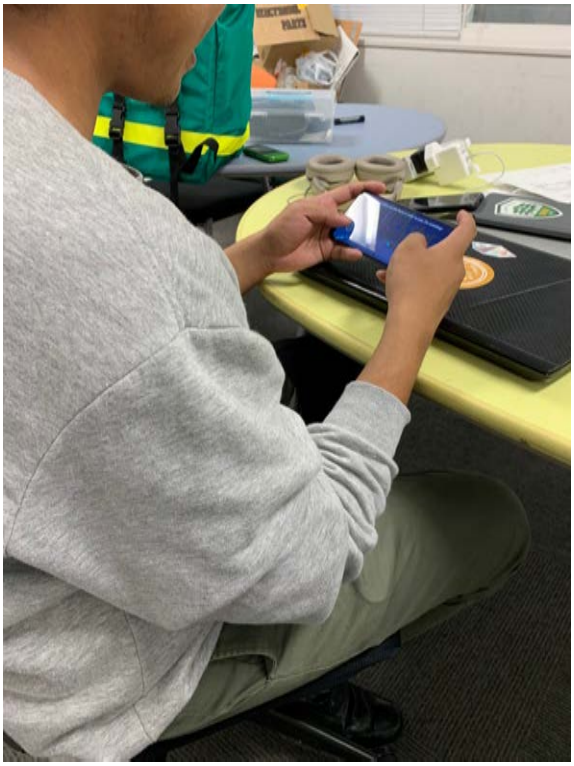

Figure 5.9 Participant 4 was Playing the Sensor Version of the Game

5.5.3 Accelerometer

Thirdly, the use of the accelerometer. When participants were playing the button version of the game. It seems that they were not aware of the use of the "Rotation Button". Most of the participants did not pull down the pillar when they passed by the alert zone. This step is not mandatory, many participants did not realize that they could bring down this pillar with the "Rotation Button". When they arrived the skeleton soldiers alert zone and read the words "pull down the pillar"

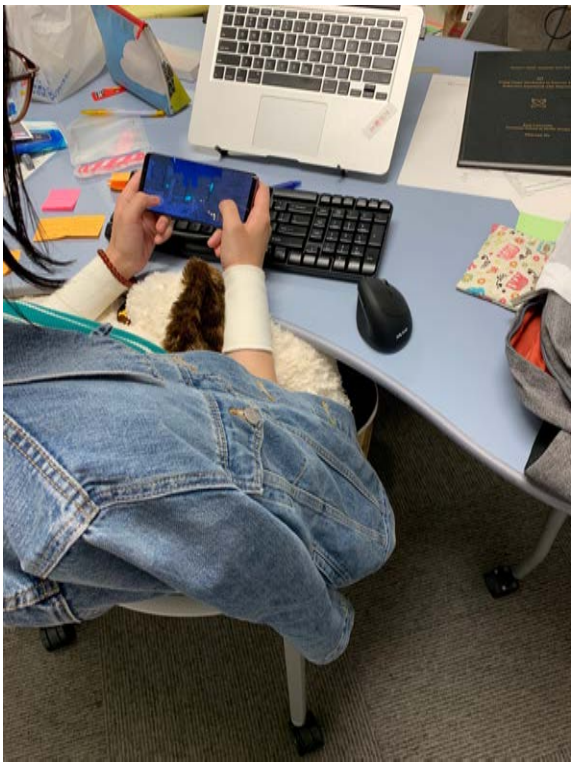

Figure 5.10 Participant 1 was Playing the Sensor Version of the Game

on the screen, most participants tried at least once to touch the pillar in the screen and it seems that they tried to use the finger touch to remove the pillar. Some participants simply stopped trying when they found that nothing would happen if they touched the pillar. Although the "Rotation Buttons" are not far away from where they touched on the screen, many participants just ignored these buttons. On the way they came back, participants finally found out that they could remove or pull down something in the scene with the "Rotation Button". Because the path was blocked, they must do something in order to push the game forward.

In the sensor version of the prototype game, it was a bit different. Since participants were not explained about how to bring down the pillar after playing the button version. It seems that they found out by themselves about how to bring down the pillar in the alert zone. It is very natural to slope a plane and bring down things which are on that plane.

One more thing that was observed in the user test is that some participants

did not rotate the smartphone in the way which was expected to. They turned the smartphone over and rotated it horizontally. It was designed to rotate the smartphone vertically. Since the game is basically a 2.5D platforming game, we thought it was natural that the player would rotate the phone to left or right to affect the items in the game scene. But it seems that it did not work in the way we expected. Especially among those participants who do not play games very often, they were confused when they met the barrier which needs to use gravity to clear. They failed a few times and in the end they passed the barrier (maybe accidentally).

5.5.4 Other User Behavior During the Test

In addition to the way that participants interacted with the game through sensors in the smartphone, there is also something else as could be noticed.

During the test, Participant 13 tried to touch the treasure boxes set in the game scene. She wondered if she could collect some items through clicking on these boxes (though the boxed in the prototype game are not interactive).

5.5.5 User Feedback

After the user test, the participants were interviewed and they told how they felt about the prototype game. Their answers were also written in the questionnaire. Most participants preferred the sensor version to the button version. Some of them also gave some interesting feedback, they are listed below.

Participant 3 said that the controls are much more intuitive for the sensor version. It is easier to control compared to the button version, and he instinctively knew what to do to progress.

Participant 7 said that she could not fully experience the functions and stories without the designer's explanation.

Participant 10 also provided some feedback about the gameplay of the microphone. She played the prototype game in the Project Room of Collaboration Complex, Keio University, Hiyoshi Campus, this room is usually noisy and it was noisy during the test. She said that the sensor version is much more interesting with the movements and sensor. But the second one is difficult to play in a noisy

environment. Instead of getting lost in the game, she was actually more aware of her surroundings because people were so noisy. It was difficult to control the fires. Even she was not making sound or blow at the smartphone, the fire still went off occasionally due to the noise in the Project Room.

Participant 13 complained that the button version was too common. It looked like an old fashioned game and lacking entertain experience.

5.6. Results

14 participants undertook the user test, 11 female and 4 male between the ages of 23 and 29. 9 of them are Chinese, 3 Indonesians, 1 Japanese, and 1 Canadian. And many of participants are video game fans. According to the survey conducted before the test, 9 of them define themselves as video game players, which means they play video games very often. The result of the survey is list below (Figure 5.11).

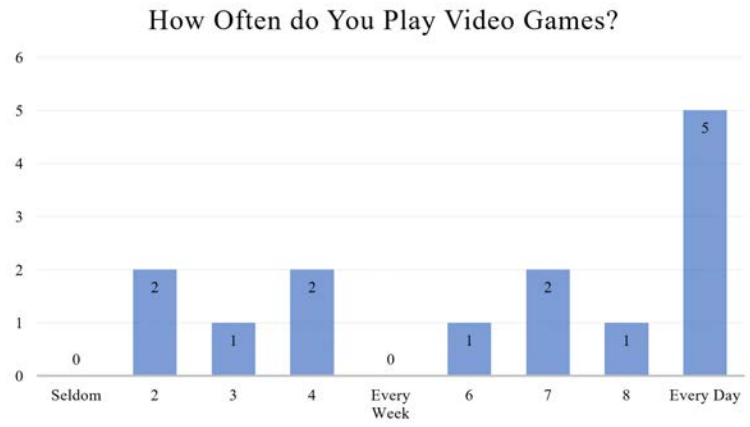

Figure 5.11 How Often do You Play Video Games

9 out of 14 participants claimed themselves play video games more than once a week. 5 participants even play video games every day. These 9 participants are counted as "player" in this test. They have played many games and have had a lot of gaming experience. The result of "Player Group" and "Non-Player Group" (the other 5 participants) will be compared as well.

The following chart (Figure 5.12) shows the results of the user test (answers of each participant for each question are annexed in Appendix Section F). The chart below shows the average rate of two versions of the prototype game. The blue bar is the rating of the button version and the orange bar stands for the sensor version. The difference between the blue bars and orange bars is quite obvious. The average rate of the button version is 3.82, and the average rate of the sensor version is 5.97. It can be easily found that the average immersion rating of the sensor version prototype game is significantly higher (56.28%) than the rating of the button version. These results indicate that the sensor version prototype game makes participants feel more immersive than the button version prototype game, which proves the hypothesis of this research correct.

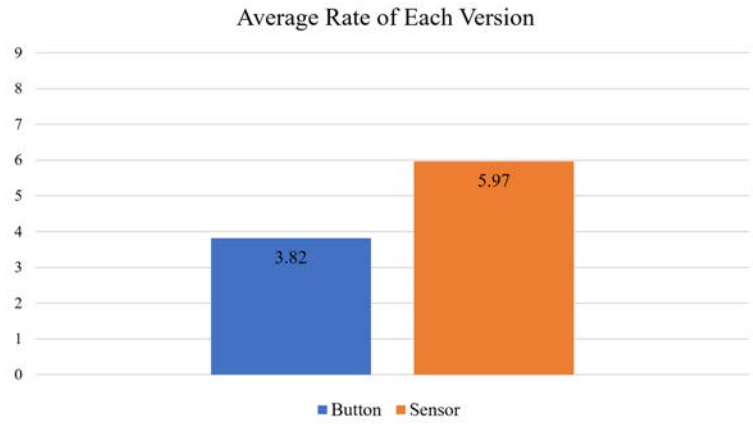

Figure 5.12 The Average Result of 2 Versions

If we compare the rate of "Player Group" and "Non-Player Group", we can find that the difference between them is very little. The result is shown in Figure 5.13.

As we can see, although the average rate from "Non-Player Group" is slightly higher than the "Player Group", the difference between the sensor version and the button version is very close. The rate difference of "Non-Player Group" is 3.78% higher than the rate difference of "Player Group". It could be considered that in general, the participants' game experience does not affect the result of the user test.

In addition, since the questionnaire is divided into 4 sections, we should compare

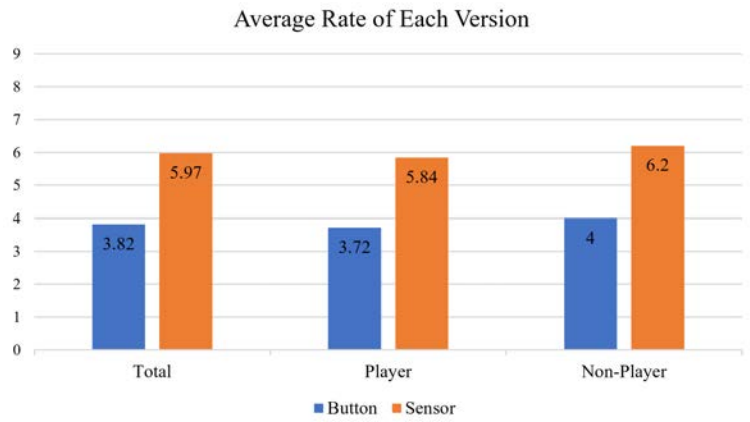

Figure 5.13 The Average Result of 2 Versions (Different Groups)

the result of 4 sections of the questionnaire separately as well. The chart below shows the result of each section.

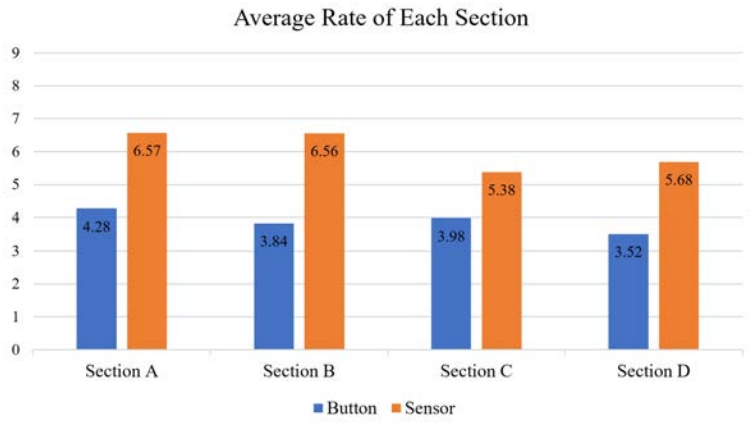

Figure 5.14 The Average Result of Each Section

In general, the average rate of the sensor version is higher than the average rate of the button version in all of these four sections. These results indicate that in all of these 4 aspects, the sensor version of the game makes participants feel more immersive than the button version. If we have a look in details, we can find that the average rate of sensor version in Section 1 (General Presence Section) is 6.57,

2.29 higher than the button version. In Section 2 (Spatial Presence Section), the average rate of sensor version is 6.56, 2.72 higher than the button version. In Section 3 (Involvement Section), the average rate of sensor version is 5.38, 1.4 higher than the button version. In Section 4 (Experienced Realism Section), the average rate of sensor version is 5.68, 2.16 higher than the button version. Although the sensor version's average rate of all these 4 sections are higher than the rate of the button version, the differences between each section are not the same. We will discuss it in the section follows.

5.7. Discussion

Overall, the results of the final user test support the hypothesis, but there is still something that needs to be discussed.

First, as we can see, the rate differences between the button version and the sensor version in four groups of question are different. Among these 4 sections, the difference value of section 3 is significantly lower than the other 3 sections. Section 3 of the questionnaire is designed to measure user's involvement level. According to the research of E. Brown and P. Cairns, the involvement with a game can be divided into three levels, engagement, engrossment, and finally total immersion. Involvement with a game moves along with the path of time and is controlled by barriers. Some barriers can only be removed by human activity, such as concentration; others can be only opened by the game itself, such as the game construction. [35] If we compare the average rate of each section between the "Player Group" and "Non-Player Group", we can find something interesting.

In Section 1, 2, and 4, the results of the two groups are different but still close. In general, the rates of "Non-Player Group" are higher than the rates of "Player Group" and the difference value is a bit lower. But the difference between the rate for two game versions is still close. Only in Section 3, the result is quite different between the two groups. The "Player Group" has a much lower rate difference between two versions of the game, only 0.91, compared to 2.25 of the "Non-Player Group". The possible reason for this could be that those experienced players are more used to play and control the game with buttons on the screen, which is very common in many mobile games. They could easily learn how to play the

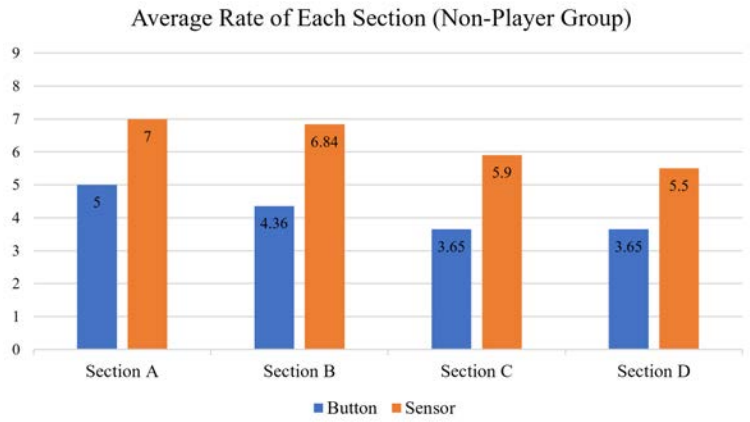

Figure 5.15 The Average Result of Each Section (Non-Player Group)

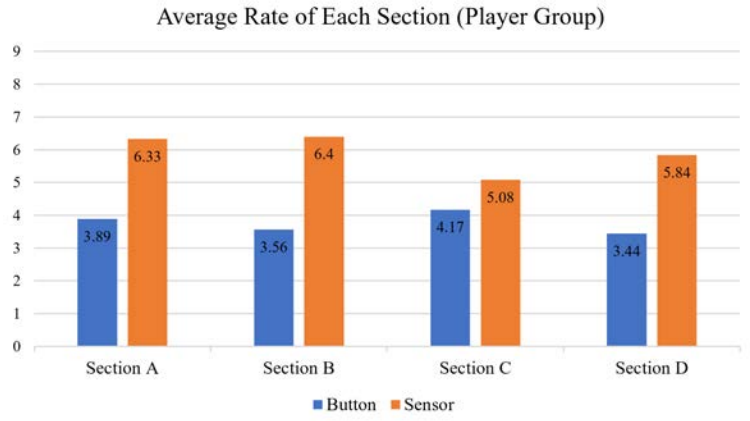

Figure 5.16 The Average Result of Each Section (Player Group)

game with these buttons so that they could focus on the game itself. Otherwise, those participants who did not have enough gaming experience, it might take them more time and effort to find out how to play the game. It might reduce the concentration level, as a result, reduced their involvement level.

Further, not only the rate difference between the two versions is lower than other sections, the rate of Section 3 itself is also lower than the other 3 sections, especially Section 1 and Section 2. This might indicate that the involvement of this prototype game could be the weakest aspect.

Although the game is designed to create a connection between the real world

and the game world through sensors, rather than just use these sensors as an input method, some participants did not fully get this point. Some participants did not realize that the game scene is related to the real world, rather than just use the real-world elements as an input method. The possible reason could be the length of the game. The prototype game only lasts around 5 minutes, which might not be long enough for some players to find out the connection between the game world and the real world.

One more thing which needs to be paid attention to is safety while playing. In the user test, participants did something different from the behavior they would act when they play a normal game, for example, going under the table. Besides, they were still focusing on the game while they were doing so. If the player tries to change the environment around them in the wild and does not pay enough attention to the real world, it might make them in a dangerous situation. We must make sure that players are not encouraged to change things which could put themselves in a dangerous condition.

Chapter 6
Conclusion

6.1. Concept Validation

This research intended to prove the concept of the prototype game *A Knight's Oath*: creating a connection between the real world and the game world with sensors can provide players more immersive gaming experience. The prototype game involves light intensity, sound volume, and gravity in the real world into the game world. The game environment, game scenario, and gameplay are all related to the real world.

The final prototype game uses the light sensor to detect the light intensity around the player and use it to affect the brightness or item status in the game scene, the behavior of enemies, and the different endings; uses the microphone to detect the sound around the player and use it to affect the character status, game world status, and the intensity of the blaze; use the accelerometer to detect the rotation of the smartphone, so that the gravity in the game world will be affected by the rotation of the smartphone. Through these elements from the real world, the real and the game world are connected. Players can manipulate the game by changing something in the real world around them. On the other hand, the game also detects the real world actively, and react to any environmental changes, no matter if changes are made by players, as long as they are included in the game.

For the hypothesis: "Players will feel more immersive if the real-world context and the game content are connected.", it is proved by the result of the user test. The average immersion and presence rate of the sensor version is higher than the traditional button version. This result means that the game which uses sensors to link the real world and game world can make players feel more immersive than normal games.

6.2. Limitations

This design of this prototype game and its evaluation still have its limitation due to technical and some other reasons. For now, there are only three sensors applied to the game. Thus, only three kinds of environmental information have been included in the final prototype game. Although the results of the user test have proved that the gaming experience will be more immersive if these three real-world elements are included in the game, there are still many things could be added to the game.

Other than the brightness, sound, movement of the smartphone, there are still so many environmental elements which can be detected by the smartphone, for example, geographic location, time, and height. This information can be collected by GPS, barometer, and the clock in the smartphone. If we could find some methods to include this information in the game as well, the gaming experience could be more immersive and interesting.

The prototype game only lasts around 5 minutes. This is another limitation of this research. It might take players some time to realize the connection between the real world and the game world, 5 minutes are not long enough. In the user test, some participants did not realize the game world and the real world were related due to the length of the game. They did not have enough time to find out this point. In some cases, they passed the traps just because they happened to be in the environment which was needed to deal with the trap. They did not really realize why they could pass the traps unless they tried a few more times. But if the game is long enough, they are more likely to find out the connection between the real world and the game world by themselves.

In addition, the game design also needs to pay attention to the safety while playing. Since the player is expected to change the real-world environment to interact with the game, they might do something to change the real-world environment while they are still focusing on the game, which could put them in a dangerous situation. The game design needs to prevent players from doing dangerous things while playing.

6.3. Future Works

The game design proposed in this research still remains incomplete. This research will be continued to include more real-world elements inside the game. Most importantly, we believe that it could be essential to make the game story long enough so that we could have a better chance to convey the idea of "connecting the real and the game" to players. At least a few hours are necessary.

A possible expansion for this concept could be extending the game length, and most importantly, strengthening the connection between the game and the real. To realize these two points, first, we need to include more sensors and environmental information, such as GPS and barometer. Based on this new environmental information, the game story and narrative also needs to be redesigned in order to fit these new elements. Next, the game length needs to be extended. If the game is too short, the player might not be able to find out some gameplay included in the game. The possible solution is giving players more time to explore the game. A suitable narrative is also required to guide the player to find out the idea that the game world and the real world are connected.

References

[1] Tom Wijman. Mobile revenues account for more than 50% of the global games market as it reaches $137.9 billion in 2018. *Newzoo*. URL: `https://newzoo.com/insights/articles/global-games-market-reaches-137-9-billion-in-2018-mobile-games-take-half/`.

[2] The-VR-Headset. Vr headset sales: Idc predicts 54% increase in 2019. *VR Headset*. URL: `https://thevrheadset.com/vr-headset-sales-in-2019/`.

[3] Jason D Moss and Eric R Muth. Characteristics of head-mounted displays and their effects on simulator sickness. *Human factors*, 53(3):308–319, 2011.

[4] Eugenia M Kolasinski. Simulator sickness in virtual environments. Technical report, Army research Inst for the behavioral and social sciences Alexandria VA, 1995.

[5] Charlene Jennett, Anna L Cox, Paul Cairns, Samira Dhoparee, Andrew Epps, Tim Tijs, and Alison Walton. Measuring and defining the experience of immersion in games. *International journal of human-computer studies*, 66(9):641–661, 2008.

[6] Janet Horowitz Murray. *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. The Free Press, New York, NY, USA, 1997.

[7] Jonathan Steuer. Defining virtual reality: Dimensions determining telepresence. *Journal of communication*, 42(4):73–93, 1992.

[8] Mel Slater. A note on presence terminology. *Presence connect*, 3(3):1–5, 2003.

[9] Bob G Witmer and Michael J Singer. Measuring presence in virtual environments: A presence questionnaire. *Presence*, 7(3):225–240, 1998.

[10] Elizabeth Bell. *Theories of performance*. Sage, 2008.

[11] Donald M. Davis Philip J. Auter. When characters speak directly to viewers: Breaking the fourth wall in television. *Journalism & Mass Communication Quarterly*, 68(1-2):165–171, 1991.

[12] Karen Collins. Breaking the fourth wall? user-generated sonic content in virtual worlds. In *The Oxford Handbook of Virtuality*, page 351. Oxford University Press, 2014.

[13] Steven Conway. A circular war? reformulating the fourth wall for video games. *Journal of Gaming & Virtual Worlds*, 2(2):145–155, 2010.

[14] Alison McMahan. Immersion, engagement and presence. *The video game theory reader*, 67:86, 2003.

[15] Team Salvato. Doki doki literature club! [PC], 2017.

[16] Philip J Auter. Psychometric: Tv that talks back: An experimental validation of a parasocial interaction scale. *Journal of Broadcasting & Electronic Media*, 36(2):173–181, 1992.

[17] Galactic Cafe. The stanley parable. [PC], 2013.

[18] Toby Fox. Undertale. [PC, PlayStation 4, PlayStation Vita, Nintendo Switch], 2015.

[19] Takeshi Kitano Taito Cooperation. Takeshi no chosenjo. [Famicom], 1986.

[20] Hudson Soft. Raid on bungeling bay. [NES], 1987.

[21] Nintendo. The legend of zelda. [Famicom, NES], 1986.

[22] Konami Computer Entertainment Japan. Boktai: The sun is in your hand. [Game Boy Advance], 2003.

[23] Electronic Arts. Real racing 3. iOS, Android, 2013.

[24] Codemasters Software Company Ltd. F1 mobile racing. iOS, Android, 2019.

[25] Ketchapp. Scream hero. iOS, Android, Microsoft Windows, 2017.

[26] BreakFirst. Fitflap. iOS, Android, 2015.

[27] The Pokemon Company Niantic. Pokemon go. iOS, Android, 2016.

[28] Jesse Schell. Understanding entertainment: story and gameplay are one. *Computers in Entertainment (CIE)*, 3(1):6–6, 2005.

[29] Hua Qin, Pei-Luen Patrick Rau, and Gavriel Salvendy. Player immersion in the computer game narrative. In Lizhuang Ma, Matthias Rauterberg, and Ryohei Nakatsu, editors, *Entertainment Computing – ICEC 2007*, pages 458–461, Berlin, Heidelberg, 2007. Springer Berlin Heidelberg.

[30] Thomas Schubert, Frank Friedmann, and Holger Regenbrecht. The experience of presence: Factor analytic insights. *Presence: Teleoperators & Virtual Environments*, 10(3):266–281, 2001.

[31] Valentin Schwind, Pascal Knierim, Nico Haas, and Niels Henze. Using presence questionnaires in virtual reality. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI '19, pages 360:1–360:12, New York, NY, USA, 2019. ACM. URL: `http://doi.acm.org/10.1145/3290605.3300590`, `doi:10.1145/3290605.3300590`.

[32] Merel Krijn, Paul Emmelkamp, Roeline Biemond, Claudius de Wilde de Ligny, Martijn J Schuemie, and Charles A.P.G van der Mast. Treatment of acrophobia in virtual reality: The role of immersion and presence. *Behaviour research and therapy*, 42:229–39, 03 2004. `doi:10.1016/S0005-7967(03)00139-6`.

[33] Frederick Aardema, Kieron O'Connor, Sophie Côté, and Annie Taillon. Virtual reality induces dissociation and lowers sense of presence in objective reality. *Cyberpsychology, behavior and social networking*, 13:429–35, 08 2010. `doi:10.1089/cyber.2009.0164`.

[34] Henrik M. Peperkorn, Julia Diemer, and Andreas Mühlberger. Temporal dynamics in the relation between presence and fear in virtual reality. *Computers in Human Behavior*, 48:542 – 547, 2015. URL: http://www.sciencedirect.com/science/article/pii/S0747563215001260, doi:https://doi.org/10.1016/j.chb.2015.02.028.

[35] Emily Brown and Paul Cairns. A grounded investigation of game immersion. In *CHI '04 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '04, pages 1297–1300, New York, NY, USA, 2004. ACM. URL: http://doi.acm.org/10.1145/985921.986048, doi:10.1145/985921.986048.

Appendices

A. Unity Resources

The following section describes the resources used to create the prototype games (both preliminary prototype game and final prototype game). They can be found in the Unity Asset Store, both free and purchased contents are included.

A.1 PLAYMAKER

This package is a visual scripting tool which allows you to realize the creation in a visualized interface rather than just coding. It can improve efficiency.

https://assetstore.unity.com/packages/tools/visual-scripting/playmaker-368

A.2 GyroDroid

This package provides access to every single sensor of your Android device, helps remove device and orientation inconsistencies, and just makes sensor-aware games work.

https://assetstore.unity.com/packages/tools/gyrodroid-1701

A.3 Top Down Shooter ToolKit

The package contains a framework and materials for top-down shooter games of any kind. This package has been used to create the preliminary prototype game.

https://assetstore.unity.com/packages/templates/systems/top-down-shooter-toolkit-tds-tk-50777

A.4 POLYGON - Dungeons Pack

The package contains a pack of characters, props, weapons and environment assets which can be used to create a fantasy themed polygonal style game. The game world in the final prototype game is mostly based on this asset pack.

https://assetstore.unity.com/packages/3d/environments/dungeons/polygon-dungeons-pack-102677

A.5 POLYGON - Pirates Pack

The package contains a pack of characters, props, weapons and environment assets which can be used to create a pirate themed polygonal style game. Some items in this pack are used in the final prototype game.

https://assetstore.unity.com/packages/3d/environments/historic/polygon-pirates-pack-92579

A.6 POLYGON - Nature Pack

The package contains a pack of trees, plants, terrain, rocks, props,and FX assets which can be used in a polygonal style game. Some items from this package have been used in the prototype game.

https://assetstore.unity.com/packages/3d/vegetation/trees/polygon-nature-pack-120152

A.7 POLYGON - Knights Pack

The package contains a pack of characters, buildings, props, items and environment assets to create a fantasy based polygonal style game.Some items from this package have been used in the prototype game.

https://assetstore.unity.com/packages/3d/environments/fantasy/polygon-knights-pack-83694

A.8 Control Freak 2 - Touch Input Made Easy!

The package contains a tool set to create a control system for touch screen. The control system in the prototype game is made with this asset.

https://assetstore.unity.com/packages/tools/input-management/control-freak-2-touch-input-made-easy-11562

A.9 Hero General Animation Collection

The package contains 170 animations clips which can be used in Mecanim. The animation of characters in the prototype game is based on this package.

https://assetstore.unity.com/packages/3d/animations/hero-general-animation-collection-5988

A.10 Simple Waypoint System

The package contains tools to create paths right within the editor, then tell any game objects to follow path via our movement scripts. The patrol path of skeleton soldiers in the prototype game is created based on this asset.

https://assetstore.unity.com/packages/tools/animation/simple-waypoint-system-2506

A.11 Simple Sky - Cartoon assets

This package contains a skydome with time of day, sun, moon, stars, and clouds. The skydome in the prototype game is made based on this asset.

https://assetstore.unity.com/packages/3d/simple-sky-cartoon-assets-42373

A.12 500 Skill icons

This package contains 500 skill icons which can be used in many kinds of games. Some of these icons are used in the button version of the final prototype game.

https://assetstore.unity.com/packages/2d/gui/icons/500-skill-icons-136564

B. Survey Applied Before Playing the First Prototype Game

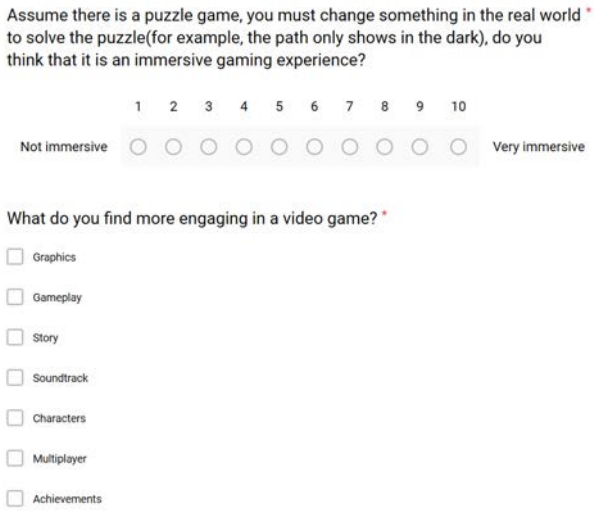

Figure B.1 Questionnaire Before Playing the First Prototype Game

C. Questionnaire Applied After Playing the First Prototype Game

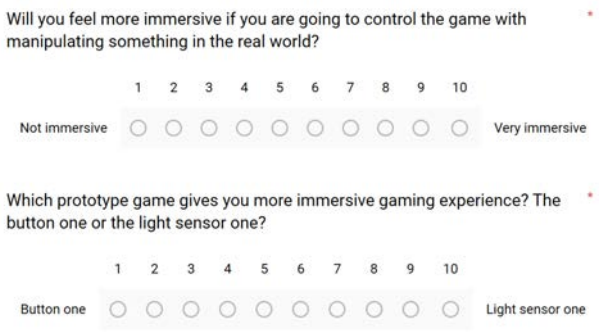

Figure C.1 Questionnaire After Playing the First Prototype Game

D. Questionnaire Applied Before Playing the Final Prototype Game

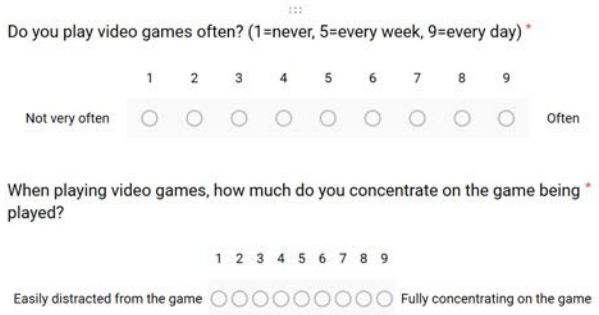

Figure D.1 Questionnaire Applied Before Playing the Final Prototype Game Part 1

Figure D.2 Questionnaire Applied Before Playing the Final Prototype Game Part 2

E. Questionnaire Applied After Playing the Final Prototype Game

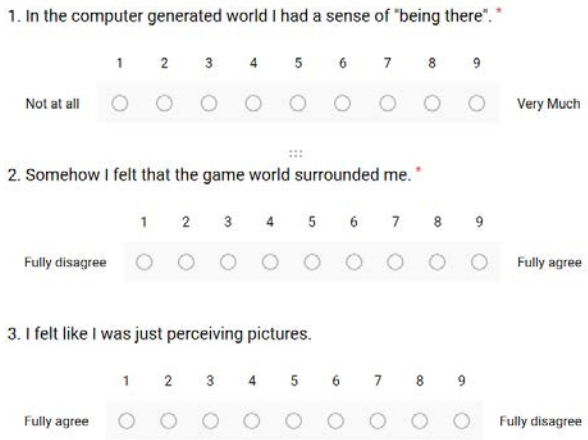

Figure E.1 Questionnaire Applied After Playing the Final Prototype Game: Part 1

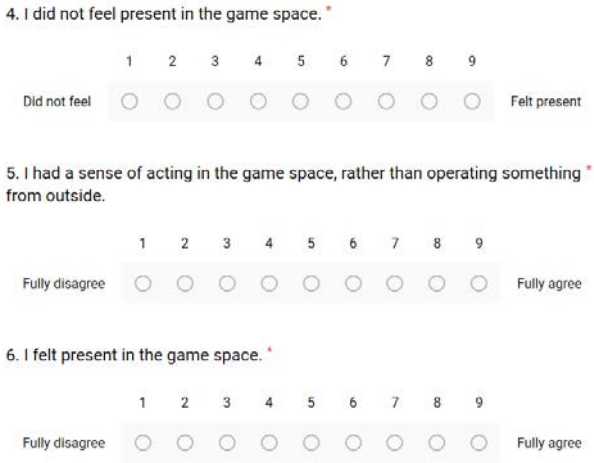

Figure E.2 Questionnaire Applied After Playing the Final Prototype Game: Part 2

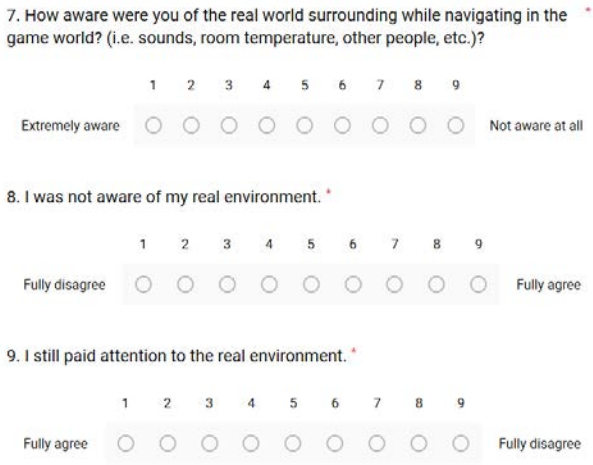

Figure E.3 Questionnaire Applied After Playing the Final Prototype Game: Part 3

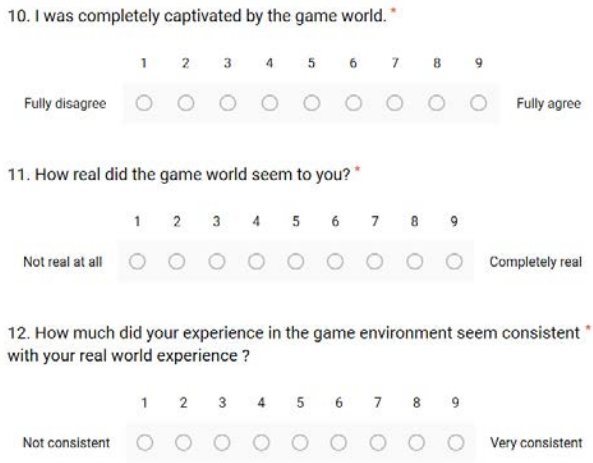

Figure E.4 Questionnaire Applied After Playing the Final Prototype Game: Part 4

Figure E.5 Questionnaire Applied After Playing the Final Prototype Game: Part 5

F. Results of the Questionnaire

Table F.1 Result of Questionnaire of the Button Version Q1 Q7

Rate	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Participant 1	4	4	6	3	3	4	7
Participant 2	4	2	6	5	4	4	3
Participant 3	3	5	4	3	1	4	5
Participant 4	6	6	5	4	4	4	5
Participant 5	4	4	4	5	2	3	2
Participant 6	6	4	3	3	6	4	6
Participant 7	7	5	7	4	4	6	4
Participant 8	3	2	5	6	2	2	6
Participant 9	3	2	2	1	4	3	5
Participant 10	4	4	3	4	2	4	5
Participant 11	4	4	7	3	3	3	6
Participant 12	3	3	3	3	3	3	4
Participant 13	3	2	6	4	3	3	2
Participant 14	6	5	4	6	5	5	4

Table F.2 Result of Questionnaire of the Button Version Q8 Q14

Rate	Q8	Q9	Q10	Q11	Q12	Q13	Q14
Participant 1	4	4	4	3	3	3	3
Participant 2	4	6	4	4	4	7	3
Participant 3	9	9	4	5	1	4	2
Participant 4	2	1	3	4	1	2	1
Participant 5	2	1	1	2	1	3	1
Participant 6	4	3	3	3	6	4	3
Participant 7	3	3	5	6	4	5	4
Participant 8	5	5	3	2	2	2	1
Participant 9	5	5	3	4	4	7	3
Participant 10	5	5	3	3	3	4	2
Participant 11	1	7	6	4	3	7	1
Participant 12	3	3	4	3	3	3	3
Participant 13	1	3	4	6	6	6	3
Participant 14	5	2	2	7	6	3	4

Table F.3 Result of Questionnaire of the Sensor Version Q1 Q7

	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Participant 1	7	7	8	7	8	7	6
Participant 2	7	7	6	7	6	6	7
Participant 3	7	7	6	7	8	8	4
Participant 4	7	8	8	8	8	7	3
Participant 5	6	7	8	6	7	7	4
Participant 6	6	6	6	5	5	6	5
Participant 7	7	6	2	3	7	7	7
Participant 8	5	5	5	4	4	4	4
Participant 9	7	7	6	6	7	6	5
Participant 10	6	6	7	7	7	7	2
Participant 11	7	7	8	6	7	8	8
Participant 12	7	7	6	7	7	7	6
Participant 13	5	6	6	7	6	6	6
Participant 14	8	8	8	6	8	8	4

Table F.4 Result of Questionnaire of the Sensor Version Q8 Q14

Rate	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Participant 1	6	4	6	6	6	6	5
Participant 2	6	6	7	6	5	4	5
Participant 3	3	5	7	7	8	6	5
Participant 4	3	3	8	8	9	8	6
Participant 5	5	5	6	5	7	6	5
Participant 6	4	4	6	5	6	4	4
Participant 7	7	4	6	7	6	6	5
Participant 8	4	5	5	2	6	3	3
Participant 9	3	5	6	6	6	4	6
Participant 10	4	3	5	6	8	7	5
Participant 11	8	8	7	7	8	2	4
Participant 12	7	7	7	7	7	7	7
Participant 13	7	5	6	6	6	3	7
Participant 14	5	5	7	6	5	3	4