

User Experience Design for Smartwatch Games

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Abstract

This research aims at addressing several user experience design challenges while in the process of developing smartwatch games. The challenges were caused by the difficulties of interacting with the tiny smartwatch screen. In this practice-based research project, a smartwatch game prototype was built to explore the answer to the challenges. In this prototype, the Apple Watch's Digital Crown was used as the main interaction method, in association with some simple touch interaction as a supplement. This interaction method proved to be a more superior way, in terms of precision and screen visibility.

This practice-based research consists of a 50 percent creative production and a 50 percent written exegesis. The creative production is a smartwatch game prototype presented as an online interactive mock-up and its screen recording. The written exegesis presented herein includes the literature review, the methodology, the design process and the description of the prototype, and the findings.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

A handwritten signature in blue ink, consisting of stylized Chinese characters followed by the name 'SamLi' in a cursive script.

Li Huangyu

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Intellectual Property Rights

The author asserts the intellectual copyright for the smartwatch game prototype contained in this thesis. All rights of the owner in regard to the prototype are reserved. The publication contained in all its formats is protected by the copyright.

The copyright of the mobile game “Spirit Guardian” is owned by Mechanist Games. The use of its trademark, screenshots and game design in this thesis was authorised by Mechanist Games.

Chapter 1: Introduction

1.1 Overview

The smartwatch is one of the most popular innovative technologies in the recent years. These smartwatch devices can be used for timekeeping, to check messages and notifications, and more importantly, they can run thousands of apps. The ultimate potential of the smartwatch is yet to be explored.

There are already over 200,000 apps in the App Store for the Apple Watch (Wareable, 2017). Some game developers have started making games for the smartwatch. Although there are some disadvantages for gaming on the smartwatch, such as the tiny screen, the limited processing power and battery capacity and the lack of input methods (Rawassizadeh, Price, & Petre, 2015). However, there is still an enormous potential for smartwatch gaming if the unique ways people use the gadget can be utilised. There are scenarios where the smartwatch can be handier than the smartphone, as the smartwatch has two strong advantages over other devices: “their mount location and (probably more important) the continual connection to the skin” (Rawassizadeh, Price, & Petre, 2015).

The user experience of gaming on a smartwatch is very different compared with today’s generation of smartphones and tablet devices. For the purpose of understanding how existing games could be adapted to facilitate a positive user experience for smartwatch gaming, this research investigates the concerns, criteria and design considerations necessary to game on a device that historically was not meant for user interaction. With this in mind, the aim of the study is to contribute to the design understanding for gaming interactivity on tiny devices, and it proposes to advance the knowledge related to the study of user experiences for wearable computing.

1.2 Aims of the study

The aim of the study is to look into the user experience design challenges of creating smartwatch games, and find out how to address the challenges. Therefore, the research questions are as follows:

- Research Question 1: What are the issues and challenges of making smartwatch games?
- Research Question 2: How to address the issues and challenges?

In this practice-based research, a smartwatch game prototype has been developed to explore the answer to the research questions.

1.3 Significance of the research

The user experience related to gaming on the smartwatch is very different from the mobile version. The smartwatch suffers from two major constraints that have to do with keeping them small enough to wear on a wrist – their small screen size results in

restricted input and output, and their small hardware results in weaker computing capability and especially limited battery capacity (Rawassizadeh, Price, & Petre, 2015). The constraints suggest the significance for research in new interaction techniques and new user interface patterns. However, no previous research was found in this area at the time this research began.

Meanwhile, some game developers have started making smartwatch games straightaway. The first-person shooter game “Doom” (Davenport, 2014) and the mobile game “Minecraft” (Davenport, 2014) were transplanted to the Android Wear smartwatches. Without the interaction methods designed for the smartwatch, these games are hard to play. With more and more smartwatch games emerging, it is more important than ever to conduct research about the user experience design for smartwatch games.

1.4 Scope and limitations of the study

Because of the limitations of time and resources, this research is to focus on the interaction and screen layout, rather than creating a real game. The prototype is only for demonstrating the user experience design.

The genre of the smartwatch game prototype is Action Role-Playing (A-RPG). The user experience design for other game genres will possibly vary. According to the researcher’s observation of the App Store for Apple Watch, the most popular smartwatch game genres keep changing from time to time.

The prototype runs on the Apple Watch platform, since Apple is leading the market (Strategy Analytics, 2017). The Apple Watch’s Digital Crown is used as the main interaction method in the prototype. The user experience design is different on other smartwatches, especially the device doesn’t have a rotating dial similar to Digital Crown, or the screen is circular instead of square.

1.5 Positioning the researcher

As a computer game professional, I had been working in the game company Mechanist Games. The mobile action role-playing game (A-RPG) Spirit Guardian developed by Mechanist Games has been used as the inspiration for the prototype for this research because this is the mobile game I’m most familiar with. The company also provided support in regard to gameplay documents during the research.

1.6 Structure of the exegesis

The exegesis includes six sections as follows:

1. Literature review: This chapter outlines the existing literature that is relevant to this research. It helps to understand the background of the study.
2. Methodology: This chapter introduces the creative-production methodology and explains the research design.

3. The prototyping process: This chapter illustrates the prototyping process through ideation, concept validation, and refinement. It also documents the decision-making process during the prototyping.
4. The prototype: This chapter describes the final output of the prototype in a step by step process.
5. Reflection and evaluation: This chapter reflects and evaluates the process of the user experience design of the prototype and the creative-production project itself.
6. Conclusion: This chapter includes a summary of the research findings, the limitations of the research.

Chapter 2: Literature Review

2.1 Introduction

This literature review presents a summary of contextual knowledge as relevant to the concerns of this study, including existing smartwatch games, game design strategies for a tiny screen, and the user experience design with respect to the small screen. The chapter looks at the smartwatch as a wearable computing device and provides an overview of the developments of this fairly new platform. The literature review aims to provide a general context for gaming on the smartwatch.

2.2 The smartwatch

At present, the smartwatch is considered the most generic form of wearable computer. Academics often use the term “wearable computer” to refer to “any body-worn computer that is designed to provide useful services while the user is performing other tasks” (Starner, 2014, p. 10). This section reviews the definition and the brief history of the smartwatch. The advantages and the disadvantages of the smartwatch are also discussed.

2.2.1 What is the smartwatch?

The Human-Computer Interaction (HCI) experts Cecchinato, Cox and Bird (2015, p. 2) suggested the definition of the smartwatch to be “a wrist-worn device with computational power, that can connect to other devices via short-range wireless connectivity; provides alert notifications; collects personal data through a range of sensors and stores them; and has an integrated clock”. The leading smartwatch manufacturer, Apple Inc. (2015), described its Apple Watch as “deliver[ing] important information when and where you need it, [it] helps you easily perform everyday tasks in seconds, instantly connects you to the people and things you care about most, all while keeping precise time” (para. 3).

The history of the smartwatch can be traced back to the 1980s when Seiko released the “Pulsar”. The “Pulsar” watch became the first watch with a user-programmable memory function (Doensen, 2010). In 1998, Steve Mann built the world’s first wristwatch that ran the computer operating system Linux. Following this, he was coined “the father of wearable computing” for his invention (Clarke, 2000). However, these early models are not comparable to the modern smartwatch, as they exist today. In 2012, the Pebble Smartwatch Kickstarter campaign became one of the most successful crowd-funding projects ever (Rawassizadeh, Price & Petre, 2015), and since then the smartwatch has received growing attention from the public. Then the year 2013 was considered to be the “year of the smartwatch”, because “the components have gotten small enough and cheap enough” and the popular smartphones are compatible with the smartwatches (Greengart, 2013, para. 3). More than 20 models of the smartwatch have been released since then. Android Wear smartwatch was announced by Google in 2014, and the first sales of the Apple Watch took place in 2015 (The Verge, 2014).

2.2.2 The Apple Watch

According to the statistics by Strategy Analytics (2017), global wearables shipments reached 22 million units in the first quarter of 2017. Apple captured a 16 percent market share and became the world's largest wearables vendor. As for the smartwatch market, the statistics by International Data Cooperation (2016) showed that Apple maintained its position as the market leader with a market share of 41.3%. Therefore, the Apple Watch generally represents the trend of the smartwatch in recent years.

The Apple Watch is powered by the operating system watchOS. Besides the built-in apps, users can install thousands of third-party apps. Apple (2015) announced there were already 3,500 watch apps by the time the Apple Watch was launched. Apple's CEO, Tim Cook (2015), confirmed that more than 8,500 watch apps were available in the third quarter of 2015. At the time of this study, there were more than 200,000 apps in the App Store for the watch (Wareable, 2017). Hundreds of watch games were recommended by Apple and other media companies. Apple's App Store is constantly updated with new games.

Meanwhile, Android Wear is another smartwatch platform that keeps pace with Apple Watch. Android Wear is a version of Google's Android operating system that is designed for smartwatches and other wearables. It has the ability to download applications from the Google Play Store.

2.2.3 Advantages and disadvantages of the smartwatch

According to Rawassizadeh, Price and Petre (2015), professionals from the Association for Computing Machinery (ACM), explain that in order to keep the smartwatch small enough to wear on a wrist, they have two major disadvantages: "their tiny screen size results in restricted input/output, and their small hardware results in weaker computing capability and especially limited battery capacity in comparison to larger devices" (p. 2). On the one hand, the tiny screen size results in difficulties fitting a keyboard on a smartwatch. It also makes the smartwatch a poor choice for displaying video and images. Samsung released the Gear S series smartwatch that features curved screens, in an effort to increase screen size (Darrell, 2014, para. 1). Nevertheless, they are still not big enough for a keyboard. Even though Apple Watch and Android Wear have voice input for simple user interaction (Rawassizadeh, Price, & Petre, 2015, p. 2), this also restricts performing more complicated tasks.

Accordingly, the restricted computing and battery capacities make it less feasible for a smartwatch to process sophisticated tasks. Many smartwatches solve this problem by offloading power-consuming sensors, such as, GPS, and extensive computing operations to the smartphones that they are paired with through a low-power Bluetooth connection (Rawassizadeh, Price, & Petre, 2015, p. 2). However, the disadvantage of low performance is likely to be solved with the further development of the technology. For example, the Apple Watch Series 2 released in 2016 is equipped with the Apple S2 processor, which provides 50 percent higher performance than its predecessor in the first generation of Apple Watches. In spite of the disadvantages, the future of the smartwatch is still promising.

Rawassizadeh, Price, and Petre (2015) argued that the smartwatch has two unique advantages. First, its mount location on the wrist, and second, the continual connection to the users (p. 2). This means that the interactions with the smartwatch do not always require both hands. “In particular, users do not need to hold the device, which is required by smartphones and one hand is completely occupied” (Rawassizadeh, Price, & Petre, 2015, p. 2). Therefore, there are scenarios where playing on a smartwatch is easier than playing on mobile devices.

Rawassizadeh, Price, and Petre (2015) suggested the need for new interaction techniques for the smartwatch (p. 3). They argued that the existing smartwatches “have very small screens with no or few buttons on the side”. This makes the traditional interaction methods we use on the smartphone, such as tapping on the small on-screen buttons, difficult on the smartwatch. Therefore, new interaction algorithms and also new user interface (UI) patterns need to be developed for a better user experience (UX). Rawassizadeh, Price and Petre (2015) emphasized that the existing approaches to interaction design on the smartwatch should be optimized for “better precision on a tiny screen and lower recourse usage” (p. 3).

2.3 User experience design

In this section, the chosen methods and theories that are important to this research are mentioned and described.

2.3.1 User experience (UX)

User experience (UX), is a widely used term to describe the aspects of a user’s experience while interacting with a software system that includes various variables, such as, an interface, graphics and physical interaction and so forth (Henrik & Martin, 2012). UX is often used as an umbrella where beneath, many diverse designs and usability principles join together to create products. The typical deliverables of the UX include wireframes, prototypes, storyboards, sitemap and written specifications (Henrik & Martin, 2012).

2.3.2 Usability

Usability is a term widely used to describe the ease of use of human-made products, such as application software, websites or tools (Henrik & Martin, 2012). Today, usability is a fundamental attribute to judge the quality of software systems (Hartson, Andre, & Williges, 2001). According to Nielsen (1994, p. 1), usability is, “A quality attribute that assesses how easy user interfaces are to use. The word “usability” also refers to methods for improving ease-of-use during the design process.” And according to the international standard of usability, ISO 9241-11 (1998): “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.”

2.3.3 Interaction Design (IXD)

Interaction design (IXD) is the profession where one is designing an interactive product, service system or environment. The phenomena “interaction” that occurs while the user interacts with a product is what the discipline interaction design intends to inspect and shape (Henrik & Martin, 2012). Similar to many designs, interaction design also affects human behaviour however with a slight convolution, due to the ubiquity of many software systems, such as, cars, phones and computers, since using them involves exhibiting complex behaviours which gave birth to the discipline, interaction design, as we know it today (Cooper, 2007). This study is, in principle, based on interaction design since it intends to explore the interaction design for the tiny screen on the smartwatch.

2.3.4 Recent studies about the user experience design for smartwatch

At the time this research commenced in 2015, there was barely any study about the user experience design for the smartwatch because smartwatch devices were fairly new and the market leaders, Apple and Google, had just announced their products in 2015. However, with the iteration of the smartwatch hardware, more and more studies have emerged, that have to do with the user experience design for the smartwatch.

Some examples of recent user experience studies are the following: Xu and Lyons (2015) explored the smartwatch design space by utilizing the Light-emitting diode (LED), which expands the display on the smartwatch’s tiny screen. Kerber, Kruger and Lochtefeld (2015) investigated the effectiveness of the interaction with the map navigation app on the smartwatch that indicated that the navigation task completion time performed on the smartwatch is significantly worse than that on the smartphone. Dunlop, Komninos and Durga (2015) studied the methods of text entry on the smartwatch, exploring the possible solution for the difficulties in information input/output on the smartwatch. Xiao, Laput and Harrison (2015) studied the interaction with the smartwatch with mechanical pan, twist, tilt and click, and pointed out the smartwatch has a “multi-degree-of-freedom mechanical interface” (Xiao, et al., 2015, p. 4). Several case studies about developing the smartwatch app were also found. That these have all been undertaken recently indicates the growth in user experience research on smartwatches continues to be a growing area of exploration.

2.4 Video games

A video game, at its most basic level, is the implementation of a game in a computer-based console that uses some type of video output (Bernhaupt, 2010). Providing a formal definition of a video game was one of the first challenges that game studies faced. To be considered a game, many factors must be taken into account and for this reason, the following definition is suggested (Juul, 2005, p. 36): “A game is a rule-based system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels emotionally attached to the outcome, and the consequences of the activity are negotiable.”

2.4.1 Gaming on mobile devices

According to the definition in *The Art of Game Design: A Book of Lenses* (Schell, 2014), a mobile game is a video game played on a feature phone, smartphone, smartwatch, PDA, tablet computer, portable media player or calculator.

Mobile games tend to be small in scope (in relation to mainstream PC and console games) and many prioritise innovative design and ease of play over visual spectacle. Storage and memory limitations place constraints on file size that presently rule out the direct migration of many modern PC and console games to the mobile space (Schell, 2014).

2.4.2 Gaming on the smartwatch

Moreover, Square Enix Inc. announced the smartwatch game *Cosmos Rings* in 2016. This is the first Apple Watch-exclusive Role-Playing Game (RPG) (Square Enix, 2016). This game uses the Apple Watch's Digital Crown to turn back the clock in the game. Some concepts of this smartwatch game are quite similar to my prototype, which is demonstrated in Chapters 4 and 5.

2.5 Summary

In this literature review, the advantages and disadvantages of the smartwatch were reviewed and explored. During the development of the smartwatch game prototype, the aim has been to make use of the advantages and avoid the disadvantages. The notions of several user experience design theories (UX, IxD, usability) were reviewed, which forms the basis of the research design. The literature about video games, especially about gaming on the small form factor has also been reviewed.

Chapter 3: Methodology

3.1 Introduction

The methodology of this research and the research design are presented in this chapter. A detailed design process in the development of the prototype is also presented.

3.2 Practice-based research

This research is practice-based. In practice-based research, new knowledge is partly acquired by the methods of practice and its outcome (Candy, 2006). The practice usually includes artefacts. In this research, a smartwatch game prototype was developed as the artefact. During the development of the prototype, the new knowledge about the issues and challenges of the user experience design for smartwatch games has been explored.

To distinguish the practice-based research and the non-academic practice, Scrivener (2002) argues that the aim of the practice-based research is to acquire transferable new knowledge, rather than producing the artefact itself. Therefore, in this research, the prototype has been developed for the purpose of demonstrating the development of the idea and the findings of the user experience design for smartwatch games, rather than making a real smartwatch game in working order.

In addition, this practice-based research is formed in a manner that meets the transferability standard. The artefacts in the practice-based research should be accompanied by the documentation of the research process, the analysis and the reflection (Candy, 2006). Therefore, this exegesis has been written to include those components mentioned above, as a part of the practice-based research.

In the practice-based research, the documentation is important (Candy, 2006). The documentation demonstrates how the researcher “arrived at, explored and expressed the identified issues, concerns and interests” (Scrivener, 2004, p. 3).

3.2.1 Reflective practice

Donald Schön’s reflective practice theory combines action research and practice-based research. His theory consists of the concepts of reflection-in-action practice (RIAP) and reflection-on-action practice (ROAP) (Schön, 1983). RIAP is to “think on our feet”, which means the reflection happens during the practice. In other words, ROAP is to “learn from experience”, which means the reflection happens after the practice. The combination of RIAP and ROAP is “the process spirals through stages of appreciation, action, and re-appreciation, whereby the unique and uncertain situation comes to be understood through the attempt to change it, and changed through the attempt to understand it” (Scrivener, 2000, p. 10).

In this research, the reflection-in-action practice was conducted throughout the development of the prototype. The RIAP includes the concerns and choices of designing every single element in the screen layout and interaction methods, to ensure a good user experience design. The ROAP was carried out after the prototype is developed, in order to identify the issues and challenges of the user experience design challenges for smartwatch games and to evaluate whether the prototype met the goals and addressed the challenges. The result of the ROAP will be the findings of the research. All the major RIAP and ROAP are documented.

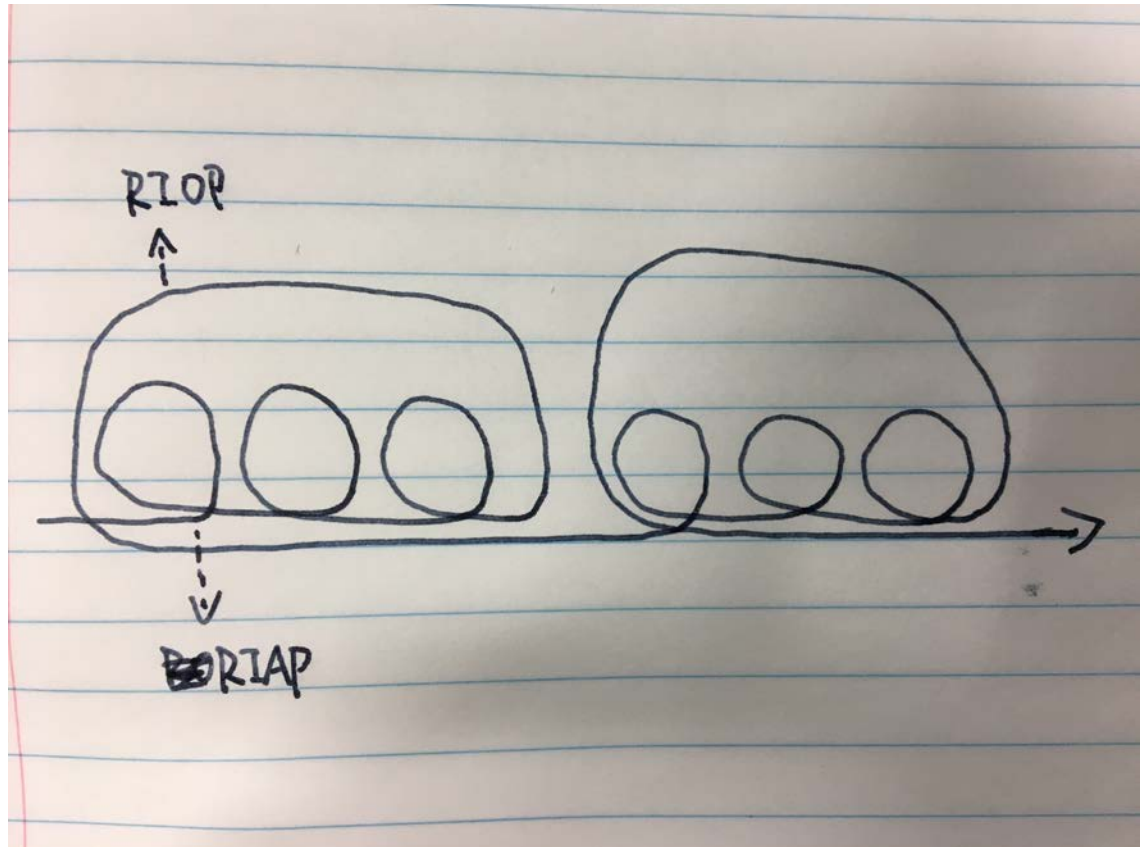


Figure 1. RIAP & RIOP

3.2.2 Iterative design and prototyping

A prototype is “an initial model of an object built to test a design” (UXL Encyclopedia of Science, 2015, para. 1). The purpose of building a prototype is to test whether the design works or not. The designer can improve the design if problems are spotted at the time the prototype is evaluated. Therefore, it often goes through several iterations of the prototype before the definitive version. The prototype is not meant to be perfect, and it may replicate only a portion of the whole product (UXL Encyclopedia of Science, 2015).

Lenore (2010) defines the differences among the sketch, the wireframe, the prototype, and the final design:

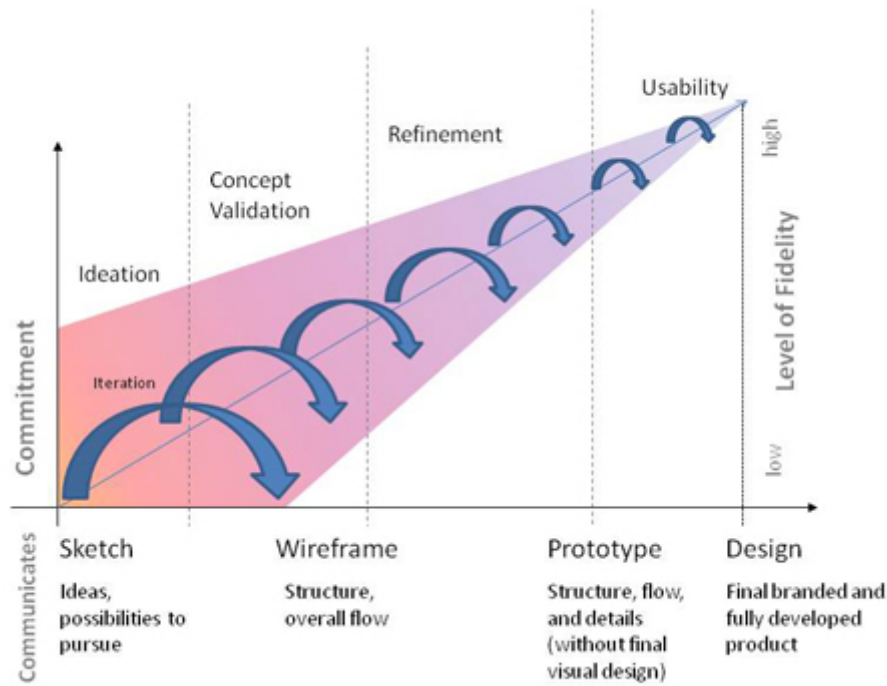


Figure 2. The Sketch to Design Continuum (Lenore, 2010)

According to Lenore's continuum (2010), a sketch is a quick hand-drawing, intended for ideation. It's the first step of the iteration. The sketch should be suggestive and exploratory, rather than confirming. A wireframe is then to put the sketches together and to reveal the structure of the design. It also reveals the concepts that require validation. The purpose of the prototype is to refine the design by confirming the decisions and fine-tuning the details. The final iteration is to make the design fully developed and deliverable, based on the feedback from the preliminary stages of the design.

3.3 Research design

My research design is based on the theory suggested by Lenore (2010). In order to make a smartwatch game prototype, I started with the sketch to explore the idea and to solve the key user experience challenges as possible. Then the wireframe is made, to put the sketches together, and to validate whether they worked in the structure. Finally, the prototype is made, to make the design interactive and deliverable.

3.4 Summary

In the methodology chapter, an outline of the theory of practice-based research and the method of reflective practice was provided. These methods lead to the iterative design. The prototyping process in this study is an iteration process. The research design is based on the stages of the prototyping process.

Chapter 4 Spirit Guardian for Apple Watch

4.1 Introduction

In this chapter, the prototyping process of the Spirit Guardian for Apple Watch is demonstrated. I started with identifying the key user experience challenges that I would encounter in the prototyping process. I also looked at the constraints of the Apple Watch platform and decided which portion of the original game is replicated. Then the major concerns and choices during the prototype development are explained, as the evidence of reflection-in-action and reflection-on-action practice.

4.2 Key user experience design challenges

In the literature review, I found that the smartwatch has the constraints of restricted input/output due to the tiny screen and the limited performance and battery life due to the small hardware (Rawassizadeh, Price, & Petre, 2015). Since this research is about user experience design, the constraints caused by the tiny screen are where the challenges exist in terms of building the prototype.

The restricted input/output means that the interaction and the display on the smartwatch's tiny screen are different. The major smartwatch vendors provide guidelines for the smartwatch app developers to address the input/output issues. Since Apple is leading the smartwatch market, I looked at the Apple watchOS Human Interface Guidelines for reference. The first rule of the watchOS Design Principles is "lightweight interaction". According to the guidelines (Apple Inc., 2015), lightweight interaction means "Apple Watch was designed for quick interactions that make the most of the display and its position on the user's wrist. Information is quick and easy to access and dismiss. The best apps support fast interactions and focus on the content that users care about the most." (para. 2)

Additionally, the guidelines provide three design themes which are quite important to the interaction design for the watchOS apps (Apple, Inc, 2015, para. 6-8):

- *Glanceable*. The Apple Watch app should provide the most essential information to the user without distraction.
- *Actionable*. The onscreen display should always be current and relevant.
- *Responsive*. The interaction with the app should be quick. The app should respond to the user and provide immediate feedback.

The guidelines provide information about app components, navigation, visual design, typography and so forth. I will mention these guidelines if they are relevant in the latter prototyping sections.

4.3 The limitation of the Apple Watch hardware and software

According to the market analysis mentioned in Chapter 2, Apple Watch is leading the smartwatch market and will probably become the benchmark for the market as they have for the smartphone and tablet market. Therefore, my prototype was mainly based on the Apple watchOS platform.

On 24 April 2015, the Apple watchOS was released alongside the Apple Watch (Apple Inc., 2015), and it was very limited. The animations would have to be generated frame by frame on the iPhone and then sent to the Apple Watch (Apple Inc., 2015). There is not any allowed use of the Digital Crown control or any kind of gesture support (Komarov, 2015). At the Apple Worldwide Developers Conference (WWDC) 2015, the watchOS 2 was released along with the support for native third-party apps. Finally, at the WWDC 2016, Apple announced the watchOS Software Development Kit (SDK) 3.0, which provides seven times faster app launch speed and, more importantly, support for Digital Crown and touch events (Apple Inc., 2015). Meanwhile, in the Apple watchOS Human Interface Guidelines, Apple encourages the use of Force Touch and Digital Crown (Apple Inc., 2015). More importantly, the Apple watchOS SDK now supports SpriteKit and SceneKit. These technologies render 2D and 3D content programmatically, instead of relying on a sequence of images for animation in the older versions of watchOS SDK (Apple Inc., 2015).

In spite of the fact that the watchOS supports many features to make my prototype possible, there are still limitations in terms of the processing power and battery capacity to prevent my prototype from working as a real game by the time the thesis is written. The SoC (system on chip) embedded in the Apple Watch (first generation) – which is called Apple S1 – features a 520MHz single core CPU, a PowerVR SGX543 GPU, and 512MB RAM (iFixit, 2015). This combination provides the insufficient performance to run real-time 3D games. Additionally, the tiny battery also makes high performance on the smartwatch difficult (Reza, 2015). Therefore, the prototype is focused on addressing the user experience design challenges, rather than providing a real gaming experience in working order.

4.4 The original mobile version of Spirit Guardian and the content of the prototype

I decided to make a smartwatch game version of Spirit Guardian. This game is successful in various East Asia markets but not very famous around the world (Mechanist Games, 2016). I chose this game because it's developed by my former employer Mechanist Games. Therefore, I'm familiar with the game mechanics and I have access to the resources from the development team.

Spirit Guardian is a real-time action role-playing game (A-RPG) for mobile devices. This game is compatible with smartphones and tablets running iOS and Android. This game includes combat system, Player versus Enemy (PvE) system, Player versus Player (PvP) system, and progression system. The features of the combat system are listed below:

- Auto-Combat: The player can switch between Auto/Manual Combat.
- Auto-targeting: Target selection is not required but manual override is available.
- Attack Move: The character is automatically assigned to a move action.
- One click to cast skills: Point-and-select is not required.
- Vanquish is available on full scores completion of a level.

Additionally, the combat system was a squad-based team fight rather than single mode. Therefore, ensuring the whole fight is under control is challenging, especially on the tiny screen. This requires simplicity in regard to combat control and maintaining the key elements of A-RPG control at the same time.

Due to limitations in regard to time and resources, I decided to focus on the combat system of Spirit Guardian in my prototype.



Figure 3. The Spirit Guardian home screen

4.5 Ideation

Through brainstorming and playing with the current smartwatch games for reference, I came up with several concepts for the prototype and started the ideation.

4.5.1 Journey map

First of all, as mentioned above, the content of the prototype should demonstrate how the A-RPG combat system could possibly work on the smartwatch. Since the prototype is not an actual working game, I decided to make a journey map for the game containing the key features and functionalities in the combat system. A journey map, in the context of user experience design, refers to “a visual or graphic interpretation of the overall story from an individual’s perspective of their relationship with an organization, service, product or brand, over time and across channels” (Grocki, 2014, para. 3). I made the journey map based on my experience as the game developer. The journey map includes:

- **Character idling:** All the characters are standing in the game and waiting for the further command, as no enemy is engaged.
- **Auto-pilot:** When the Auto-pilot is switched on, all the characters are automatically navigated to engage the enemy, so they start moving. The manual movement of the character, by tapping on the destination, is not required, while Auto-pilot is on.
- **Auto-combat:** While the Auto-combat is switched on, all the characters would automatically start the combat while they engage the enemy. It is not necessary to tap on the enemy to start the combat while Auto-combat mode is on.
- **Character using superpower:** The character gains energy if they are being hit by their enemies in the combat. When the character's energy bar is full, its Superpower is charged and ready to be used.
- **Normal attack:** The character fights against the enemies without using Superpower.
- **Interrupting enemy's superpower:** The enemies can release their Superpower too. If the enemy's Superpower is being released, it takes time, which varies from several tenths of a second to several seconds to charge. And if the enemy's Superpower is being charged, there's a bar showing the status on the screen for a warning. So that the user can release the Superpower of one of the characters, if there's any available, to interrupt the releasing process of the enemy's Superpower.
- **Health level low:** The character can be killed if its health level drops to zero. So, it's important to heal the character if its health level is low. The character's avatar flashes in red as a warning in the original game.
- **Hit by enemy's Superpower:** If the user fails to interrupt the enemy's releasing of the Superpower or doesn't react to it at all, the characters can be hit by the enemy's Superpower and the affected characters' health levels will drop.
- **Healing:** It's a special Superpower that can be used by some of the characters. The release of the Superpower of healing is the same as other Superpowers.
- **Focus fire on one enemy:** If the Auto-combat mode is on, the characters automatically select the enemy, by either who is nearest to them, or who hit them, to fight against. However, the target is often not most threatening one. So, the manual override of selecting the right target is important. As soon as one of the enemies is selected, all of the characters focus fire on it.
- **Combat ending:** If all of the enemies are defeated, the characters win and the combat ends. Otherwise, the characters are defeated and the combat ends as a loss.

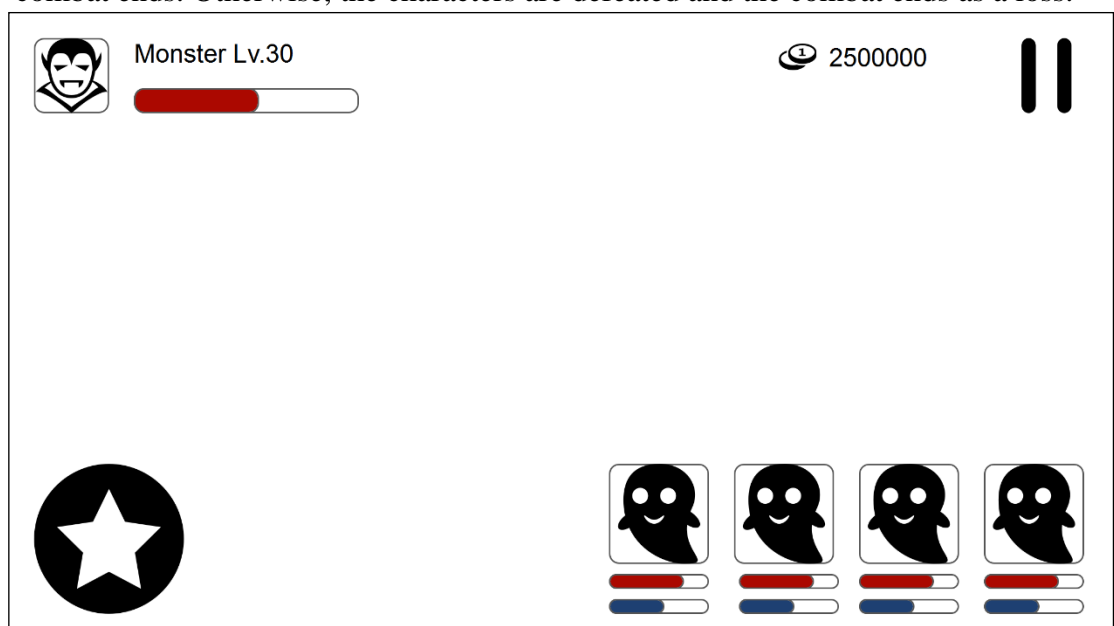


Figure 4. The wireframe of Spirit Guardian combat system

4.5.2 Interaction method

In order to address the user experience design challenge – lightweight interactions, the interaction method should be carefully chosen. The above-mentioned game techniques – selecting superpower and focusing fire – both require target selection. So, it's important to decide how to select the target on the tiny screen. In the original game, the user taps on the character's avatar to trigger its superpower. However, placing four avatars at the corner of the smartwatch's tiny screen is not an option.

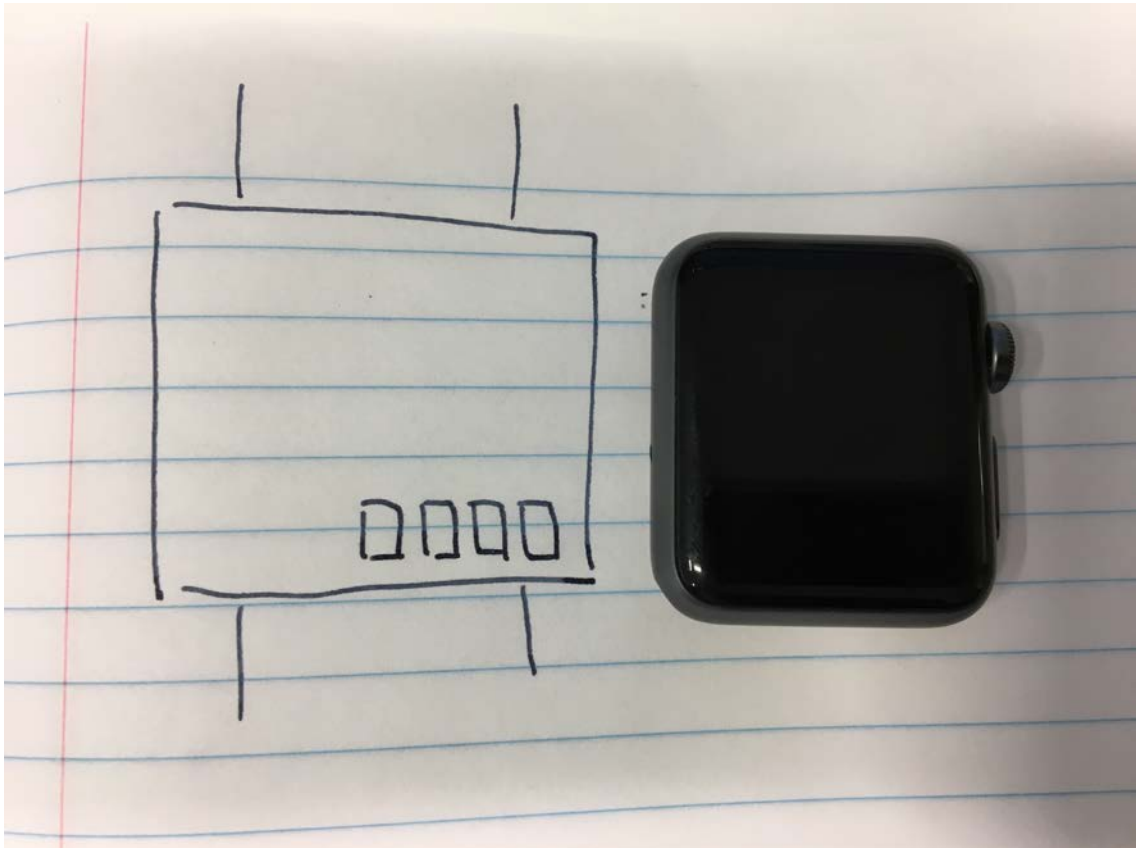


Figure 5. Interaction method 1 - Tap

I came up with a concept using swipe gestures from different edges of the screen to activate the character's superpower. The advantages of this design are:

- Easy-to-read superpower indicators
- Simple and effective interactions

However, as I played with the mock-up on the paper, I realized that the proportion of the screen that was blocked by the finger was often too large, especially if the swipe gesture was triggered from the opposite side (for example, swipe from the left using right hand).

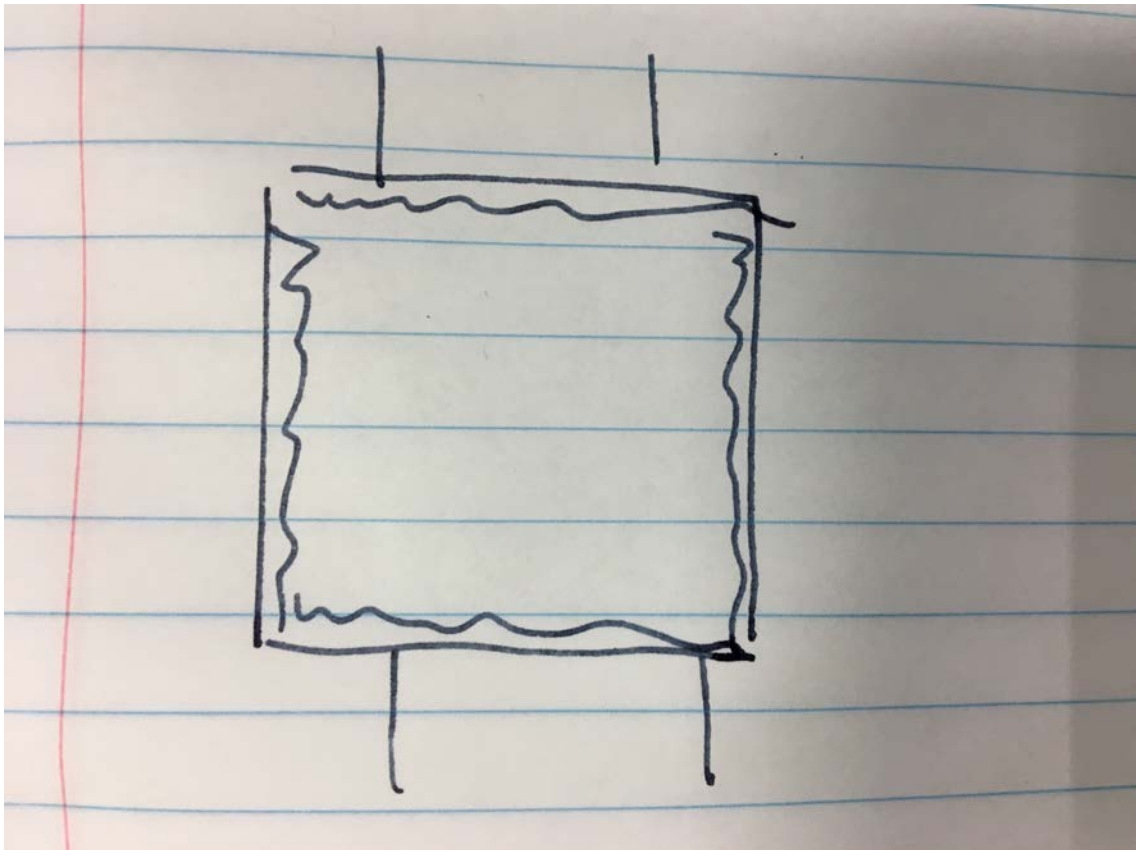


Figure 6. Interaction method 2 - Swipe

To prove this point of view, I conducted an experiment. I used a high FPS (frame per second) camera recording myself achieving some goals by tapping and swiping on the Apple Watch. The video recording demonstrated that the finger can block the screen by as much as 40 percent. The finger sometimes blocks critical game information, this leads to a poor user experience.

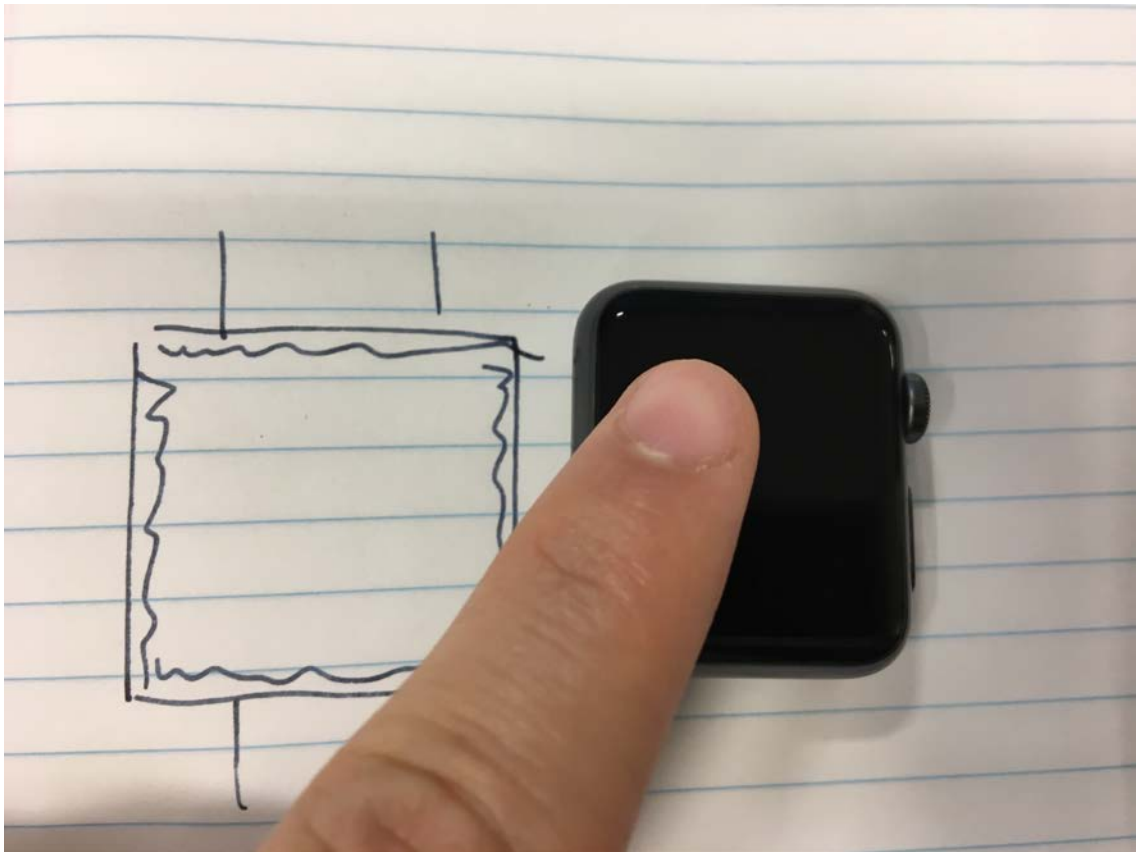


Figure 7. Interaction method 2 testing

Although other interaction methods, such as voice, haptic, and gesture interfaces were recommended (Rawassizadeh, Price, & Petre, 2015), I decided to take the Digital Crown into consideration. The advantages of Digital Crown over other interaction methods include:

- It is recommended in watchOS human interface guidelines.
- The finger doesn't block the screen.

Additionally, the accelerometers or gyroscopes are not recommended by Apple for the direct manipulation of the app's interface. According to the guidelines, "Touch events, gestures, the Digital Crown, and Force Touch menus are more precise ways for users to interact with the interface. Some motion-based gestures that may be difficult to replicate precisely, may be physically challenging for some users to perform, and may cause the screen to dim" (Apple Inc., 2015, para. 3).

Therefore, I came up with the second concept. If there are multiple superpowers available (more than one and less than four as in the original game), the user selects the desired one by rotating the Digital Crown clockwise. The cycle goes as a loop, which means it goes back to the first superpower while rotating further than the last superpower.

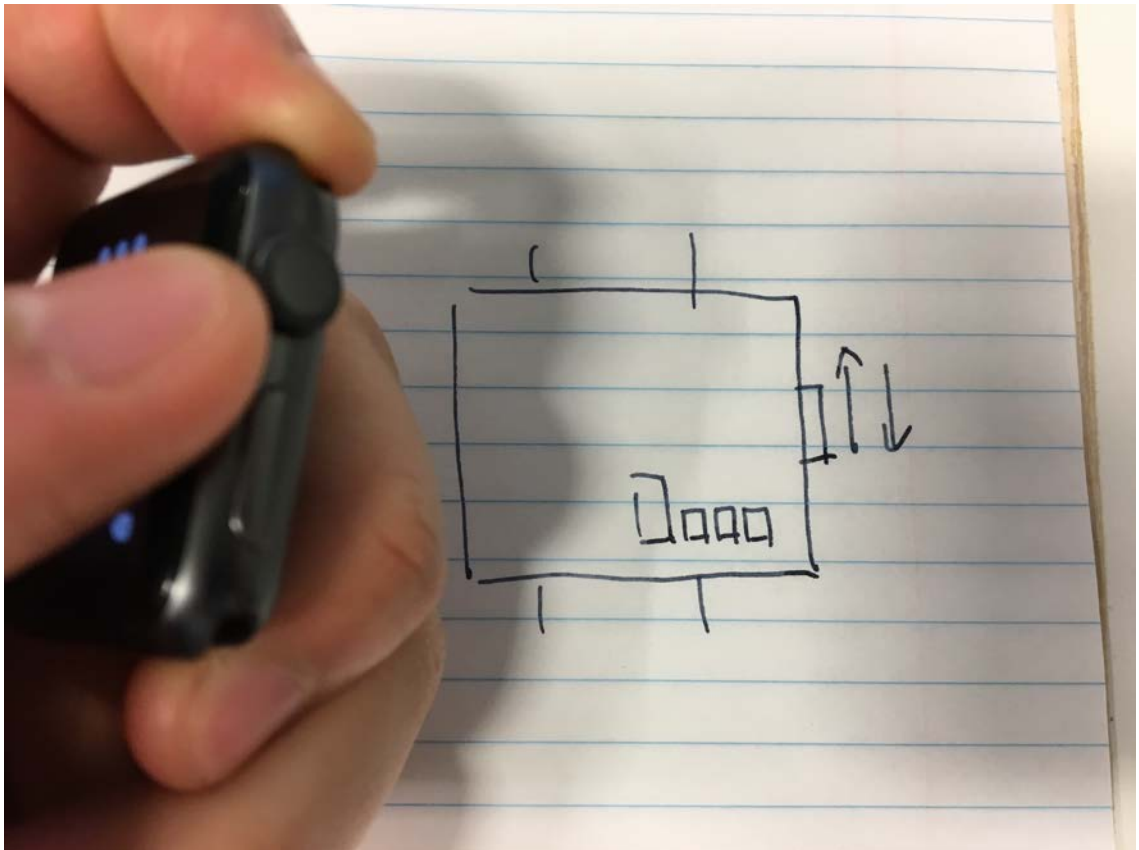


Figure 8. Interaction method 3 – Digital Crown

To prove its advantage, I conducted another experiment. I use the Apple Watch's timer app and utilise the Digital Crown to select "15 minutes", "30 minutes" and "60 minutes". I recorded the time spent to complete the task and compared to the time to trigger the superpower by tapping on the character's avatar in the original game.



Figure 9. Interaction method 3 testing

The results demonstrated that using Digital Crown to achieve the given goal is as easy as doing so by tapping the on-screen button on the phone. However, the experiment I conducted is a simple and theoretical one, without considering the real-world experience of using the Digital Crown. Although Apple's Digital Crown generally received a good reputation (TechRadar, 2015), it may not work as well on a similar device with another rotating gadget.

To sum up, factoring the advantages which are – less chance of blocking the screen and possibly easier to interact – I decided to adopt the Digital Crown as the main interaction method in the prototype.

4.6 Concept validation and prototyping

With the brainstorming done, I started to validate the concepts and put the concepts together to build the prototype.

4.6.1 Prototyping tool

First of all, I had to choose a prototyping tool in order to make an interactive prototype. I compared some of the most popular solutions, including Proto.io, InVision, and Marvel. Then I decided upon to use Proto.io. Although Proto.io is considered to have the longest steepest learning curve, it was the only prototyping tool with Apple Watch template at the time this prototype was developed.

4.6.2 Navigation

There are two navigation modes supported in the watchOS SDK: page-based and hierarchical. Runeblade, as one of the most successful RPG smartwatch game currently available (WIRED, 2015), utilised the page-based navigation mode with custom modal sheets. A custom modal sheet is a full-screen view that slides over the app's current screen. This type of sheet is used if presenting a custom interface modally. The top-left corner of the modal sheet is reserved for the Close button, which dismisses the interface (WIRED, 2015).

However, the prototype was designed to be a real-time 3D game. So, neither of the navigation modes was adopted. Actually, navigation is not a priority in the prototype as the original game features the Auto-pilot system, which means the characters move automatically. As mentioned above, this feature allows simplicity on combat control while maintaining the key elements of A-RPG control.

4.6.3 Layout

According to watchOS Human Interface Guidelines (Apple Inc., 2015), there are some rules about the layout:

- Avoid displaying too much information on screen at once
- Create visual groupings to help users find the information they want
- Use the full width of the screen
- Use a menu to replace buttons when appropriate
- Limit the number of side-by-side controls in your interface
- Left align elements

In the original game, the characters and the enemies are moving about freely during the combat. I think on the smaller screen, there are several disadvantages if they still move freely. First, the information is not visually grouped. The user may need to quickly find the character who requires healing and the enemy whose superpower needs to be interrupted. It's easier to find the information if it is well grouped. Second, it's possible that if all of the characters and enemies are moving to one side of the screen, then the full width of the screen is not well used. Therefore, I decided to group the characters and place them on the left side of the screen while the enemies were approaching on the right side. Although it looks a bit like a turn-based game, it still maintains the A-RPG genre.

The other elements of the interface were sourced from the original game. The name of the enemy boss and its health bar are displayed if the characters engage a boss. The characters' health bars and energy bars are cancelled to avoid displaying too much information. Instead, the character flashes in red if its health level is low and the superpower indicator shows up if its energy is full. The superpower indicators are placed on the right bottom corner to create a look similar to the original game. These indicators are stacked, presenting as a "menu" rather than buttons to save the

space. Each character's superpower indicator is in an assorted colour to make it more visually clear.

The coin gathering indicator is dropped as it's not very relevant to the combat and the tiny smartwatch screen doesn't have the luxury to display it. The auto/manual pilot switch is dropped as the Auto-pilot is the only navigation mode available in the prototype. The pause icon is also dropped as Force Touch is used to pause the game.

4.6.4 Interaction

According to watchOS Human Interface Guidelines (Apple Inc., 2015), user interactions on Apple Watch generate touch events and gestures. If the user taps a button or another control, Apple Watch calls that control's associated action method. The action methods are defined for the controls in the interface and are used to respond to user interactions. The system also provides automatic responses. However, the currently provided interaction mode in watchOS needs to be abandoned as it makes the real-time 3D game not realistic. The guidelines (Apple Inc., 2015, para. 3) said "Avoid using standard gestures to perform nonstandard actions. Unless your app is a game in active gameplay, redefining the meaning of standard gestures leads to confusion and complexity." It is understandable that Apple set the limitation for a more consistent user experience of Apple Watch. Even so, it is still possible to treat the game apps differently.

There are two rules about Digital Crown in the guidelines (Apple Inc., 2015):

- Provide visual feedback in response to Digital Crown interactions
- Update your interface at an appropriate rate

As mentioned in the ideation process, I tried to prove that Digital Crown is a more effective interaction method and wanted to use it as the main interaction method in the prototype. The Digital Crown lets users scroll content without obstructing their view of that content. In the latest released watchOS 3, it is possible to use the Digital Crown input to create sophisticated custom interfaces. According to the guidelines (Apple Inc., 2015), apps access the Digital Crown directly or through pickers. With direct access, the app receives the raw rotational data. Therefore, I decided to use the Digital Crown for superpower selecting and enemy targeting, since they are two of the main game skills in the original game.

The user rotates the Digital Crown clockwise for superpower selecting and anti-clockwise for enemy targeting. The method of superpower selecting is generally mentioned above. If one superpower is selected, its indicator is enlarged.

As the user selects the desired superpower, it can be triggered by tapping on the screen. In the beginning, I was thinking about triggering after the superpower is selected for one second and requires no tapping operation. However, I thought it may slow down the pace of the game as sometimes the superpower needs to be triggered quickly to interrupt the enemy's superpower. Therefore, I decided to add the additional tapping operation to confirm the superpower is desired to be triggered as needed, preventing faulty operation.

As the superpower is triggered, there's visual feedback on the screen. Meanwhile, if the superpower is selected but not triggered, the enlarged indicator goes back and the superpower selecting mode is ended.

On the other hand, the user rotates the Digital Crown anti-clockwise for enemy targeting. The method is similar to the superpower selection. A crosshair is displayed on the enemies in enemy targeting mode.

However, I decided not to apply the tapping operation to confirming enemy targeting for several reasons:

- Enemy targeting is often followed by superpower triggering. Adding another tapping operation slows down the pace of the game.
- The penalty of targeting the wrong enemy is lower than triggering the wrong superpower. If the wrong enemy is targeted, it's easy to rotate the Digital Crown and re-target.

4.7 Summary

The prototype is developed through ideation, concept validation and refinement. In each of the stages, the iterations were documented.

Chapter 5: The Prototype

5.1 Introduction

In this creative-production project, I developed a smartwatch game prototype. In this chapter, I will describe the prototype in a step-by-step process, while referring back to the prototyping process demonstrated in Chapter 4. This prototype was based on the action role-playing mobile game (A-RPG) Spirit Guardian. The prototype was designed to address several user experience design challenges while making game apps for the tiny smartwatch screen, rather than providing a real gaming experience in working order. The prototype contains the combat system derived from the original game, with emphasis on the design of the interaction and screen layout.

The prototype contains some instructions to guide the user throughout the gameplay. It is recommended to follow the instructions. If any of the steps are not completed as instructed, the user has to do it again in order to proceed with the instruction.

5.2 The step-by-step guide

Step 1 Beginning

In the very beginning of the game, the characters are idling at the starting point of the dungeon. In the mobile version, the user can either activate the Auto-pilot system by tapping on its icon, or by moving the characters manually by tapping on the map. Nevertheless, as explained in Chapter 4, the manual pilot mode was removed for the reason of lightweight interaction. The icon was also removed. This is so that the Auto-Pilot is set as default and no interaction is required in this step.

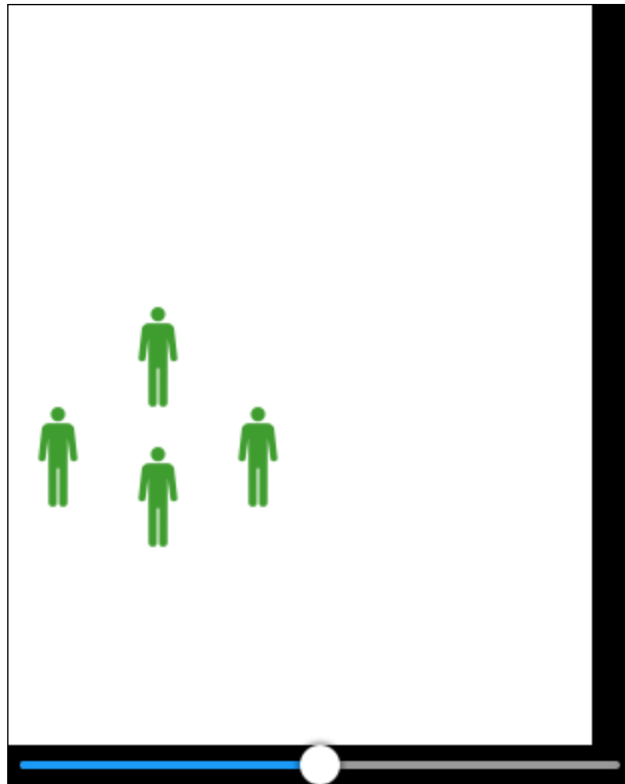


Figure 10. Prototype Step 1 – Beginning



Figure 11. Original game Step 1 – Beginning

In terms of the screen layout, compared to the mobile version, I removed the pause button, the character avatars and their health/energy bars, and the gold collector. In Chapter 4, I have explained the design process of the screen layout. These items were considered non-critical so they were removed to make room for critical items. In terms of the layout, it was kept the same, as much as was possible, so it would be similar to the mobile version.

At the same time, the pause button was replaced by Force Touch. Although the character avatars and their health/energy bars were removed, there are indicators that are displayed and while the health status is low/the energy bar is full. And although the gold collector was removed, the animation of the gold collecting still exists. And since the gold collecting system is not relevant to the user experience design, it is not included in the prototype.

Step 2 Engaging

The characters move forward in the dungeon, as soon as the “Auto-pilot” mode is activated. The characters keep moving until they engage the enemies. In the mobile version, with the appearance of the enemies, the name of the enemy boss and its health bar is shown on the top left corner of the screen. In the prototype, the information was positioned on the top of the screen. As mentioned in the screen layout design in Chapter 4, this design is meant to make use of the tiny screen, while the spacing of the elements adheres to the Apple watchOS Human Interface Guidelines (Apple Inc., 2015).



Figure 12. Prototype Step 2 – Engaging



Figure 13. Original game Step 2 – Engaging

Step 3 Enemy targeting

Once the characters encounter the enemies or vice versa they will begin to engage in a battle sequence. The ability to “focus fire” is one of the core mechanics for winning combat within the game.

In the original game app on mobile devices, targeting an enemy can be achieved by tapping on a specific enemy on the touch-sensitive screen. However, as explored in Chapter 4, this is not an effective mechanism for enemy selection while using the small screen real estate on the smartwatch due to the fact that the fingers of users could obscure the watch display. A more effective interaction method is the use of the Digital Crown. This is because it avoids the problem of the user obscuring the screen information with the hand. I decided to use the Digital Crown as the primary method for targeting enemies.



Figure 14. Prototype Step 3 - Enemy targeting



Figure 15. Original game Step 3 – Enemy targeting

In Figure 4 the user experience for allowing a user to select their desired Superpower is shown. The UX design implemented within this prototype allows a user to adjust the Digital Crown by rotating it anti-clockwise to target the enemies. Due to the constraints in the Proto.io prototyping software, representations of a Digital Crown as presented on the physical watch device are not possible.

To replicate the action that this dial would provide for the user, a slider was created instead and positioned at the bottom of the prototype interface (as shown Figure 4). This slider is used for the purpose of demonstrating how the user interaction would operate if used on a physical Apple Watch.

While the user interacts with the Digital Crown (slider), a crosshair is displayed on a target enemy. The user can continue to dial the crown anti-clockwise to cycle through each of the presented enemies. Once the user has selected the appropriate target enemy they can pause their cycling and 500 milliseconds later the target is confirmed. Once confirmed, all four characters will focus their attack on the selected enemy until the target is defeated. If they wish to change the focus of the attack at any time they can use the Digital Crown to cycle to a different enemy for the characters to focus on.

Step 4 The first Superpower

At this stage, some of the characters' energy bars are full and their Superpowers are available. In the mobile version, the character avatars are replaced by the corresponding Superpower indicators to notify the user. The indicators themselves become the buttons for triggering the Superpowers.

As mentioned in Chapter 4, the avatars and their energy bars were removed and the Superpower indicators are only displayed if the corresponding Superpowers are available. They are positioned on the bottom right corner in my first prototype. This is because in the mobile version, the Superpower indicators are also on the bottom right corner and my intent was to make the smartwatch version look similar to the original game.

The Superpower indicators are stacked if and when more than one is available, rather than aligned horizontally as in the original game. This design was explained in Chapter 4 and again, it is also meant to make full use of the tiny smartwatch screen.

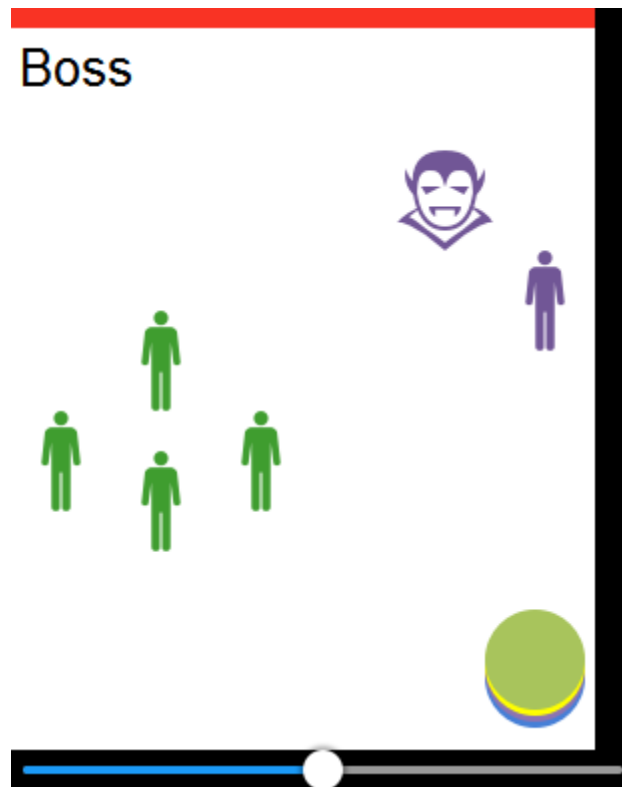


Figure 16. Prototype Step 4 - The first Superpower



Figure 17. Original game Step 4 - The first Superpower

In this step, in order to trigger the Superpower, the user is instructed to 1) select the desired Superpower by rotating the Digital Crown (slider), and 2) confirm the selection by tapping on the screen.

First, the interaction with the Digital Crown (slider) for Superpower selection is similar to the enemy targeting operation that is demonstrated above in Step 3. The user adjusts the Digital Crown by rotating it clockwise to select the desired Superpower. A slider

was positioned at the bottom of the prototype interface to replicate the Digital Crown. Therefore, while the user interacts with the Digital Crown (slider), the selected Superpower indicator is popped up and enlarged. The user can continue to dial the Digital Crown clockwise to cycle through each of the available Superpowers. In this step, the user is instructed to drag the slider twice as the second Superpower is required in the prototype's storyline to attack the enemy. Additionally, I believe the user will get a better understanding of how the prototype works with more interaction.

Second, the user is instructed to tap on the screen to confirm once the desired Superpower is selected. This is different from the operation of enemy targeting that is mentioned above in Step 3. In Chapter 4, I argued that the Superpower selection should be confirmed by tapping on the screen. This design was to help avoid a false operation, as Superpower selection is one of the more important and less forgiving core mechanics of the game. If the user turns on the Superpower selection mode by mistakenly interacting with the Digital Crown (slider), it can be cancelled by rotating the Digital Crown (slider) anti-clockwise once. So that with one anti-clockwise rotation, it neither selects the Superpower backwards nor enters the enemy targeting mode. To select the Superpower backwards, the user should dial the Digital Crown (slider) further to cycle to the desired one. To enter the enemy targeting mode, the user should dial the Digital Crown anti-clockwise once again after cancelling the Superpower selection mode.

Once confirmed, the Superpower is triggered and the second enemy is eliminated.

Step 5 The second Superpower - healing

In this step, according to the journey map, one of the characters is attacked by the enemy's Superpower. Once this occurs the character requires healing. In the mobile version, the character's health bar is low and its avatar glows in red to notify the user. However, the character avatars and the health bars were both removed in the screen layout of the prototype, as explained in Chapter 4. Instead, I decided to add a glow effect on the wounded character if its health status is low. This design and the design of the Superpower indicator that is mentioned in Step 4 both contribute to a concise screen layout, and only display critical information as necessary.



Figure 18. Prototype Step 5 - The second Superpower – healing



Figure 19. Original game Step 5 – The second Superpower – healing

In order to heal the wounded character, the user is instructed to use the Superpower selection again and trigger the first “Healing” Superpower. The operation is similar to the Superpower triggering described in Step 4. At the point the healing is complete, the red glow effect is removed and the wounded character is ready to fight again.

Step 6 The third Superpower - interrupting

In order to take advantage of the Superpower, the user should master the game skill of interrupting the enemy's Superpower. This skill can be achieved by triggering the character's Superpower while the enemy's Superpower is being charged. In the mobile version, while the enemy is charging its Superpower, a loading bar is shown on top of the enemy to alert the user. In the prototype, the design is similar to the original game. In this step, a loading bar is shown on top of the enemy boss, alerting the user that the enemy boss is charging its Superpower. The user is therefore instructed to trigger another available Superpower of their own character. The process is similar to the Superpower triggering described in Step 4. To designate that the operation is successful, the enemy boss's Superpower is interrupted, its health status is lowered, and the characters are saved from attack.

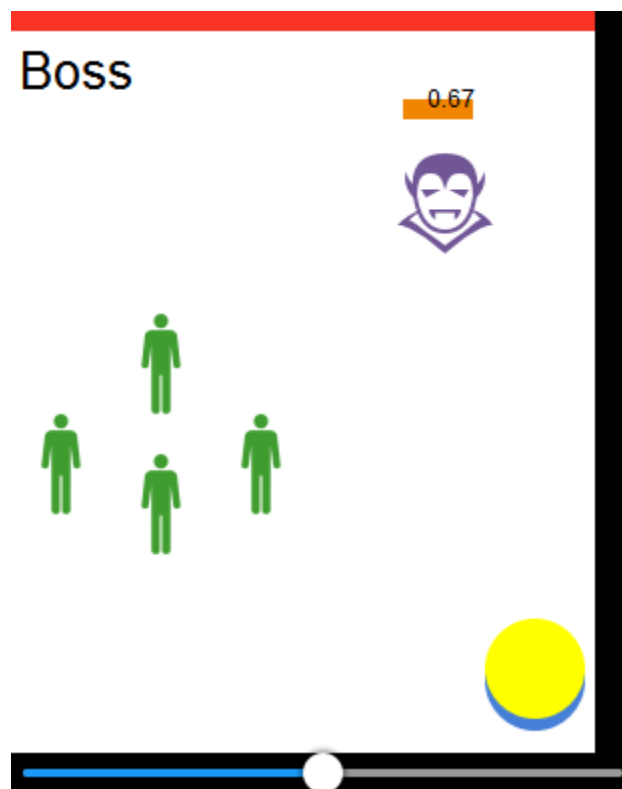


Figure 20. Prototype Step 6 - The third Superpower – interrupting



Figure 21. Original game Step 6 – The third Superpower – Interrupting

Step 7 End

In this step, the user is instructed to trigger the last available Superpower to beat the low health status enemy boss. The process is similar to the Superpower triggering described in Step 4.

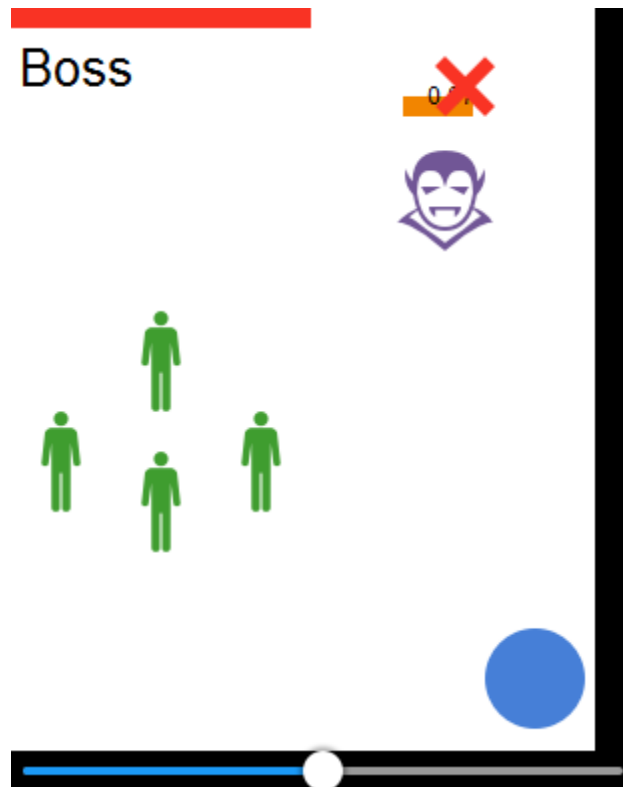


Figure 22. Prototype Step 7 – End



Figure 23. Original game Step 7 – End

Finally, the boss is defeated and the user wins the combat.

5.3 Summary

The prototype is explained in a step-by-step guide. The concepts brought up in the ideation and prototyping process were validated.

Chapter 6: Reflection and Evaluation

6.1 Introduction

In this chapter, I will reflect on the user experience design of the prototype and the creative-production process. This is the Reflection-On-Action in the reflective practice.

6.2 Reflection on the user experience design

Having developed the smartwatch game prototype, I had further reflections on the user experience design. There are four areas that I have come to understand.

First, it is important to evaluate whether the key user experience design challenges brought up in Chapter 4 have been solved. I used the design principles in the Apple watchOS Human Interface Guidelines (Apple Inc., 2015) as the benchmark.

Lightweight interaction: Much effort was made for lightweight interactions, including the cancellation of the manual pilot, using Digital Crown as enemy targeting/Superpower selection, and one tap to confirm Superpower. As a game player, both of the core game skills – focus fire and Superpower interruption – can be achieved by using Digital Crown. As demonstrated in Chapter 4, using Digital Crown is as fast as tapping on the touchscreen.

Holistic design: I modified the design and made the Superpower selection more seamless and created a stronger interactive experience in terms of the relationship between the on-screen activity and the use of the physical “Digital Crown” operation.

Glanceable: I tried to keep the look of the screen layout of the smartwatch version similar to the original mobile version as much as possible while eliminating unnecessary information to keep the screen layout concise. Efforts included the removal of the pause button, the removal of the gold collector, the removal of the character avatars, and only display the Superpower indicator while available. Even so, there is still room to improve the design of the Superpower indicator. In my design, the indicators are stacked if more than one is available. Although I chose this design to keep the screen layout concise, it is arguable that the user may not see the Superpower indicators more easily other than the top one.

Actionable: This is relevant to the above one. I removed the character avatars and the Superpower indicators are only displayed if available. This design was “ensuring that what’s on screen is always current and relevant” (Apple Inc., 2015, para. 4). However, the design of the low-health indicator can be improved. The characters’ health bars are removed alongside their avatars. So, the user needs to rely on the red glow effect to identify whether the character is in a low-health status. This effect may fail to catch the user’s attention during the game. Even though I developed several other designs to indicate the low-health status, these designs breach the “glanceable” rule mentioned above. So, I settled on the red glow effect.

Responsive: Although it's not obvious in the prototype, due to technical limitations, the smartwatch game always provides feedback to the user. For example, the visual effects are shown while Superpower/enemy targeting is triggered. Furthermore, the use of haptic feedback and sound effect can be researched in the future.

Second, it is a reflection on the general process of the user experience design. I did not carry out the research about the user as the smartwatch technology is too new and the persona of the potential smartwatch game players remained unknown while this research has been conducted. And I did not carry out the user testing due to limitations in terms of time and resources, and the lack of Digital Crown support in Apple watchOS SDK by the time the prototype was developed. Therefore, further research about the smartwatch game users along with the development of the smartwatch technology is necessary. Additional research is necessary to test the prototype as control of the Digital Crown becomes available in the Apple watchOS 3.0.

Moreover, although the colour palette and the typology are parts of the user experience design, they were not taken into consideration in the prototype because they are more relevant to the theme of the original game.

Third, it is a reflection on the interactive method. One of the major limitations of the prototype is that it is based on the Apple platform and utilises the Digital Crown. Although Apple is leading the smartwatch market as mentioned in Chapter 2, it is unpredictable whether the trend will continue in the future. The Digital Crown is patterned by Apple. The user experience of the prototype cannot be guaranteed while using other rotating devices, such as the bezel on Samsung Galaxy Gear 2. Many other smartwatches do not even have any rotating devices. Therefore, it is reasonable to conduct separate research related to smartwatch game interaction using only the touchscreen.

Fourth, the prototype only contains the combat system derived from the original game. Although the combat system is the core of the game it is also challenging to make smartwatch versions for other systems, for example, the main screen, the dungeon map, and the character upgrade system. In the original game, many interactions are required and it is also necessary to display an abundance of information in these systems. In order to design a fully working smartwatch version of Spirit Guardian, the user experience design of these other sections needs to be developed.

6.3 Reflection on the creative-production project

In the beginning of the research, I planned to make a real smartwatch game app by programming in Apple's Swift language. However, I decided to create a prototype instead. The reasons for this change are as follows.

First, the Apple watchOS 2.2.1, which was available at the time this prototype was being developed, does not support many critical features that I had planned to use, for example, the Digital Crown support. The Digital Crown support was announced at WWDC 2016 and comes with the watchOS 3.0. The watchOS 3.0 had not been released

at the time the thesis was started. However, with the official support of Digital Crown, the potential for further research based on this prototype exists.

Second, in spite of the fact that I was previously involved in the development of the game Spirit Guardian, I do not have programming experience. Therefore, I had to learn programming from scratch if I decided to use the Swift language. And programming an A-RPG is beyond my capability even if I manage to master the Swift language. Thus, I decided to forego the programming direction and use Proto.io to generate a prototype.

Meanwhile, there are several thoughts about the prototyping tool Proto.io. This is since I compared several prototyping tools and decided to use Proto.io. It has Apple Watch template support and a rich UI library that saves time. Nevertheless, one of the biggest disadvantages is that it does not support the Digital Crown, even after Apple announced official Digital Crown support in WWDC 2016. To solve this problem, I created a slider to simulate the interaction with the Digital Crown. Another disadvantage is that although Proto.io provides the iOS app for user testing, it does not have a smartwatch app. Therefore, user testing on the smartwatch is difficult. I argued in Chapter 4 that using Digital Crown as the interaction method is much better than tapping on the smartwatch's touchscreen. However, without the chance to deploy the prototype on a real smartwatch with a real Digital Crown, it is difficult to prove this point. The lack of a native Apple Watch app from Proto.io is the primary reason that no user testing was conducted that is possible to be included in this research.

Chapter 7: Conclusions

7.1 Introduction

In this creative-production project, I developed and presented a prototype of a smartwatch game, based on the mobile game Spirit Guardian. This prototype aims at addressing several user experience design challenges that arise from the smartwatch's tiny screen. The prototype was conceived through an iterative design process involving reflection in action and reflection on action. The theory has been put into practice by developing the prototype through the ideation, concept validation and refinement. The research process was documented and reflected.

7.2 Answering the research question

Research Question 1: What are the issues and challenges of making smartwatch games?

First, the most outstanding feature of the smartwatch is its small form factor. This leads to the constraints of restricted input/output due to the tiny screen, and the limited performance and battery life due to the small hardware. This research is about user experience design, therefore most of the findings aim at solving the problems caused by the tiny screen size.

The major smartwatch vendors realised the problem and provide guidelines for the smartwatch app developers to address the input/output issues. For example, the smartwatch market leader, Apple Inc., recommends “lightweight interaction” as the first rule in the Apple watchOS Human Interface Guidelines. It is considered as the biggest challenge in the making of the smartwatch game prototype.

Second, there is a problem that was not mentioned in the guidelines. While sketching the wireframe, I found that the finger may block the smartwatch screen by up to 40%. It's a prominent issue for smartwatch game developers as the finger could block the critical on-screen display that the player needs to make decisions in the gameplay. For example, the low-health warning and the superpower-ready indication are important in many A-RPG games.

Third, it is the technology limitations. At the time this research commenced, the latest watchOS available was 2.2.1. In this version, direct control of the Digital Crown was not possible. In watchOS 3.0, the feature was made available. However, the button next to the Digital Crown still cannot be utilised by the app as it's reserved for the task switch. The smartwatch app developers should pay attention to the limitations made by the smartwatch vendors, while more and more new features are made available in newer firmware versions.

Research Question 2: How to address the issues and challenges?

First, keep the core game mechanics and remove other interactions. Many of the mobile games have complicated game mechanics to keep the game amusing. However, lightweight interaction is important on the smartwatch as its input/output area is much smaller. Some of the elements that are not relevant to the core game mechanics can be removed for lightweight interaction. For example, in the demonstrated A-RPG mobile game, a gold coin collection counter is displayed in the game. This is to encourage the player to collect more gold coins. But it should be removed in the smartwatch version. The Auto Combat switch is removed as well and the system is automatically triggered, as the manual character control is not feasible on the smartwatch version.

Second, utilise the Apple's Digital Crown instead of the touchscreen. I mentioned the problem of the finger blocking the screen. The Apple Watch provides the Digital Crown to control the app without touching the screen. To avoid critical gameplay information being covered, it's recommended to utilise the Digital Crown. Some smartwatches other than Apple Watch provide similar input methods too. For example, Samsung Gear S3 features the rotating bezel. Moreover, the Digital Crown is proved to be as quick and precise, and even better, as the touch screen through several experiments in the research.

Third, provide on-screen feedback when using the Digital Crown. The user expects feedback when touching the button on the screen. Similarly, feedback should be provided when using the Digital Crown. The Digital Crown itself cannot provide feedback so on-screen feedback is necessary. In the watchOS, a tiny screen bar is displayed when the Digital Crown is used. In the smartwatch game prototype, the Superpower indicators are shown in the top right corner next to the physical location of the Digital Crown.

Forth, make sure the on-screen display is glanceable. Being glanceable is one of the design principles in Apple watchOS Human Interface Guidelines. On one hand, elements irrelevant to the core game mechanics should be removed as mentioned, to enhance the readability of the critical information. On the other hand, some elements that are not always important can be hidden until it's necessary to be displayed. For example, in the prototype, the Superpower indicators are only shown when the characters' superpower are ready to be used.

Fifth, pay attention to the consistency with the original game. If the developer is making a smartwatch version of the mobile game, consistency is important. The colour palette, the typography, and the on-screen display are expected to be similar to the original game as much as possible. However, due to the technology limitations, some of the consistency is not currently possible, for example, the complex real-time 3D animation.

Sixth, use haptic feedback and sound effect. This is not reflected in the prototype due to the limitation of the prototyping tools. However, it's worth mentioning that providing proper feedback is a part of good gaming experience. Although there are constraints of the hardware ability, most of the smartwatches are equipped with vibration or haptic generator and speaker to make the feedback possible.

7.3 Implications of the study and limitations of the findings

Given more time and resources, the prototype could have been fully-functional and allowed user testing. So that the findings can be evaluated in a more precise way. Further research with a fully functional prototype is recommended.

Moreover, this prototype is based on the Apple Watch platform, it may not work well on other smartwatch platforms.

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