Analyzing Interactive Digital Narratives and Mechanics in Mobile Augmented Reality Puzzle Adventure Games

Zixuan Wang

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Abstract

This paper provides a deeper understanding in the game design for particularly marker-less Mobile Augmented Reality applications. Many papers have gone into the user experience and techniques in Mobile Augmented Reality applications. This paper will analyze interactive digital narratives and mechanics in a small selection of mobile augmented reality puzzle adventure games through two frameworks in order to convey the relationship between them in these games. The purpose of the paper is to offer insights into what aspects in narratives and mechanics could be improved for the game design of mobile Augmented Reality puzzle adventure games.

Table of Contents

Introduction

Due to the increasing popularity of mobile devices worldwide, the widespread use of AR on mobile devices has become a growing phenomenon (Nincarean et al., 2013). Since the release of ARkit by Apple, developers can create mobile Augmented Reality Games based on this framework (Dilek and Erol, 2018). Therefore, it is important to analyse the game design of this new version of mobile games, mobile AR games.

The purpose of this study is to discuss on the interrelationship between the interactive digital narratives and the mechanics of mobile Augmented Reality games and provide practical suggestions to enhance users' immersion when application programmers design the mobile Augmented Reality games. Most studies of AR games only research on the attributes of AR (Kim et al., 2014), whereas few studies focus on the relationship between the narratives and the mechanics in the game design of interactive AR games. In order to explain what aspects in particular of the games are effective and what aspects can be improved, this paper will analyze a small collection of mobile AR games applying two frameworks. One is the Elemental Tetrad framework on games from Jesse Schell (2015) that analyzes the mechanics of the games, the other is the Interactive Digital Narratives framework from Hartmut Koenitz (2010) that analyzes the narratives in the interactive digital media.

Chapter 1 Background

1.1 Background of MAR

Augmented Reality (AR) has become one of the most popular research fields in innovative mobile application system development (Chang and Tan, 2010). Augmented Reality allows juxtaposing multimedia contents, for example, 3D animation, video, and audio on a real-time image which is captured by a camera (Guimaraes et al, 2015). In this way, Augmented Reality content is positioned between the virtual world and the real world. What is the difference between Augmented Reality and Virtual Reality then? The fact is that in contrary to traditional Virtual Reality, the real world environment in Augmented Reality is in a prevailing role rather than completely suppressed in Virtual Reality (Bimber and Raskar, 2005). Instead of immersing the user into a completely synthetic world, Augmented Reality embeds synthetic information while maintaining the view of the real environment captured (Guimaraes et al, 2015). Recently, as various enabling technologies such as object tracking, GPS, image recognition, sensors that measure location and orientation become available on smart phones, it is possible to make AR technologies delivered on mobiles devices. According to Carmigniani et al. (2010), AR applications can be classified into four types: the entertainment and education, the medical, the advertising and the mobile types. In this paper, we will discuss on the mobile types. Mobile Augmented Reality (MAR) is defined as 'generated by augmented reality and accessed in the mobile environment' (Irshad and Rambli, 2014).

MAR is divided into two categories which are marker-based and marker-less (Kim et al., 2014). Marker-based MAR application require a camera to recognize a specific marker, for example a QR code, in order to deliver the information. On the contrary, marker-less MAR means utilizing users' location data or image recognition technology from mobile devices, then superimpose virtual data related to an immediate environment. Therefore, in this way, marker-less MAR applications are not restricted by specific location (Kim et al., 2014). MAR is a good platform to tell a story because it can provide an immersive storytelling environment as a result of real-world locations and objects could be transferred into matters in the story that is simulated to users' imagination (Nam, 2014). In this paper, discussion on MAR games will focus on marker-less mobile augmented reality applications.

1.2 Technology in MAR

ARkit is a framework that has been released by Apple which enables the developers to build marker-less AR games on the iOS platform (Dilek and Erol, 2018). It is based on the technology of Visual Inertial Odometry that accesses the camera sensor data to track the position of the mobile device in the real world coordination (Dilek and Erol, 2018). However, ARkit also has some limitation and backwards in term of the technique. Dilek and Erol (2018) points out that the technique of ARkit is based on analyzing the feature points that are distinguished from the others in the captured scene. Therefore it requires that the captured image has to be eligible for that. If the lightness in the scene is not enough or the image is too blurred due to excessive shaking, the quality of the augmented reality may decline (Dilek and Erol, 2018).

ARToolkit is an open source toolkit that includes a library that supports marker identification and tracking (Henrysson and Ollila, 2004). It works by taking camera parameters and calculating the orientation of the camera at a marker image as an input, and then returns a transformation matrix. And the camera matrix contains two kinds of parameters, which are intrinsic and extrinsic. Together the two parameters are used to calculate the coordinates in a calibration procedure (Henrysson and Ollila, 2004).

1.3 User experience in AR games

User experience is defined as an individual insight or subjective concept of the experience of using technological devices or systems (Irshad and Rambli, 2014). As the MAR is an innovative and emerging format and platform for games to provide a vivid interface to digital contents, it is insightful to research on what aspects enhance the user experience in MAR games. Kim et al (2014) propose that there are four key factors that contribute to the user experience on AR applications. The first one is perceived usefulness, which significantly influences the continuous intention; the second factor is the perceived enjoyment, which is vital but not a guarantee of the success of an application though; the third one is the quality of the level of information which also affect the perceived of enjoyment to some extent; the forth factor is visual quality and interaction (Kim et al., 2014). Kim et al (2014) emphasize the positive influence of visual quality and interaction. They propose that through manipulation and interaction with the virtual objects, more perceived

enjoyment arises from the user experience of a mobile AR application (Kim et al., 2014). However, interactivity does not show a significant influence on perceived usefulness, which possibly because of the limited size of smartphones (Kim et al., 2014). Nevertheless, the kind of application that is discussed in this paper is game application which is more focused on the perceived enjoyment rather than the usefulness. In previous research, Nam (2014) proposes that AR interactive narratives can improve the user experience of in-situ narrative production, even it is a simple setup of AR system.

1.4 Puzzle Adventure games

Puzzle adventure is a genre of entertainment games, which consists of two types: one is Real Escape Games, the other is Electronic Puzzle Game (Li et al., 2013). In the Real Escape Games, players are locked in a sealed room During the game, the game player must find the clues in order to escape the room in a limited time. Usually, players are working as a team. They need to combine all the clues that are hidden in different locations in the room, and use the mental skills such as logic and knowledge to solve the puzzles (Li et al., 2013). Embedded narratives can be found through the logical design. Similarly, Electronic Puzzle Game also includes the puzzles and narratives, but it uses multimedia technologies to present the entire game scene (Li et al., 2013). The main purpose of puzzle adventure games is to provide challenges and interactions with the players (Zhou and Wu, 2012). In the Augmented Reality system, virtual objects are imposed on the real world environment in order to achieve the feeling that they are coexist in the same space, which is useful in the puzzle adventure games (Li et al., 2013). Therefore, Augmented Reality could be applied to them (Li et al., 2013).

1.5 Selection Criteria

Games are chosen based on these criteria:

1. Be a marker-less mobile Augmented Reality application
2. Be a puzzle adventure game
3. Have a plot in the game

The games chosen are as follows: *Shadows Remain*, *Yume* and *Silent Streets: Mockingbird.* All of the three games are released on the iOS platform. The first game *Shadows Remain* is a game full of horror elements. It is about a story of finding a lost person through finding clues

and solve puzzles in different kinds of rooms. It have very realistic visual aesthetics in the style of the rooms. The second one *Yume* is a game full of Chinese traditional elements. This game tells a story of helping a little girl call Ling to go back home. The third game *Silent Streets: Mockingbird* is about the adventure of a detective in a Victorian town. The players can examine the murder scene through AR technology in this game.

Chapter 2 Framework

2.1 The Elemental Tetrad

To analyze the mechanics in the puzzle adventure games, this paper will use the framework of the Elemental Tetrad of Jesse Schell (2015) which provides the methodology of analyzing mechanics in games. Schell (2015) proposes that there are four elements that support a game, which are the technology, the aesthetics, the mechanics and the story (see Figure 2.1). He emphasizes that the four elements are equally important in a game, but with different visibility. He proposes that the technology is the least visible, whereas the aesthetics embraces the most visibility to the players (Schell, 2015). And mechanics and story are in the middle level of visibility. Then Schell (2015) use *Space Invader* as an case to analyze the elements inside the game and proposes that the four elements in this framework should be aiming to the same goal in order to give the users the best experience. Schell (2015) proposes that game mechanics are the core of a game. Removing all of the technology, aesthetics and story, game mechanics are the interactions that remain (see Figure 2.1.). He presents a taxonomy to classify the game mechanics by six areas, which are space, object, actions, rules, skills, and chance. *Space* is defined as a mathematical construct in the game mechanic (Schell, 2015). Schell (2015) proposes that space should be analyzed both virtually and physically when stripping away all the aesthetics or visual elements. *Object* is the thing that the players interact with. According to Schell (2015), A*ction* can be divided into two perspectives: *basic action* and *strategic action*. *Basic action* means the base interaction that the players can do with the objects, whereas *strategic action* means how the players do with the basic action in a strategic way in order to achieve the goal. Therefore, basic actions contain strategic actions. He proposes that the rule is 'the most fundamental mechanic'. Because it defines how the space, objects and actions operate together in order to achieve the important thing that makes a game -- the goal. Skill is a mechanic that focus on the players rather than on the game itself (Schell, 2015). Schell (2015) proposes that the skill can be divided into three categories: the physical skill, the mental skill, the social skill. The physical skill involving strength and physical endurance. The mental skill means observation and puzzle-solving skills. The social skill includes coordinating with partners and fooling the opponents. Chance mechanic means uncertainty and randomness.
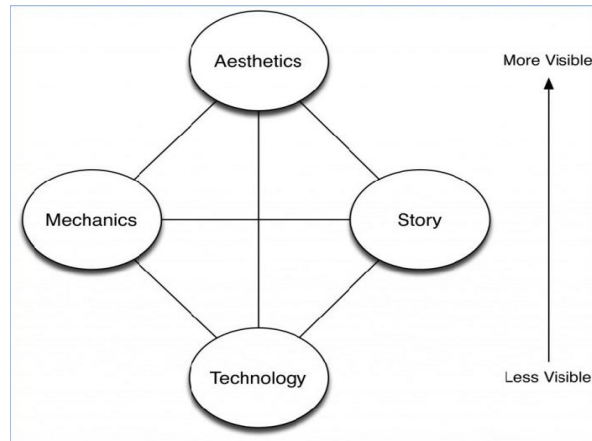
Figure2.1. The framework of The Elemental Tetrad (adapted from Schell, 2015)

2.2 A Theory of IDN

To analyze how the interactive digital narratives in the story improve the immersion and user experience of an AR game, this paper will use a theoretical framework for understanding interactive storytelling proposed by Koenitz (2010). He proposes a model of Interactive Digital Narratives (IDN) that is inspired by the theory of cybernetic art that came from Roy Ascott (1990). As a result of that interactive narratives were not easily applicable to the traditional theories of narratives since many theories are based on non-digital media. The purpose of this framework is to introduce a theoretical framework on analyzing the IDN in the emerging interactive narratives that is different from the traditional digital media narratives (Koenitz, 2010). Koenitz (2010) researches on the framework that is proposed by Janet Murray (2001) based on the theory of computer as digital media and propose a new framework. He mentions that the perspective of Murray (2001), in which she proposes that 'interactivity' and 'narrativity' are not segmented. Computer-based narratives are created by harnessing the availability of digital media and are enhanced through engagement so that the player would have the experience based on arousing and rewarding narrative expectations, as well as actively creating beliefs about the story world (Murray, 2001). Koenitz (2010) proposes that the view here reinforced the aspects of emerging interactive narratives. Then he refers the definition that was proposed by David Herman (2002) in the theory of augmenting narrative. Herman (2002) defines narrative as a tolerant, flexible cognitive framework for constructing, communicating, and reconstructing the world of spiritual projection. This definition is compatible with Murray's framework in the way that it

separates the narrative from a particular form or media and expands the possibilities and areas for experimentation. Koenitz (2010) proposes that Herman's definition on narrative also serves in his theoretical framework in IDN.The purpose of this framework is to introduce a theoretical framework on analyzing the IDN in the emerging interactive narratives that is different from the traditional digital media narratives (Koenitz, 2010).

Koenitz (2010) coins *system* as a term to describe 'potential narratives' which include all the digital assets that include the digital representations of images, sound, movie clips, texts. In addition, *system* also contains the hardware that is connected in the digital installation, including keyboards, mice, sensors. Therefore, the definition of *system* is that the digital artifact and the hardware that the artifact is executed on. Then he proposes another term called *process*, which means what the action of the user, which can also be interpreted as an interactor, shapes through the engagement of the user. A participatory *process results a product* that means an 'instantiated narrative'. Nevertheless any single *product* is a part of IDN, it's important to note that it represents only a specific instance that will alter once the process changes. Therefore, the *product* itself is strictly limited as a representative of IDN work in terms of theoretical IDN analysis. Koenitz (2010) emphasizes that a thorough analysis of any IDN should include a review of the *system*. Plot and discourse are usually brought up together in the manifestation of IDN (Koenitz, 2010). However, since the IDN *system* includes and encodes various aspects of stories and utterances by providing specifically expressed content and structure, it is no longer possible to distinguish between the two categories. Koenitz (2010) shows that If we intend to fully and properly describe IDN, these aspects need to be analyzed in the terminology.
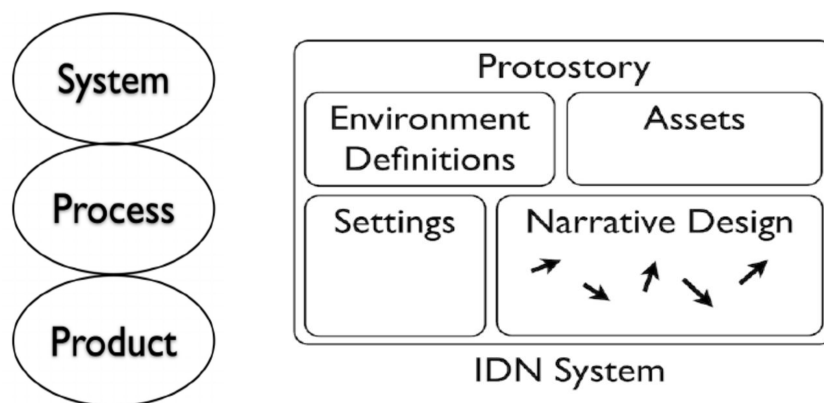

Figure 2.1. IDN framework (adapted from Koenitz, 2010)

This framework includes a term called *protostory* (see Figure 2.2)*. Protostory* is a 'procedural blueprint' to depict the specific content of the IDN *system* of potential narratives, which not only includes the programming codes, but also the artistic contents or assets that contribute with the realization of narratives (Koenitz, 2010). Instead of plot or discourse, he proposes a term called *narrative design* to describe both structure and content with a flexible manifestation. *Narrative design* contains the concept of *narrative vector* which means the logic of the sequencing of the elements and the relationships among them. *Narrative vector* depicts the plot points that proceed the development of story in order to prevent the player from getting lost in a plot (Koenitz, 2010). N*arrative vector* does not deal with isolated structure, but with the whole part of the narratives. Therefore, narrative vector is an important component to the whole structure for the reason that it makes sure the interactor is on the right track and trigger events.

From this perspective, IDN have a clear definition of a form of expressive narratives in digital media, implemented in a system containing potential narratives, and instantiated narratives that are produced through the process of participation of the interactor.

2.3 Analysis procedure

In the analysis of the games, we will first use the framework of The Elemental Tetrad to have a understanding of the four elements that support the game, which are the *technology*, *aesthetics*, *mechanics* and *story*. Then we will use the methodology of analyzing the *mechanics* from six perspectives in this framework. In order to analyze the interactive digital narratives of the element of *story,* the theory of IDN will be utilized. In this framework, *story* can be analyzed from the perspective of *system, which* contains four parts: *environment*, *assets*, *settings* and *narrative design*.

Chapter 3 Shadows Remain

3.1 Introduction to the app

Shadows Remain is a mobile augmented reality horror puzzle-solving game that is released in 2017 on the iOS platform. It is developed by Halfbrick Studio, which is the creator of Fruit Ninja and Jetpack Joyride. The players need to solve mind-bending puzzles under the mechanic of optical illusion in the augmented reality scenes in this game. Examining the hidden objects and finding mysterious clues are also a thrilling experience in this story-driven episodic adventure.

3.2 Mechanics

3.2.1 Space

Physically, Shadows Remain is a marker-less AR application, therefore the players are not limited with the locations. There is a instruction interface shown at the beginning of the game that elaborates what kind of physical space can gives the players the best experience of the game. There is a bar at the bottom of the interface that changes by the degree of the green color and the text of 'ideal' (see Figure 3.1) in contrast with the red color in order to show that to what extent can the players achieve the best experience out of this AR game.Virtually, the space of Shadows Remain is built on three dimensional box-like rooms. The players are shown to various kind of rooms that contains different kinds of puzzles.
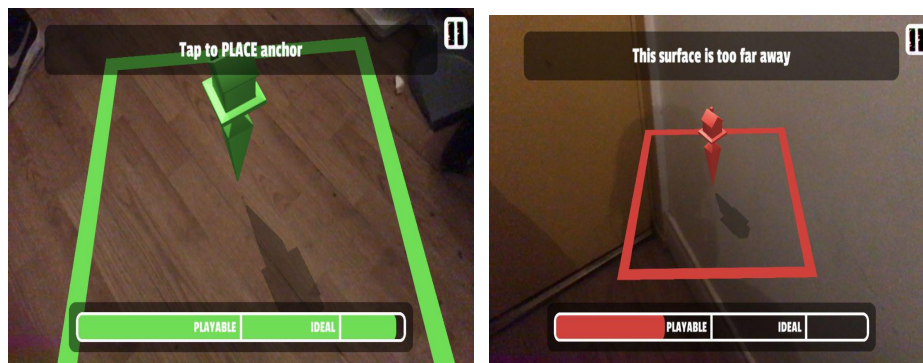

Figure 3.1. The text of the interface that shows it is 'perfect'

3.2.2 Object

The objects in Shadows Remain are varied. For example, all the paintings on the wall and boxes, doors, papers on the ground, the handles, etc. Different levels have various objects, but basically are the daily stuff in a room that people live in. It should be mentioned that the types of the objects in this game is very comprehensive and the number of the objects is

rather big (see Figure 3.3). From cereal boxes to little forks, almost everything in the room are the objects that the players can interact with, which increase the immersion of the game in the mechanics.

Figure 3.3. The objects in the scene

Figure 3.4. The fourth room

3.2.3 Action

Basic actions involves tapping, collecting and spinning. The players can tap on the objects in order to see more information about it and collect the key objects that are defined in each level. Also, the players can spin the room around in 360 degrees on the plane in order to have a thorough investigation and see each corners of the room to find the key objects. The spinning mechanic could also be concluded as a strategic action that is afforded by the AR game. There is also a spinning mechanic in the basic action, but here this mechanic is utilized strategically in terms of the definition of strategic action. As a result of that this is an AR game based on the optical illusion rule, the game requires the players to spin the perspective of view of the virtual space to achieve the specific image. Optical illusion is produced by a phenomenon called cognition Impervious, which is a particular adaptation of our vision system to standard vision condition (Bach and Poloschek, 2006). These adaptations have been "hardwired" into our brains, which may lead to inappropriate interpretation of the visual scene (Bach and Poloschek, 2006). So the players spin the room strategically to a specific position in order to achieve the optical illusion and solve the puzzle instead of just spinning the room randomly. The players can also spin the handles in a strategic way. In the fourth room, the players need to spin the two handles separately to adjust the positions of legs, arms and head of the wooden puppet to the right place. And then spin the perspective of view of the whole room to achieve the optical illusion. This is a good example of enabling the spinning mechanic in two different strategic way: spinning the room

and the handles, which increase the complexity of the puzzles for players to solve.

3.2.4 Rule

The rule of Shadows Remain is collecting the key objects and then achieving a certain image by spinning the perspective of viewing the room based on optical illusion which is afforded by AR games. Then the players can enter the next room, or level. There is a consequence among these mechanics that is fixed by the rule. The players cannot trigger the optical illusion until they have collected enough key objects. Also, the players cannot enter the next room until they have finished the optical illusion mission.

3.2.5 Skill

Physically, this game requires little physical skills. The players just need to move around a bit indoor through the game. Mentally, Shadows Remain requires the players with both good observation skills and puzzle-solving skills. With regard to the rules of this game, the players need to observe the room to find key objects and solve the puzzles. Therefore, this game is high demanding in players' mental skills. Socially, this game requires no social skills as it does not involve any social mechanic.

3.2.6 Chances

This is no randomness or uncertainty in this game.

3.3 Technology

This game is built by ARkit. So this game is only playable on iPhone or iPad.

3.4 Aesthetics- visual and audio

The visual style of Shadows Remain is cinematic and realistic. Aspect ratio refers to the ratio of the width and height of the screen (Kirby, 2019). And in this game, cinematic aspect ratio is applied in order to create a sense of watching a movie for the players (see Figure 3.4). The visual design of the rooms is very close to the daily life layout of rooms. There are a puppet and a ominous wooden fake leg remain in the rooms. The puppet and the leg are the illusion of the 'shadow' which echoes the title.

There are fives rooms in total. The first room is a living room with dimmed lights from the television. The aesthetic style of this room is dark and depressive, which foreshadows the atmosphere of the story (see Figure 3.3). The second room is another living room that belongs to a couple. In this room, there is a Christmas tree standing and it is snowy outside

from the view of the window. The aesthetic style of this room is warm and lovely, which is contrary to the style of the first room. The players can see the sunshine and the particles of the dust in the air, which is very realistic and immersive (see Figure 3.4). The third room is a kitchen which also has a warm style with sunshine through the window. The fourth room is the bedroom of the couple. The style is a bit dark and depressive, but overall not scary (see Figure 3.4). The fifth room is the final room with the most dark and terrifying visual style. It seems to be a studio where to make puppets. Rusty machines, scary puppets with no eyes,wooden legs and arms of puppets hanging vertically create a weird and thrilling atmosphere. Handles are designed to be visually easy to understand its mechanics that can be spun around to change the positions of the wooden legs and arms. Due to the fact that audio usually plays a significant role in this specific genre of games aiming to create an atmosphere of fear and uneasiness (Kromand, 2008). Audio in a game can purposely add the uncertainty between the diegetic and non-diegetic narratives (Kromand, 2008). Shadows Remain is a horror game, therefore the aesthetics of audio is also playing an important role in creating immersion to the players. Immersion through sound in this game comes from a variety of aural objects. For example, the ringing sound of the phone, the sound of the suddenly opening door, the sound of wooden handles when the players spin the handles. The sounds are stereo, as a result, the players need to wear headphones in order to experience the immersion of the sounds. Moreover, the volume of the audio in this game is changing by the distance from the players to the AR scene. For example, in the first task, the players need to tap on the phone in order to pick it up. If the players are far from the scene, the volume of the ringing is lower, which is an innovative way of audio aesthetics.

Shadows Remain combines the visual and audio aesthetics properly. For example, at the beginning, the protagonist, the mother is awakened by the ringing sound of a phone. In this part, the players are shown to the lighting object, together with the sound of the ringing. In this way, the players can be immersed inside this game immediately. Moreover, after the protagonist picks up the phone, the voice in the other side is mixed with acoustic current in order to enable the players with a feeling of really calling someone. The vocal sound of the protagonist is through the whole game, which gives the players a cinematic sense.

3.5 Story

3.5.1 Environment

The environment of Shadows Remain is based on three dimensional graphics using optical illusion to solve puzzles.

3.5.2 Assets

The assets of this game contains texts, graphics, videos and audios. The texts include the introduction of the developers of this game, the instructions for the mechanics and the subtitles through the game which can be turned off in the setting interface. Subtitles are important for the reason that it is a story-driven game, including subtitles in the game not only makes the players understand the story better, but also complies to the cinematic style of this AR game. The graphics include the three dimensional model of the room and the auxiliary graphics to assist the players to achieve the optical illusion. After the player tapping on an object, there is a three dimensional model of this object shown that the players could have a thorough inspection of it. The movie clip at the beginning introduces the developers and also the environment of the whole story happens in a cinematic way. Videos also play a role of the transitions between each level. After the players enter the room, there is a short movie clip with the vocal of the protagonist expressing her feelings about this room, which create strong immersion in this game. Videos are also the triggers to the optical illusion puzzles. As a result of the mechanics of this game, the players have to collect enough key objects in order to trigger the puzzles. So the videos here are utilized to remind the players that they can start using optical illusion to solve puzzles. The audios in this game including the background music and vocals are an important element in narratives . The background music at the beginning is very thrilling. The vocals not only tell the story but also play a role of instructor. For example, in the first room, the first mission is to find the phone which is ringing ans is lit up. Then there is a text that tells the players to find the lighting object. If the players tap on the wrong object, there will be the audio of the protagonist saying 'I should probably find the phone first' or 'That's definitely not a phone' (see Figure 3.3). The interaction between the game and the players is completed through audios.

3.5.3 Settings

The user interface is designed in a black and white style which is clean and easy to

understand. There are many instructions that consist of texts and images to explain the space and the mechanics (see Figure 3.9).
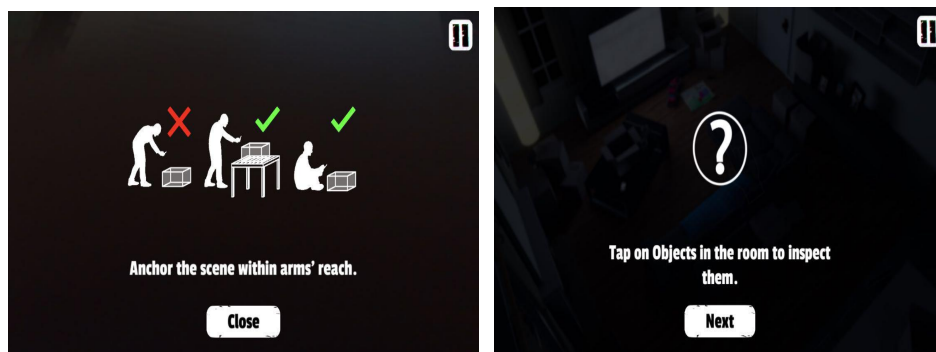

Figure 3.9. Instruction on space and mechanics

3.5.4 Narrative Design

Overall, it is a linearity narratives game, however, not completely. Because the players can have a choice at the end of the game. Therefore, the story in the game is multi-linear narratives, which means that there are alternative paths or varied chains of events based on the players' decision between the starting point and the end point of the story (Neitzel, 2014). The combination of the linearity and non-linearity is innovative for the puzzle-solving games, especially AR games. The narrative vectors in this game are formed by videos. Cut scenes are usually found at the beginning of the game, introducing the location and time of the action, the protagonist and possible goals (Neitzel, 2014). For example, at the beginning, a video of the protagonist complaining about the ringing phone inside a dimmed living room is shown to the players, then the players have to follow the instruction to find the phone in order to convey the fact that the protagonist's son is missing. Then after that, the players will enter the second room and be shown to another video in which a man requires the players to find a canary. Therefore, the videos in this game are playing a role as narrative vectors.

Chapter 4 Yume

4.1 Introduction to the app

Yume is a fantasy AR puzzle-solving mobile game released by NetEase Studio on the iOS platform in 2017. It tells a story of a Chinese girl called Ling who loses her memories enters into her dream of ancient China to find her memories back. 'Yume' means dream in Japanese, so dream is the theme of this game. Yume uses optical illusion combined with AR technology to create puzzles, involving a lot of complicated and detailed calculations and comparisons by the application, in order to give the correct feedback at the right time. Through solving the puzzles, users will help Alice to shuttle through multiple dreams and retrieve the fragments of her secrets in the story.

4.2 Mechanics

4.2.1 Space

Physically, this is a marker-less AR application, so the users can play this game wherever they like as long as there is a flat surface. There is no instruction in this game on where to play it. Therefore, the physical space completely depends on the users. The flat surface in the physical space is essential to this game as a result of mobile AR applications superimposing 2-dimensional or 3-dimensional graphics on the top of the perspective of the real world (Kounavis, Kasimati and Zamani, 2012), which means beneath the virtual graphics, there is a real world plane that appears in the camera. In this way, the vision that appears on the smartphone , which includes both the real world images and the virtual graphics will enhance the credibility, thus increase the immersion of the users. The virtual space of Yume is varied with levels. Each level has a different virtual space, which make the players feel a sense of curiosity to explore the virtual space.

4.2.2 Object

Because it is a puzzle-solving game, it involves with various kinds of objects for the players to utilize in order to advance the game. The objects in each level are different, but the objects that the player can use and move around is limited to one kind in a level. For example, in level four, the object is the blocks that are similar to dice, however, not exactly dice (see Figure 4.1). And in order to solve the puzzle, the players should align the blocks properly according to the different numbers on them. Then there is nothing else that is usable or

changeable except for the blocks. In level two, the objects are the lightening blue arrow-figured buttons on the pillar. One is pointing to the left, while the other is pointing to the up. Through tapping on the buttons, the player can move the positions of the squared blocks with patterns between the two pillars. Also, the arrows-figured button is the only object that the players can interact with in this level.

It is reasonable that the object is limited in a puzzle-solving game as a result of preventing the players from messing around and getting confused and then failing to solve the puzzle.
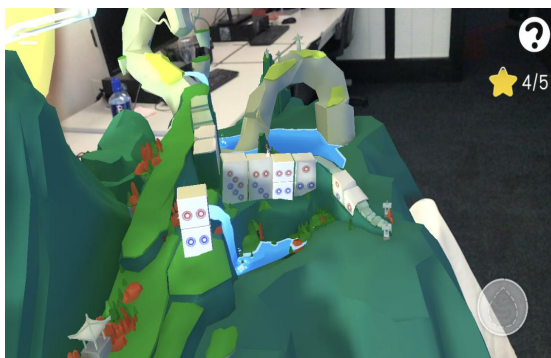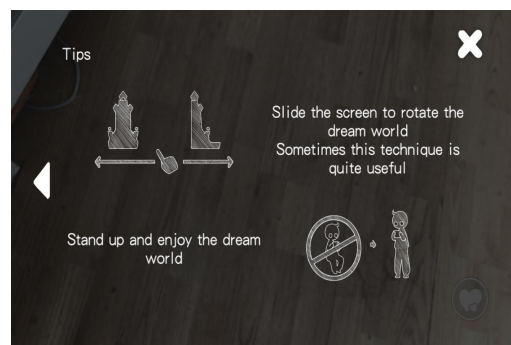

Figure *4.1*. The dice-like objects

Figure 4.2. Instruction for movement mechanic

4.2.3 Action

The way the players interact with the object is through tapping, spinning, collecting and moving. The players can tap on the buttons, spin the blocks, collect objects and move. The main character Ling is not controllable, all the actions of the players are dealing with the puzzles. In the collection mechanic, players can collect the objects that are shining on the ground. However, this mechanic is not told by text or image. Therefore, this is a mechanic for those who have curiosity on exploring the game world. After collecting, players can look back to their collections in the 'setting' interface The movement mechanics in Yume is afforded by AR games (see Figure 4.2.). The movement mechanics requires the players themself to move physically in order to play under the rule of optical illusion which is not common in non-AR games on mobile devices.

There are some emerging mobile games also use optical illusion as a mechanic, for example, *Monument Valley* is a representative game in which the players interact with the environment based on optical illusion mechanic to solve the puzzle and find the exit on the map. However, what it lacks is the mechanic that the movement of the players, which is a special mechanic afforded by AR games. Some puzzles cannot be solved if the player remain one position.

4.2.4 Rules

The players cannot control the protagonist. Only if the players solve the puzzle successfully, can the protagonist Ling move on the map. So the rule is solving the puzzle by interacting with the specific objects inside the game world environment.

4.2.5 Skills

The players need some understanding of Chinese in order to play this game. Before the players enter the next level, a poem will show up on the screen which hides the hints for the puzzle in the next level. For example, the poem shown implies that there will be two mountains that stop the protagonist from moving forward. Then the players may reckon that they need to solve two puzzles in this level for the reason that there are two mountains in this level. Therefore, some level of understanding of Chinese is required to get the full game experience from Yume (see Figure 4.2.). However, the players who have no knowledge of Chinese can also play this game since this game supports various languages, including English. But we can see that, the translation from Chinese to English is not very accurate, as the important number 'two' is not implied in the English version (see Figure 4.4.). Therefore, there is some information missing in the English version, which is less friendly to the English-speaking players.

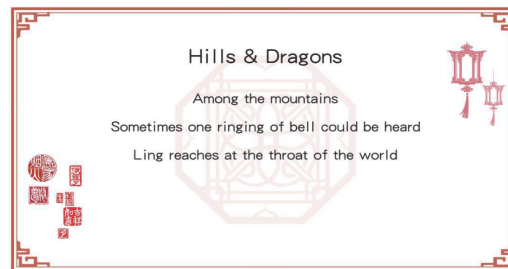*Figure 4.3.* The Chinese poem in the game   *Figure 4.4.* The English version

4.2.6 Chances

There is no randomness or uncertainty in Yume. All the puzzles are designed with one correct solution. So there is no randomness for the players to find other way to access the next level.

4.3 Technology

The tools that Yume uses to achieve the augmented reality is ARkit.

4.4 Aesthetics -visual and audio

Overall, the visual style of this app is abstract, cartoon stylized and full of traditional Chinese style elements. It is outstanding in integrating Chinese elements with the structures and buildings to display the puzzles. For example, the 'dragon' which appears in level four (see Figure 4.5). is well combined with the mountains. The dragon is cartoon stylized and traditional as it is well known that dragon is Chinese traditional characteristic symbol.

Figure 4.5. The dragon in the room   *Figure 4.6.* The map

On the contrary, the design of the map is rather realistic, which mimic the real map in ancient China(see Figure 4.6). The overall style of the map contains the traditional ancient Chinese painting elements. For example, the figure of the cloud, the ancient-China stamp stylized text and the figure of river (see Figure 4.7).
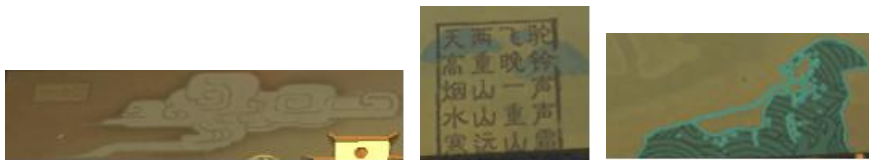

Figure 4.7. The cloud, text and river

There is a background music in this game varied in different levels and sound effects when users push a button. The background music are pieces of traditional Chinese music that are consistent with the story of Ling of finding her memories in ancient China. For example, in level two of Yume, the game world is set in a desert, therefore the music includes the sound of flute that aims to create a feeling of immersion for the players to feel like standing in a real desert alone.

4.5 Story

4.5.1 Environment

The environment of Yume is built on three dimensional geometric graphics that are projected on the real world environment. And the puzzles are based on geometric design in the three

dimensional view.

4.5.2 Assets

The assets of Yume consists of videos, texts, sound and graphics. The main character of Yume is the little girl Ling (see figure 4.8) which is shown in a small three dimensional graphic which is not a controllable object.

Figure 4.8. The graphic of Ling

Most of the graphics in Yume are three dimensional in terms of it is an AR game, however, two dimensional graphics are also used to elaborate the information that the developers want to show to the players. For example, in the 'collection' function, what the players have collected through the game are shown in images and together with texts to explain the meaning of it in Chinese tradition (see Figure 4.9).
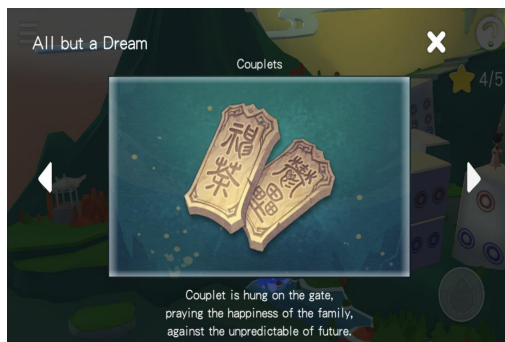

Figure 4.9. The collection   *Figure 4.10.* The opening video

The level interface is designed as a three dimensional map (see Figure 4.6.), on which each level has an image that implies what the main theme of this level is.

4.5.3 Settings

The user interface design is clear and easily understood (see Figure 4.11.). There are seven buttons in the function list, all in white and clean style. The first one is 'close' button, which means close the button list; the second one is the 'back' button, which means get out of the level; the third one is the 'restart' button, which means restart this level; the forth one is the 'camera' button, which means the players can screenshot whenever they feel like to; the fifth one is 'collection' button, which means the players can see the objects they pick up through the game; the sixth button is 'user' button, which contains the players' account information;

the seventh button is 'setting' button, by which the players can change the volume of the game and the language (see Figure 4.12.).
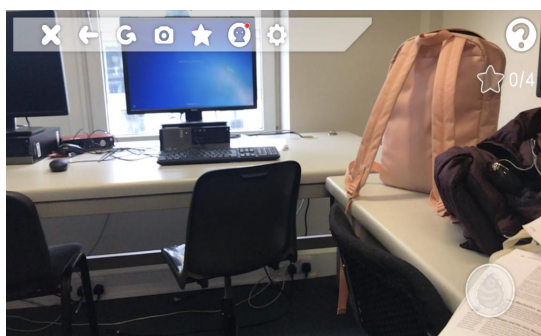

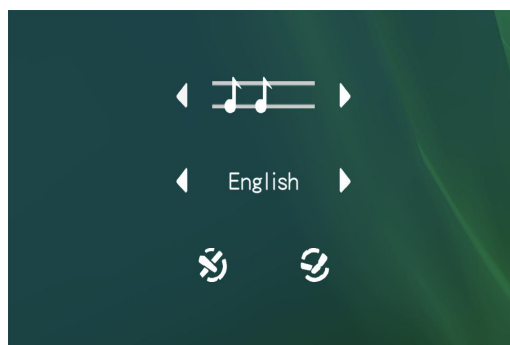Figure 4.11. The user interface   Figure 4.12. The setting interface

The question mark on the right top of the user interface is the 'help' button, which gives the players the information on how to project the dream world on the tabletop at the start (see Figure 4.13.). The user has to enable the camera of the phone and find a platform to in order to access the game. There is a grid shown that helps the user to find the platform more easily (see Figure 4.14.). Also there is texts that tells the user to press the button after deciding the platform.

Figure 4.13. The instruction of projecting   Figure 4.14. The grid assisting the projection
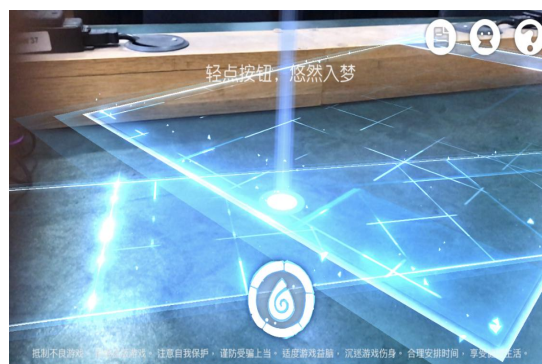
In terms of saving and restore function, Yume does not have the save button, which means the data are stored automatically. As a result, players don't need to save the process, which is a good design. Because the act of saving a game is taking the players outside the game world, which is harmful to the immersive experience of the players (Adams, 2014).

4.5.4 Narrative Design

This is a completely linear narratives based game. The player follows the storyline in each level and does not influence the plot development. The player faces the puzzles designed by the developers as he goes through the story. And actually the puzzles form the main part of

the story. The narrative vectors in this game consist of videos and the images with texts. The movie clip at the beginning of the game introduces our protagonist -- Ling who is sitting besides the sea, looking at the reflection of herself (see Figure 4.10.). And there is a text that tells the user that she is in a dream. This opening sequence has made a good introduction to the game world and set the stage for users to follow. The images with texts are the main narrative vectors because it is a linear story. So the players need to follow the map and the texts to know what will happen next. It should be noted that the texts after each level contain the hints of the puzzle in the next level, which encourages the players to read the text and therefore get a better understanding of the plot.

Chapter 5 Silent Streets: Mocking bird

5.1 Introduction to the app

Silent Streets: Mocking bird is a detective story-driven mobile augmented reality game combining an in-built pedometer, which was released by Funbakers Studio in 2018 on the iOS platform. This game will allow players to return to the dark world of the Victorian town of Snowport and solve a series of terrible murders in and around the boxing world behind the scenes. The game tasks the players to walk around in the real world physically in order to reach the location on the map to accomplish the missions, which allows the players to participate in real-world exploration via augmented reality. At the beginning of 2010, it seems that AR is gaining attention, but it soon dropped until Pokemon Go repopularited it. Silent Streets uses Apple's ARKit to implement the augmented reality part of the game and has integrated augmented reality has been with the detective story well.

5.2 Mechanics

5.2.1 Space

Silent Streets: Mocking bird is a marker-less AR game, therefore the players are not limited with regard to the location. It should be mentioned that it requires the players to move physically in the real world. And steps are calculated by an in-built pedometer, therefore the space of this game physically is the whole real world. Virtually, the game contains both two dimensional and three dimensional environment. In the dialogues with the non player characters (NPC) in the game, the players are shown to the two dimensional interface (see Figure 5.3), whereas in the process of finding clues on the scene, the players are immersed into three dimensional space (see Figure 5.2).

5.2.2 Objects

Unlike Shadows remain, in which the players can interact with objects that are not the key objects, the objects in this game are limited with the key ones. The players can also interact with the texts in order to push the storyline. The objects include the lamp on the desk, the shelves that can be opened, the certain part of the corpse, etc. Innovatively, there is a blue spectrum viewer that assists the players to find the clue.

5.2.3 Actions

The basic action that the player can apply to the objects is simple in this game, just tapping.

The players tap on the key objects in order to collect them. Moreover, the players can tap on the texts to choose their answers when being questioned or what they would like to ask about the suspect. Besides this mechanic, *Silent Streets: Mocking bird* also include the movement mechanic that is afforded by AR games. However, unlike Yume, in which the players move physically just inside the room in order to achieve the optical illusion, *Silent Streets: Mocking bird* encourages the players to walk outside in order to feel like a real detective. Therefore, *Silent Streets: Mocking bird* requires the players to move much more physically in the movement mechanic. Because the players just need to walk no matter where so it is not a strategic action. The strategic action in tapping mechanic is to tap on the blue spectrum viewer to enable the special vision in order to find the clues more easily.
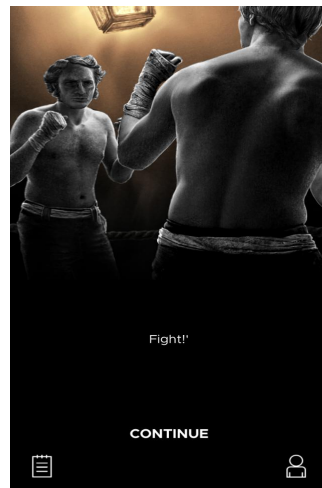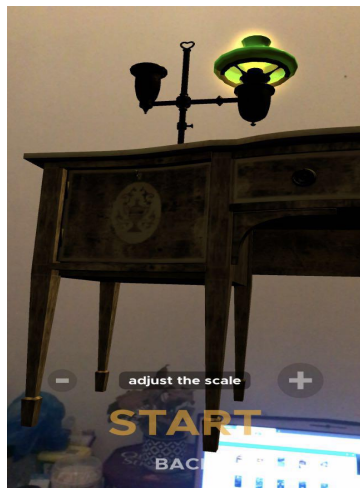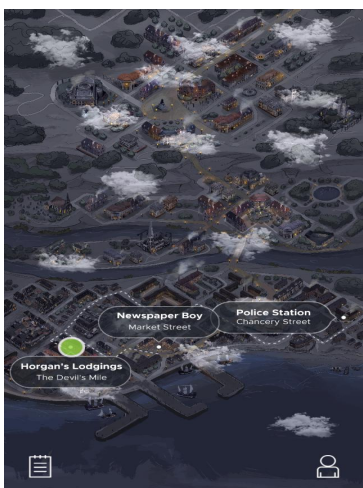

Figure 5.1. The map   *Figure 5.2.* The unsuccessful AR Projection   *Figure 5.3.* The plot of boxing

5.2.4 Rules

There is a rule with regard to the tapping mechanics. The player can only tap ten times in limited time when examining a scene. Therefore, this rule creates a challenge for the players to avoid keeping tapping wildly, which is opposite with the rule in Shadows Remain that it would like to see the players tapping and searching around randomly. This rule not only creates an intense and nervous atmosphere but also prompts a challenge to the players. Another rule is that the players have to find all the key objects in order to enter the next mission which is similar with the rule in Shadows Remain. In terms of the movement mechanics, the rule is related to the map (see Figure 5.1.). The longer the distance of the objective location on the map, the more steps the players need to walk. The players also have other options of waiting for a couple of minutes or riding a cab which means accelerating the

process by just one click if they don't want to walk.

5.2.5 Skills

The skills required in this game are both physical and mental. Physically, the players need to have the ability and stamina to walk around in order to achieve the best experience of being a detective who is walking around the city to solve the puzzles of crimes. Mentally, as a detective game, it requires high observation and puzzle-solving skills. Moreover, according to the rule of limited tries and limited time, the players need to have enough spirit to solve problems under the pressure. Furthermore, it also requires good memory skills and decision making skills because the players need to remember the details of clues for the reason that there are plots in which the the players are asked about the detail information of the victim by NPC. Socially, it requires no social skills in this game.

5.2.6 Chances

This is no randomness or uncertainty in the mechanics.

5.3 Technology

This game is built by ARkit.

5.4 Aesthetics- visual and audio

The visual design of this game is classical Victorian style. The interface is utilizing with realistic black and white style with color accent. The images of the characters are drawn in black and white in two dimensional graphic. The audio design consists of vocal and background music. In the dialogue with the NPC, the players can hear their voices that are immersive and vivid. The background music is thrilling and complied to the main style of murder and crimes. However, there is no sound for the tapping mechanics, which leads to the occasions that the players have no idea whether they have tapped on the right thing.

5.5 Story

5.5.1 Environment

The environment of *Silent Streets: Mocking bird* is based on the physical movement in the real world and using AR technology to impose a three dimensional model in the real world. However, unlike Yume or Shadows Remain, this game does not require the players to find flat surfaces. Therefore, the players can impose the AR models wherever in the three dimensional space. But this cause the problem of unrealistic experience for the players if the

player does not place it well (see Figure 5.2). But *Silent Streets: Mocking bird* includes the function of scaling the size of the scene, which can help the players to make adjustment to the scene in the augmented reality environment.

5.5.2 Assets

The assets in the interactive digital narratives are graphics, texts and sound. The story is conveyed to the player in scattered parts and the assets are presented in different ways: verbally at the beginning of the game and through the tasks; through the NPC's monologue in audio , visually cut scenes of graphics.

The texts are the main assets in this game. Unlike Yume or Shadows Remain, the plot of this game is manifested by texts. Also, the players need to make decisions that will affect the path they take throughout the story by choosing different texts. The game provides hints about where is the next place the players should go to by texts, but the players can ask the right NPC about the right questions and show them the right items to get vital information and in order to complete the sideline tasks. There is background sound for each image in order to better depict the plot. For example, in the scene of the boxing competition, there is people's noise and cheering sound in the background which is very immersive together with the image (see Figure5.3). Therefore the combination of sound and graphic is good in this game.

5.5.3 Settings

The user interface is clean in black and white. The color of the texts is white. The player can start a new game or restore the purchase to go back to the chapter. In the 'credit' interface, the players can see the information of the developers of this game. In the 'language' interface, the players can choose from six different languages. There are two icons that are always shown on the interface. The one on the left contains three lists of information that the players need inside the game(see Figure 5.4). The players can switch among the three lists. The first list contains the mainline missions that the players need to do. Missions will be crossed off once the players accomplish them. The second list contains the key clues that the players have collected from the AR scenes. The third list includes the introduction of each Non Player Characters verbally and the pictures of them.The right icon with a figure of a man contains the information of the personal achievements of the players. The first list indicates

the case progress by counting the steps that the players have made so far. The second list contains the achievement standard by the amount of steps. The third list includes the optional quests. Therefore, the players can have a knowledge of the other tasks besides the ones in the main storyline (see Figure 5.5).
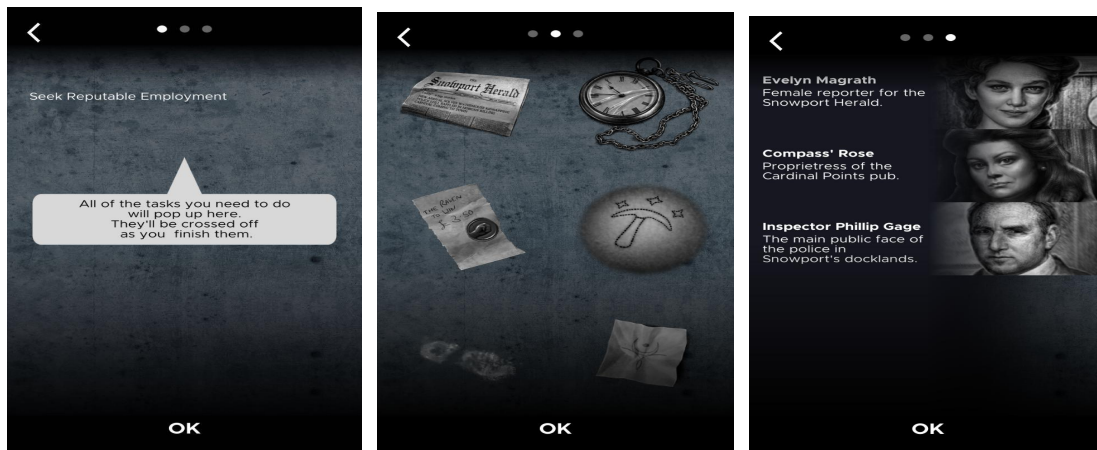
Figure 5.4. The information lists
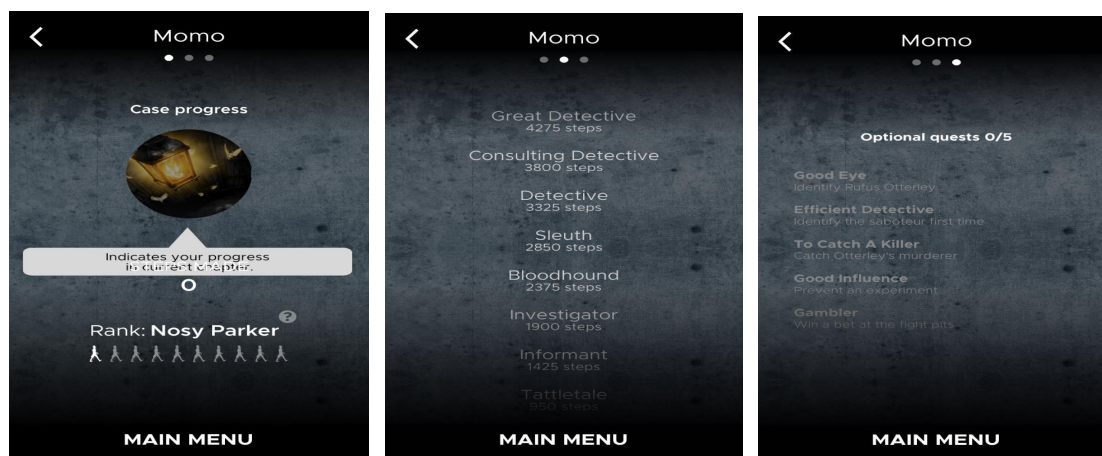
Figure 5.5. The list of personal achievements

5.5.4 Narrative Design

This game is multi-linear, unlike Yume, which using a linear path towards the end point: starting from an initial situation, following a chain of events, this game has different paths that depend on the decision of the players. The narrative vectors in this game are formed by the dialogues with the NPCs. For example, the event that players talking with Mrs Otterley leads them to the storyline of her missing husband. Then after the players talking to the Inspector, they are led to the storyline of the murder. Therefore, through interacting with the NPCs through texts, the players are on the right track of the plot.

Chapter 6 comparative Analysis

In this chapter, comparative analysis of mechanics and narratives among the three mobile Augmented Reality games, *Shadows Remain*, *Yume*, *Silent Streets: Mockingbird* under the two framework which are The Elemental Tetrad and The Interactive Digital Narratives model are presented. The intention is to summarize and compare the kinds of digital narratives and mechanics used in this type of games would improve the user experience of a mobile Augmented Reality game and what kinds of narratives is beneficial to the mechanics.

6.1 Narratives in puzzle-solving games

	Environment		Assets				Setting		Narrative Design	
	Marker-less	Marker-based	Graphic	Text	Video	Audio	Automatic saving	Manual saving	Linear	Multi-linear
Shadows Remain	X		X	X	X	X	X			X
Yume	X		X	X	X	X	X		X	
Silent Streets: Mockingbird	X		X	X		X	X			X

Table 6.1. Comparing the narratives system

As table 6.1 shows, all of the games are marker-less AR games. The technologies they use are all ARkit, which is aiming for developing marker-less Augmented Reality apps. ARkit utilizes the camera to capture the image of the players' real world environment, therefore, it does not require an marker to define the coordinate of the players. In other word, it gives the players more freedom in the locations and more immersion in narratives comparing with their experience in marker-based games.

In terms of the assets of narratives, all of the three games include graphic, text and audio. Therefore, these three assets are essential in narrating in these games. Two of the three games also have videos to work as cut scenes between different levels in order to elaborate

the story better. Video is not an essential element but an asset that can be used to advance the plot and in that way improve the narratives.

All of the games use automatic saving in the setting. Because according to Schell (2015), manual saving is a setting that destroys the immersion into the games as it distract the players' attention from the game world to the reality. Therefore, it makes sense that all of them employ automatic saving.

Shadows Remain and *Silent Streets: Mocking bird* use multi-linear narratives in the game, whereas Yume choose the linear narratives. A game with just linear narratives offers limited freedom for the players, which may easily makes the players feel boring (Neitzel, 2014). Compared with the other two games, *Yume* is weak in narratives. The linearity of story could be a reason for that.

6.2 Mechanics in puzzle-solving games

	Space		Object		Action				Rule	Skill			Chance
	3d	3d+2d	Small amount	Large amount	Tap	Move physically	Collect	Spin	Optical illusion	Physical	Mental	Social	Randomness
Shadows Remain	X			X	X		X	X	X	X	X		
Yume	X		X		X	X	X	X	X	X	X		
Silent Streets: Mockingbird		X	X		X	X		X		X	X		

Table 6.2. Comparing the mechanics

It is shown from Table 6.2 that tapping, collecting and spinning are the major actions that all of the three games have. Spinning is an essential mechanic afforded by AR games, because the players need to spin their perspective of view of the three dimensional graphics in the

games. Tapping and collecting are the major mechanics in puzzle-solving games because the players need to collect the clues in order to proceed the plot. All of the three games requires mental skills and physical skills. Puzzles are challenges of observation skills and memory skills for the players. Besides the mental skills, all of them also require physical skills. *Yume and Shadows Remain* only require a small amount of physical movement indoor, however, *Silent Streets: Mocking bird* encourages the players to walk outside and uses the in-built pedometer to calculate the steps. It is interesting that it is shown from the table that *Yume* and *Silent Streets: Mocking bird* utilize different rules: one is optical illusion, the other is calculating steps, but they both require physical skills. None of the three games involves social or the chance mechanic. However, according to Richard Bartle (1996)'s research in the theory of *taxonomy of players,* the vast majority of the players are *Socializers,* which made up the 80% of people. The *Socializars* gain fun through interacting with other players and collaborating in order to achieve a bigger goal (Bartle, 1996). Therefore, in order to cater for the majority of the players, these three games should explore the possibility of adding social mechanics into the puzzle games. Chance is an essential part of a game because chance means uncertainty which provides surprises to the players and improve the user experience (Schell, 2015). According to Bartle (1996), the other 20% of players consist of the *Achiever*, the *Explorer* and the *Killer.* He proposes that the *Achievers* like collecting and gaining more points and achievements in the game, whereas the *Explorers* do not care about points or prizes. Instead, they like to 'unlock' new areas in the map and puzzles in the game (Bartle, 1996). Because chance mechanic can add more uncertainty to the game, it is a way increase the user experience of the *Explorers* as they like to unlock the randomness. However, there is no chance mechanic in these games. Therefore, the possibilities of integrating the social skills with the mechanic and add chance mechanic to increase more randomness could be the areas of designing AR puzzle-solving games.

6.3 Relationships between narratives and mechanics

	Collecting	Optical illusion	Physical movement	Puzzle-solving
Graphic	X	X	X	X

Text	X	X	X	X
Video				
Audio				

Table 6.3 Comparing what narrative assets support the mechanics

Furthermore, table 6.3 shows that the video does not support any of the major mechanics in the three games. On the contrary, the graphic and text support all of the mechanics which including collecting, optical illusion, physical movement, puzzle-solving. Therefore, the graphic and text are playing an important role in mechanics as narrative assets in mobile AR games. And the audio and video do not support any mechanic. Although videos play an important role as a narrative vectors that depict the plot point, the possibility of utilization of videos in the mechanics instead of only in narrating need to be discovered. In terms of audio, it plays a vital role in these three games as the narrator, but it does not assist the mechanics according to Table 6.3. Therefore, how to make videos and audios supportive to the mechanics such as collecting, optical illusion and physical movement is an area that need to be explored.

Conclusion

Mobile Augmented Reality (MAR) extends the real world with virtual data in personal mobile devices. More and more puzzles games integrate MAR into the games. What aspects of the game mechanics is helpful with the interactive digital narratives and what kinds of narratives support the mechanics in the mobile AR puzzle-solving games design is worth researching. This paper attempts to analyze the mechanics and narratives and their relationship in mobile AR puzzle-solving games.

A comparative analysis is implemented among three mobile AR puzzle-solving games: *Shadows Remain*, *Yume and Silent Streets: Mocking bird.* In order to achieve the goal, two frameworks are applied to the analysis. One is the *The Elemental Tetrad* (Schell, 2015) framework that analyzes the main elements: *story, aesthetics, technology and mechanics* in the game design. Schell (2015) proposes that the mechanics can be analyzed from six areas: space, objects, actions, rules, skills and chances. To analyze the *story*, another framework of *A Theory of IDN* (Koenitz, 2010) which provides a theory of analyzing interactive digital media.

Based on the comparative analysis, we can see that graphic, texts and audio are useful as narrative assets for both narrating and mechanics in the game. However, the utilization of video in mobile AR puzzle-solving games is an area that still needs to explore. Moreover, multi-linear works well as a narrative form in the games. With regard to the mechanics, tapping, collecting and spinning are the major mechanics in these three games. The mental skill and physical skill are necessary skills for the players to play this kind of game.

The limitation of this study is that the number of the game selected is small. The future challenge is to expand the number and thus present a more comprehensive and detailed evaluation. This will be helpful in guiding the developers in designing the mobile AR puzzle-solving games.

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