COMP4801 Final Year Project

Combining Physical and Virtual Gaming Experience

Detailed Project Plan

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Table of Content

1 Introduction

Physical gaming experience stands for any physical objects for entertainment, such as teddy bears, robots, etc. Meanwhile, virtual gaming experience includes digital games, Augmented Reality (AR), etc. After clarifying the definitions of physical and virtual gaming experience, the project is then narrowed down by specifying to use the combination of robot and AR game.

The project plan is organized as follows. Chapter 2 details the background of the project with literatures review, while objectives and scope are stated in Chapter 3. Chapter 4 then describes the methodologies to talk about how the project is to be implemented. The planned schedule and milestones are provided in Chapter 5. In Chapter 6, there is a conclusion to sum up the main idea of this project. References and attributions will be included in the last chapter.

2 Background

According to The State of Online Gaming 2019 research report from the Limelight Networks, people are spending more time on gaming. Every age group shows an increasing result, while an average of 7.11 hours is spent on playing video games each week in 2019 which is higher than that of 5.96 hours in 2018 [1]. In the report of Betting on Billions, 50% of respondents, who use smartphone or tablet within 7 days during the survey conducted in December 2018, play games. As a result, games' category is included in the top 3 most-used app type [2]. These statistics are both showing that people are having an increasing demand of a higher quality gaming experience, otherwise, they will easily get bored with massive similar gaming experience that have been launched to the market.

Pokémon Go is a famous AR game, while it has the most daily revenue with USD $1,644,157 among iPhone mobile gaming apps in United States updated in September 2019 [3]. In Pokémon Go, players are required to capture the wild Pokémon that is augmented into the real-world environment (see Figure 1). However, the Pokémon is generated according to the location, and it is not specified to any object the real-world environment. As a result, switching off the AR mode can still be able to continue with the gameplay (see Figure 1). Since it is not necessary to switch the AR mode on for the gameplay and switching it on consumes the power of the mobile phone quickly, players tend to switch it off despite of losing the interactive experience brought by AR. In this project, the robot used is one of the characters for the game. It is object-specified to enhance the interaction between the real-world and virtual world to provide a better gaming experience for players.

Figure 1: Screenshots of Pokémon Go; with AR (left) [4], without AR (right) [5]

On the other hand, although entertainment robots are toys with long history, they are not fallen behind the times. Instead, the market of entertainment robots, especially those are programmable so that a series of actions can be performed, is increasing because Artificial Intelligence (AI) development is growing rapidly. The market is expected to increase at a compound annual growth rate (CAGR) of 23.06% [6]. Programmable robots are the trend nowadays, while Boston Dynamics is told to be a world leader. Boston Dynamics develops robots which can have sophisticated and smooth movements [7] (see Figure 2). However, a robot armed with excellent movements may not be interesting and useful if it is not used for any purpose. Therefore, this project tries to merge the AR technology with the programmable robot into a mobile game.
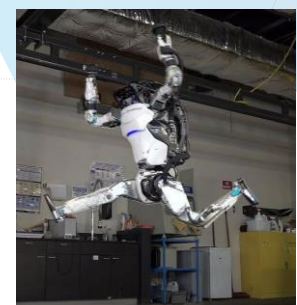

Figure 2: Robot named Atlas developed by Boston Dynamics [8]

3 Objectives and Scope

This project aims to provide a new gaming experience to the players as well as fulfill the increasing demand of better gaming experience by combining AR technology and robots.

Most of the gaming experiences nowadays are monotonous, which they are either a physical or a virtual experience. As times goes on, the development of game industry is saturated. People gets bored easily since brand-new gaming experience is difficult to be discovered for either physical or virtual entertainments. Hence, this project is combining physical and virtual to provide an interesting and fresh idea. The idea of combination may become new blood to the industry.

Combining the two complements the weakness each other. A robot provides a realistic vision of the movements, it can also be touched in the real-world. These are the advantages of playing a robot, however, it is actually not very interested to look at a robot moving around. On the other hand, AR augments computer-generated characters to the real-world environment. Although the characters are generated virtually and can only be viewed through the screen of the devices, this provides a fancy feeling to the gaming experience, and increases user interaction between the real-world and the virtual world. Integrating the strengths of both physical and virtual gaming experience, it is believed that the result of this project is found to be providing a more attractive and interesting new gaming experience to the players.

In this project, a mobile game consisting AR gaming environment that can fully control the movement of the robot in real world environment will be developed. It is a single-player role-playing-game (RPG), where the robot is the character for the players. The mechanics of the game is inspired by Tower of the Sorcerer (see Figure 3). It is a classic RPG developed in Japan and first issued in 1996. The feature of fixed-value RPG is reserved in the deliverable of this project, that means map, number of enemies, resources provided are not randomly generated. Since most of the value is fixed, choosing a correct order of the combats is deterministic for the players to pass through the levels, so it is actually also a puzzle game [9]. However, the story is changed where players are in a role of villain who breaks into the mansion to capture the princess. In the mansion, players are required to fight with some guards who try to save the princess. An exciting plot with a role that matched with the spider-like hexapod to be used is believed to make the game become more attractive.

Figure 3: Screenshot of Tower of the Sorcerer [9]

4 Methodology

The project is firstly divided into two parts, mobile application to control the robot and game with AR gaming environment. After ensuring each part of them is working properly, merging of two parts will be carried out. To be exact, the mobile application will then be modified into a plugin that can be used by Unity, the game engine that used to develop for the AR gaming environment.

4.1 Equipment and Set Up

The robot used is a hexapod, which is a spider-like robot with six legs (see Figure 4). It is equipped with Bluetooth Low Energy (BLE), so that it can connect to other device through a wireless personal area network. BLE is used because it reduces power consumption while compares to other Bluetooth technology. This can help to maintain a longer gaming time while the mobile phone is connected to the robot. In order to connect with the robot, a mobile phone which can support Bluetooth connection is needed. More than that, supporting AR technology by ARCore, which is a plugin developed and maintained by Google, with Android system is also required for the mobile phone.

Figure 4: A hexapod from Trossen Robotics [10]

4.2 Software Specifications

Since Android is used due to the simplicity of public Application Programming Interface (API) for BLE in Android compare to Core Bluetooth for iOS, Android Studio with Java language is used to develop the mobile application to control the robot. Meanwhile, Unity with C# language is used for building the gaming environment. Another way of implementing this project is using Android Studio for both controlling the robot and gaming environment. However, Android Studio is not specified for game development. Compares to Unity which is a famous game engine that used to develop game, Unity has more features and a better user interface to ease the game development. For example, Unity supports an easier implementation of animations, and it can control the locations of the game objects in the virtual 3D world easily. To support AR technology in Unity for Android, ARCore Software Development Kit (SDK) is integrated in the Unity game engine.

4 Methodology (Cont.)

4.3 Robot Controlling

Hexapod used in this project can have sixty kinds of movements (see Figure 5). There are three categories of modes, that is walking (W), dancing (D) and fighting (F). Four modes are in each category, while five directional buttons indicating the direction of movements.

	A	B	C	D
W (walk)	Low step	High step	Small step	Scamper
D (dance)	Freestyle	Ballet	Waves	Hands
F (fight)	Front legs	Front legs, unison	Swivel	Lean

Figure 5: Modes available for hexapod movements [11]

A user layout that is similar to the gamepad (see Figure 6) of the robot will be first designed to

Figure 6: Gamepad for hexapod [11]

implement the complicated controlling method. Bluetooth connection between mobile phone and the robot will then be handled after that, followed by the Bluetooth commands used to control the movements of the robot. After the connection is established, the application will simulate as the gamepad to send out formatted Bluetooth commands to hexapod communication packets. When hexapod receives the commands, it would perform the corresponding movement.
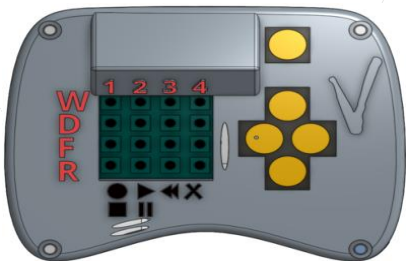
4.4 AR Gaming Environment

Since object recognition is not available in ARCore, image recognition is used to recognize the flat surface on the robot. After providing the reference images, ARCore is able to augment images or even animations that is responsive to the reference images in real-world environment. As long as the players move their hands and keep the object under the camera, ARCore can track moving images on the object. With this technology, effects like smoking, burning can be augmented to the robot for better gaming experience. Besides augmenting effects to the robot, the virtual terrain of the mansion and the enemies that the players have to fight with will also be augmented by recognizing the flat surface of the floors or walls. Therefore, players have to control the robot to walk through the augmented map for the mansion, and fight with the augmented computer-generated characters.

4.5 Combining Robot Controlling and AR Game

Since Unity supports importing Java source files as plugin for Android, only minor adjustments to the application for robot controlling is needed in order to convert it into a plugin that can be used by Unity. After building a gamepad-similar layout for controlling robot in the AR gaming environment, each button in the layout will correspond to relative Bluetooth commands built in plugin to be sent. Therefore, the mechanics would become as follows. After pressing the button in AR game, Unity would receive an event to call the relative function from the plugin for Android. Bluetooth commands would be sent out by Android plugin and received by the robot.

5 Schedule and Milestones

As mentioned in the previous chapter, the project is divided into two parts in the early stage. Robot controlling and the first half of the AR game are handled parallelly at the same time for the early stage of the project. Three major milestones are included in this project, namely the completion of application for robot controlling, conversion of application into plugin and completion of AR game. Table 1 below shows the proposed project schedule.

Date	Work Completed	
29 September 2019	First deliverables - Detailed project plan - Project website	
15 October 2019	Finalized project requirements Game review	
	Robot controlling	**AR gaming environment**
1 December 2019	User interface	Game design
31 December 2019	Bluetooth commands for connection and control of movements	Effects augmented to the surface of robot
6 January 2020	User acceptance testing	Gamepad-similar layout
13-17 January 2020	First presentation	
2 February 2020	Second deliverables - Detailed interim report - Preliminary implementation	
29 February 2020	Conversion of robot controlling application into plugin for Unity	
30 March 2020	Remaining gaming environment	
5 April 2020	Player game testing	
12 April 2020	Final adjustment	
19 April 2020	Third deliverables - Final report - Finalized tested implementation	
20-24 April 2020	Final presentation	
5 May 2020	Project exhibition	

Table 1: Proposed schedule

According to the proposed project schedule, the completion of application for controlling the robot is scheduled on 6 January 2020. Meanwhile, the second milestone which is the conversion process is planned to be completed on 29 February. The last phase that is the completion of AR game is expected before 19 April 2020.

6 Conclusion

To conclude, the goal of this project is to provide a better gaming experience to players by combining physical and virtual gaming experience. In order to demonstrate the combination of the two, an AR mobile game which supports the control of robots will be delivered at the end of the project. The game is a single-player RPG adventure game, while players control the robot to do the adventure with the storyline.

7 References and Attributions

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