Project Plan
Combining Physical and Virtual Gaming Experience

Que Xinyue 3035331769
The University of Hong Kong

1. Project Background
1.1 AR Game Overview

The game industry is evolving at a record speed during the past few years. The global gaming market valuation was $151.55 billion while the expected market increment is more than 60% within a five-year range.

Simultaneously, game players are no longer satisfactory with traditional PC and mobile games, instead, they intend to pursue more immersive and interactive gaming experiences. The fast growth of the Extended Reality (XR) technology and the entrance of XR players seize the chance to innovate AR/VR games, which brings novelty to traditional gaming experiences and increases the players’ interaction with the game world. The epoch-making AR game, Pokemon Go, which attracted worldwide players to involve and allowed players to make social contact in the game was a typical example of successful applications of AR technology to mobile games. It not only topped the game downloads for years, but also redefined the mobile game for some players. During 2017 when Pokemon Go claimed a dramatic increase, the investments in XR rose 40% on an annual basis.

Investment within AR/MR exceeded that within VR in 2017 and AR was predicted to receive $20.3 billion in 2021, compared to VR’s $19 billion. AR has accumulated a large user base, which is expected to reach 1 billion users in 2021. Compared with VR games, AR games grant players immersive gaming experiences without requirements for complex devices. The market acceptability, portability, and the ability to provide high quality experiences make AR game a good option for gamers.

Foreseeing the significant potential for AR games, tech companies released software packages to claim shares in the competitive markets with high returns. Google released ARCore to defend against ARKit released by Apple, while other tech giants also entered the competition. Those SDKs for free downloads paved the path for AR game developments and eased the life of game developers.

1.2 AR Game Introduction

Different from traditional games where players interact with the virtual game world via the digital screen, AR game adds a layer of virtual objects to the reality so that players are immersed in the game world which combines the reality and virtuality.
Marked by the appearance of Pokemon Go, the game industry witnessed the dawn of an AR age. The Harry Potter Wizards Unite is also based on the real-world map and it integrates virtual elements showing up in the Harry Potter movie to make players feel throwed at the magic world. The GhostBusters World adopts the similar idea to cover the reality with a layer of movie fantasy and makes players hunt for the iconic ghosts in the real world.

1.3 Robot

In conventional perspectives, robots are exploited in manufacturing process and factory work. However, within the decade, robots entered our daily life and IoT enabled it to be utilized conveniently for multi-purposes including household chores, education and even home entertainment.

Entertainment robotics are gaining popularity recently. The global entertainment robot market will rise to $3.7 billion in 2023 with at a CAGR of 23.06%. With Artificial Intelligence (AI) and other technologies built in, entertainment robots are designed to interact with people with actions and conversations.

Children, young people and robotic fans are the major customers of the entertainment robotics. Featured with curiosity and creativity, these customers are passionate about exploring new interactive activities with robots. In other words, the major customer segment of entertainment robots are acquiring the most interesting experiences when it is possible to interact with robots via different channels.

Inspired by the insights of AR games and robotics, this project aims to design an AR game where players will be able to control the robot movement through the game interface to interact with the virtual objects embedded in the game.

2. Project Objective

2.1 General Objective of the Project

The objective of this project is to develop an AR game that can run on Android platform.

The AR game inherits a very typical adventurous structure. It is more attractive and playable by integrating the real robot and AR effects. It should allow players to control a realistic robot to adventure on a virtual map. Through Android mobile device, players will be able to control the robot to perform different movements including run, walk and dance in all directions while at the same time control the moving speed. Robot can launch attacks to virtual enemies to defend itself from shot by enemies. During the process, robot is also enabled to collect items that might help the gameplay.

2.2 Phase Objective of the Project

Phase 1

Design an Android App in Java on Android Studio. The Android App connects to the robot via Bluetooth and interacts with the robot based on a pre-agreed protocol. The App contains a major UI on which users can control the robot movement by moving figures on the screen or pressing the buttons. Users should see the robot make movements exactly the same as the they order.
Phase 2

Integrate the AR effects by utilizing AR SDKs (ARKit, ARCore, EasyAR) on Android Platform. In addition to controlling the robot movement, players can see the robot move on a virtual environment through the UI and control it to steer away from some virtual obstacles.

Phase 3

Construct a complete game where robot fights with enemies and interact with more interesting game objects. This is the stage when Unity integrates more game objects, visual effects and more attractive game environment into the Android App.

This phase will require massive adjustments and tests to make sure that the Unity project is combined with the Android app to deliver the final playable Android game.

3. Project Methodology

3.1 Scrum – Project Management Framework

The Scrum method based on Agile software development will be the main framework and the guideline for this project. The project will be decomposed into small requirements and each requirement will fulfil a function of the final game. For example, “Players win the game when completing all missions” will be a typical requirement in the game.

Requirements will be placed onto the project backlog in terms of priority and importance in this game. The project backlog is again divided into several sprints with each sprint composed of 2-5 requirements and taking 1 week to complete. At the end of each sprint, a sprint review is conducted to inspect the Increment finished in this sprint, adjust the project backlog and make schedules for next sprint.

3.2 Case Research and Analysis

Being new to game development and AR/robot technology, it is meaningful for me to research the successful examples of AR game. Each game will be evaluated according to the game evaluation mechanism. Game features will be collected to analyse the interesting elements that drive players into the game. For example, the IP recognition and social features directly lead to the popularity of Pokemon Go.

3.3 Tools Learning and Literature Review

To develop the final game that is deployable on the Android platform, several tools and relevant literature will be carefully studied. The tools include but not limited to Android Studio, Unity, AR SDKs, robot API, 3D modelling and Android application development. Relevant articles addressing the popular games algorithm will also be reviewed to develop a more intelligent and playable game.

3.4 Game Design

The following table briefs on various designs utilized in the game.

<table>
<thead>
<tr>
<th>High-level Design</th>
<th>Structure the game world and settle down the world rules</th>
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</thead>
<tbody>
<tr>
<td>Story Design &amp; Concept</td>
<td>Delineate the story and the background of the game, the</td>
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<tr>
<td>Concept Design</td>
<td>impression of players when they enter the game</td>
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<tr>
<td>Character Design</td>
<td>Design the roles that players take on as well as NPCs, tools &amp; weapons in the game</td>
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<tr>
<td>Environment Design</td>
<td>Design the map where players can act and move</td>
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<tr>
<td>Gameplay Design</td>
<td>The skeleton of the game and defines how to play the game. It considers the player decision plan, action path and difficulty to provide compelling game experiences</td>
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<tr>
<td>Art Design</td>
<td>Design the visual and audio effects displayed in the game to render the atmosphere</td>
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</table>

3.5 Game Implementation on Android Studio and Unity

The game will be developed using Android Studio and Unity. Third-party AR SDKs will be utilized to realize the AR effects including motion tracking and environmental understanding in the game.

To make the final game run on the Android platform, Java is used to configure the application. All Increments developed in Sprints will be tested on Android platform to see if the game engine can fulfil the desirable functions for players.

4. Project Schedule and Milestones
4.1 Project Schedule Checklist

Phase one: Inception

☐ Learn the structure and utility of Android Studio.
☐ Study the basics of Java development languages.
☐ Learn robot basics. Know how to control and use them in the game.
☐ Meet supervisors to adjust the scale of the game.

Phase two: elaboration

☐ Learn the structure and utility of Android Studio.
☐ Study the basics of Java development languages.
☐ Design the game characters and very detailed gameplaying method.
☐ Design an Android App that can control the robot movement.
☐ Learn to integrate the AR SDKs onto the Android Studio.

☐ Design the high-level structure, story background and the gameplay method for the game.
☐ Make the first-version project schedule and product backlog.
☐ Design the webpage which contains all information of the project.

☐ Fulfil the AR effects in the application.
☐ Have some potential players play the game and collect user feedback, based on which to adjust the gameplay design.
☐ Make a presentation about the game in terms of the game functions and characters available at that time.
☐ Write a detailed interim report about the project.
Phase three: construction
☐ Learn and revise Unity functions for game development.
☐ Design the detailed game map and refine gameplaying method and game characters.
☐ Implement the game on Unity with all functions, possibly except the functions related to the robot.
☐ Integrate the game into the Android application. Combine them into the playable Android game.

☐ Have players play the game and collect user feedback, based on which to adjust the gameplay design.
☐ Finalize the game and deliver the tested game on the Android Platform.
☐ Write and deliver the final project report.
☐ Make final presentations about the game.

4.2 Project Timeline

<table>
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<tr>
<th>Date</th>
<th>Deliverables</th>
<th>Milestones</th>
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</thead>
<tbody>
<tr>
<td>2020.10</td>
<td>• Detailed Project Plan</td>
<td>Milestone 1: Finish the development of an Android App which can control the robot movement</td>
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<tr>
<td>2020.12</td>
<td>• Project Webpage First Update</td>
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<tr>
<td>2021.01</td>
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<td>Milestone 2: Build the AR effects into the application</td>
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<tr>
<td>2021.04</td>
<td></td>
<td>Milestone 3: Finish the detailed game design on Unity</td>
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<tr>
<td>2021.04</td>
<td>Deliverables</td>
<td>Final Presentations</td>
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<td></td>
<td>• Final Report</td>
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