HOUSE INTERIOR DESIGN WITH AUGMENTED REALITY TECHNOLOGY

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ABSTRAK

Memandangkan Malaysia semakin maju berbanding sebelum ini, teknologi Augmented Reality (AR) menjadi trend di Malaysia. Terdapat banyak perkara yang boleh ditunjukkan dengan menggunakan teknologi Augmented Reality seperti flashcard huruf. Flashcard itu akan menjadi lebih menarik untuk dibaca oleh kanak-kanak. Sebagai contoh, flahcard itu terdapat model 3-Dimensi (3D) modal untuk dipaparkan dan membolehkan kanak-kanak mengingati huruf lebih mudah. Selain itu, dengan menggunakan teknologi AR, AR boleh membantu orang ramai untuk mereka bentuk rumah dan bilik mereka sendiri. Memandangkan jika orang ramai ingin mengupah pereka dalaman untuk mereka bentuk rumah dan bilik mereka, kosnya akan lebih tinggi daripada menggunakan aplikasi reka bentuk dalaman rumah AR percuma. Justeru, bagi menyelesaikan masalah ini, Reka Bentuk Dalaman Rumah dengan teknologi Augmented Reality (AR) dicadangkan. Rekaan Dalaman Rumah dengan teknologi Augmented Reality (AR) merupakan aplikasi yang boleh membantu pengguna mereka bentuk rumah atau bilik sendiri tanpa mengupah mana-mana pereka dalaman. Aplikasi ini memerlukan pengguna mengimbas sasaran imej yang diberikan untuk mereka bentuk bilik atau rumah mereka. Manakala bagi metodologi yang digunakan dalam aplikasi ini ialah model Rapid Application Development (RAD), model RAD terdiri daripada 4 fasa iaitu perancangan keperluan, reka bentuk pengguna, pembinaan pesat dan cutover. Tambahan pula, aplikasi AR ini dibangunkan dengan menggunakan Unity, Vuforia dan Microsoft Visual Studio. Ujian Penerimaan Pengguna (UAT) akan dijalankan untuk menguji kefungsian aplikasi. 20 responden akan dipilih untuk menguji kefungsian aplikasi AR. Terdapat 13 orang responden yang merasakan aplikasi AR ini sangat berguna untuk membantu mereka mereka bentuk bilik atau rumah. Aplikasi AR ini mudahdigunakan yang mana objektif utama berjaya disampaikan.

ABSTRACT

Since Malaysia is becoming more advanced than before, the technology of Augmented Reality (AR) becomes a trend in Malaysia. There are many things that can be shown by using Augmented Reality technology such as the flashcard of letters. The flashcard of letters will become more interesting for the children to read. For example, there will be 3-Dimensional (3D) model to show up and let the children to remember the letters easier. Besides, by using AR technology, it can help people to design their own houses and room. Since if people want to hire an interior designer to design their house and room, the cost will be much higher than using a free AR house interior design application. Thus, to solve this problem, House Interior Design with Augmented Reality (AR) technology is proposed. House Interior Design with Augmented Reality (AR) technology is an application that can help the user to design their own house or room without hiring any interior designer. This application is required the user to scan the given image target to design their room or house. While for the methodology that used in this application is the Rapid Application Development (RAD) model, RAD model consists of 4 phases, which are the requirements planning, user design, rapid construction and cutover. Furthermore, this AR application is developed by using Unity, Vuforia and Microsoft Visual Studio. User Acceptance Test (UAT) will be conducted to test the functionality of the application. 20 respondents will be chosen to test the functionality of the AR application. There are 13 respondents who feel that this AR application is useful for helping them to design their room or house. This AR application is easy to use which the main objective is successfully delivered.

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CHAPTER 1

INTRODUCTION

1.1　Introduction

According to Adam Hayes, Augmented Reality (AR) is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound or other sensory stimuli delivered via technology (Hayes, A, 2022). AR can be used to develop a game application, for retail purpose, even for classroom education. House interior design AR application has helped the people to have their own desired design for their house without using any expenses.

The main inspiration of this project is due to the high cost of hiring an interior designer to design the house in the market. Since AR technology become more popular than before, so by using AR technology to develop a house interior design application can be much more attractive and more convenient for most of the people to use it.

According to Electra Nanou, there are many AR interior design applications for people to decorate their house (Electra Nanou, 2020). Thus, this project will review and analyze three existing system in the market such as the IKEA Place, Houzz and Live Home 3D. The purpose of this project is to develop a functional house interior design AR application that can help people to design their house without hiring an interior designer. The application can be used on the Android phone and does not require any costs to download it.

The house interior design application did help a lot for those who want to design their house without hiring any interior designer. Because by hiring a professional interior designer, according to Fiona Yoon, the costs of interior design services may start from RM1200 or more, which some people might not be able to afford it (Yoon, F.,2021).

Besides, according to Latitude Design, the prices for interior design can be estimated by the price per quality ratio (Design, L. , 2022). Such as Standard quality is RM70 per square feet (sqf), Premium quality is RM100 per square feet (sqf), Artisan quality is RM150 per square feet (sqf) while for Royalty quality will be RM150 above per square feet (sqf). Thus, the house interior design AR application will be the first choice for the people to design their own house without hiring an interior designer.

Moreover, one of the biggest home furniture companies in the world is IKEA. This company sells different types of home accessories and interior design items, and most people would like to go there and choose for their desired furniture. According to Emizentech, IKEA has successfully developed a furniture retail app called IKEA Place in 2017 (Emizentech, 2020). The users will be able to allow them to purchase the product that they want such as a chair, and the users will be able to use the IKEA Place to display their product in 3-dimensional. Besides, this application will show the information of the product in order to allow the users to know more information through the AR technology.

1.2   Problem Statement

During these day, in order to hire a good interior designer to design their house or room, the expenses is much higher than usual. To save money and time, this application will be able to allow the users to design their own house or room without using any expenses and without hiring any interior designer, and it is more convenient compared to the usual interior designer.

Besides, by using the Augmented Reality (AR) technology to develop an application for interior design, it enhances the experience of the users when they want to know how is the result of their desired design. Since some designs in real life might not be that much, because some materials that are used to design the house or room will be out of stock. Thus, this project will show better visualization when the users want to design their own house the way they want.

Moreover, in real life, if people want to design their house, they are required to buy the suitable furniture to design their own house and the furniture is non-refundable. Thus, this house interior design AR application allows them to design their house without buying any actual furniture.

1.3   Objectives

There are three objectives in this project and they will be stated as below:

i.   To study the requirements and functionality for the Augmented Reality (AR) application.

ii.   To design an Augmented Reality (AR) based app to help the user to design their own house.

iii.   To evaluate the AR House Interior Design Application by using Questionnaire from the user.

1.4   Scope of the project

The scopes of the project will be listed as below based on the objectives that declared as above:

i.   This project will be focused on the Augmented Reality application for interior design only.

ii.   The software that used in this project is Unity.

iii.   The tool that used in this project is Vuforia.

iv.   The project contains different type of multimedia elements such as 3D models, sounds and texts.

v.   The project allows the users to change the colour of the wall and the floor.

1.5   Significance of Project

This project will be a convenient house interior design Augmented Reality (AR) application for those who desired to save money and time to design their house without present in an actual furniture store or pay for an interior designer to help them to design their house.

1.6   Report Organization

This thesis consists of five chapters. Chapter one discusses in the introduction of this project. Introduction of the project, problem statements, objectives and scopes of this project will be included in Chapter one.

Chapter two discusses about the literature review of three different existing system in the market that are related to my project. Analysis of these three different existing systems will be included as well, such as the advantages, disadvantages, methods, tools and technology that are adapted by the existing systems

Chapter three will discuss and analyse about the methodology that are needed to be used in this project. The storyboard and the project flow of the project will be discussed in this chapter.

Chapter four will talk about the result of this project. This chapter will include the explanation for the process of development of this project. There will be having some feedback from the users that are collected for evaluation purposes.

Lastly, Chapter five will talk about the conclusion of this project which includes the limitations of the project and the future work that can help to enhance this project.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

There is a lot of Augmented Reality (AR) house interior design application in the market. Most of the Applications provide a lot of furniture and design for the users to choose their desired design for their room. Thus, this chapter will discuss the existing system in the market based on their features, platform, function and other related features. These existing applications are IKEA Place, Houzz and Live Home 3D.

2.2   Review Existing Systems

2.2.1   IKEA Place

Figure 2.1: Displaying the Furniture in the Real World by using IKEA Place.

IKEA Place is one of the famous Augmented Reality (AR) furnishing Applications. IKEA Place is available in Android for all ARCore compatible devices or iOS (IKEA., n.d.). IKEA Place is using AR technology to display and showcase its furniture and design to the users. There are more than 3200 IKEA products in IKEA Places such as beds, sofas, wardrobes and other furniture.

Besides, there are some new features in IKEA Place after its latest update. Visual search is now included in IKEA Place, which is powered by Grokstyle (IKEA., n.d.). It allows the users to take a photo of any furniture by using their phone and they can find similar IKEA products through the application. This feature allows the users can save more time to look for their desired furniture or design for their room.

Furthermore, IKEA Place is being used by a game show series, which called Matchers Keepers, hosted by Caroline (IKEA., n.d.). The contestants are required to use the IKEA Place application to pick and place different furniture over a series of three rounds, the teams score by picking out the matching item and placing them in the same spot in their room. This shows that IKEA Place can enhance the family relationship with each other.
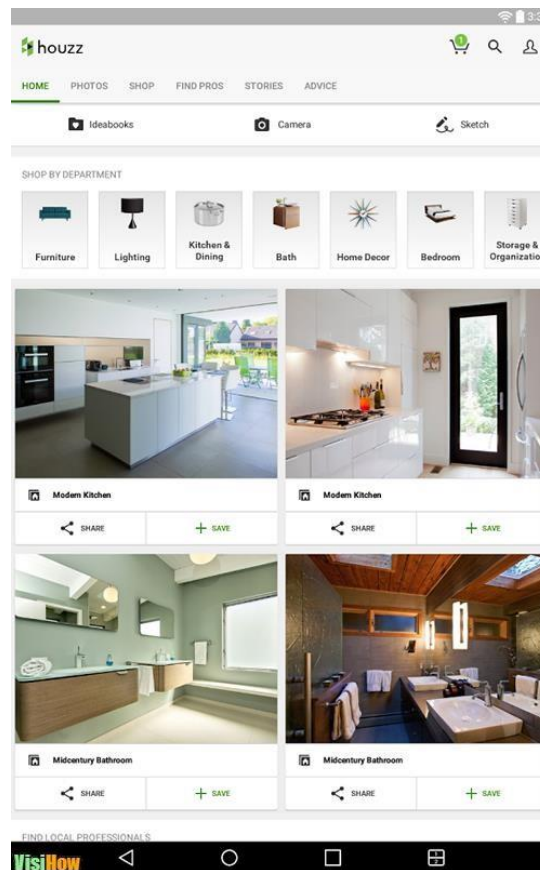
2.2.2 Houzz

Figure 2.2: Different Design and Products in Houzz.

Houzz is one of the Augmented Reality (AR) Application for interior designing. Houzz is available on Android, iOS, Windows PC and Mac OS. Houzz allows the user to browse more than 20 million high resolution photos of home interiors and exteriors design, which choose by their styles, location or room.
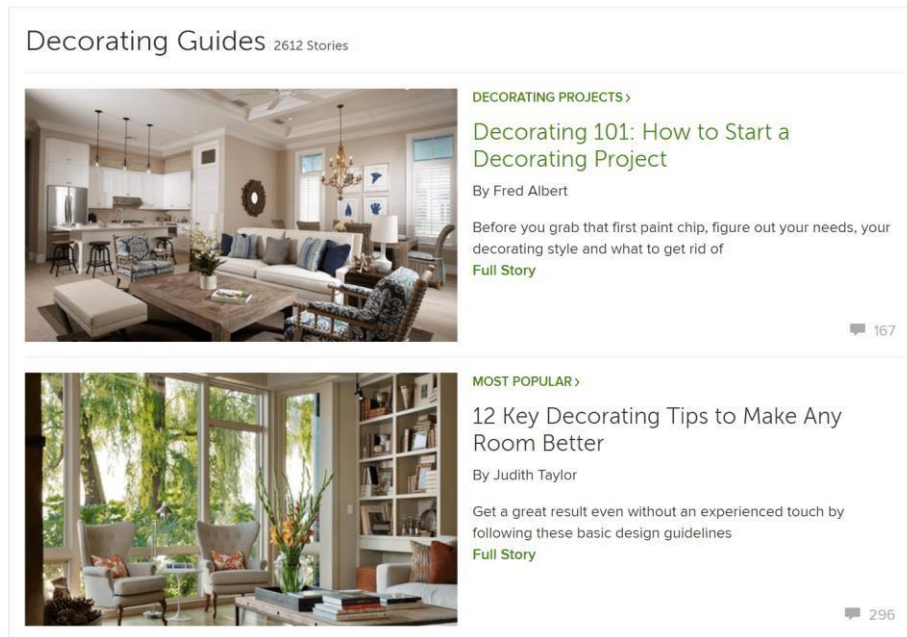
Figure 2.3: Decorating Guides in Houzz.

Besides, Houzz allows the users to search for decorating guides so the users will have a lot of suggestions on how to decorate their rooms and house. Most of the guides are written by various professional architects and interior designers (Hilary Winfield Fine Art. 2018, September 4). They will provide useful tips for different design subjects.
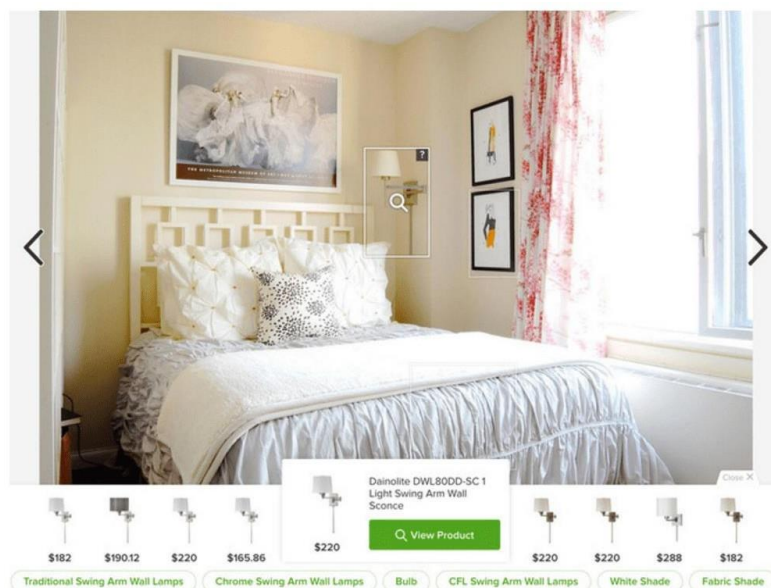

Figure 2.4: Feature of Visual Match in Houzz Application.

Furthermore, Houzz has another feature which is the Visual Match. Visual Match allows the users to scan the photos of furniture or design and this feature will try to find similar pieces in the Houzz shop with different budgets and designs (Hilary Winfield Fine Art. 2018, September 4).
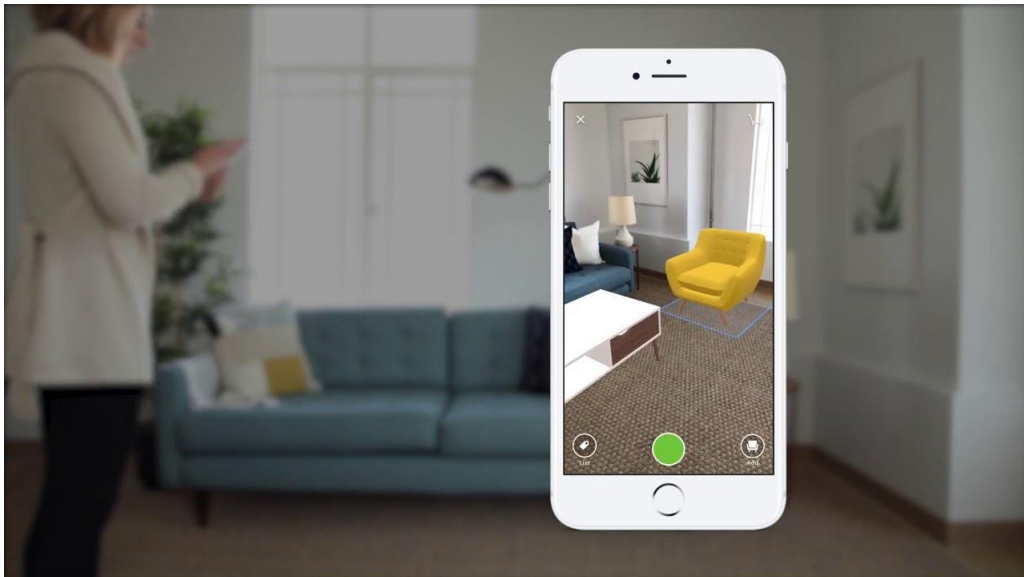
Figure 2.5: Feature of View in My Room in Houzz Application.

There is one more feature in Houzz which is the View in My Room feature. This feature allows the users to visualise their room by placing different furniture, artwork or any decoration before they buy the products (Hilary Winfield Fine Art. 2018, September 4). The users will be able to resize the objects to fit their room, if the users want to buy the product, they can buy it directly through the Houzz store.

2.2.3   Live Home 3D

Figure 2.6: Interior Design in Live Home 3D.

Live Home 3D is a program for designing houses and apartments. This program is available on iOS and PC only. This program allows the users to design their living rooms, dining rooms, offices and other types of spaces.

Besides, Live Home 3D provides different types of furniture and accessories for the users to choose from. After successfully decorating the house, the users will be able to see the 3-Dimensional (3D) model of the house or room that they have decorated previously (Software, B. L., n.d.). The users no need to worry about the accuracy of placing the objects in a room or house, Live Home 3D has the ability to position the objects accurately by using smart guides and objects snapping.

Furthermore, Live Home 3D also provides features for creating both detailed floor plans and realistic 3D views simultaneously, it has a wide export setting for 2-Dimensional (2D), 3D view and 3D models, and it has an Augmented Reality (AR) view for the mobile version.

2.3   Comparison of Existing System

2.3.1   Specification of Existing Works

Specification	IKEA Place	Houzz	Live Home 3D
Platform	Android, iOS	Android, iOS, Windows PC and Mac OS.	iOS, PC.
Internet Connection	Required Wi-Fi connection.	Required Wi-Fi connection.	Required Wi-Fi connection.
Cost	Free.	Free.	Free for Live Home 3D but for upgrading to Live Home 3D, requires $19.99 and above.
Permission	Camera, location and other.	Camera, location, phone, storage and other.	Camera, location, phone, storage and other.
Features	Visual search, realistically rendered of products, true-to-scale 3D products.	Visual match, Houzz Guides, Ideabooks.	3D Home Design Visualization, adjustable lighting, terrain editing tools.
Additional Equipment	Not Required.	Not Required.	Not Required.

2.3.2 Advantages & Disadvantages of Existing System

System	Advantages	Disadvantages
IKEA Place	IKEA Place is easy to use for most of the people and it is user-friendly for most of the users. Everything in IKEA Place is extremely straightforward in order to not confuse the users when they are using the app. Besides, IKEA Place will teach the users how to use the app first before they start to shop.	The searching feature of IKEA Place cannot search items by using model number, which will confuse the users during their searching. Besides, its Augmented Reality (AR) camera is not clear which is not user-friendly for the users.
	IKEA Place has an accurate scanning tool for the users to use and the scanning tool is working very well and smooth. It required a few minutes for the users to scan their room correctly, after that the users will be able to place their selected items around their space easier.	The users are required to have a stable internet connection and a bright environment when they are required to scan their room, otherwise the app will be a bit hard to scan the room correctly.

Houzz	Houzz provide some buying guides for the users before they are spending times to design their place.	Even though there are some buying guides for the users, but the navigation in this application is hard to navigate, which is not user-friendly for the users.
	Houzz allows the users to place their furniture in the room or house with a correct scale of the items.	Some of the products are not available for the users to view in their room.Thus, the users will not be able to experience some of the items that they have selected.
Live Home 3D	Live Home 3D has a quick and detailed 3D visualisation of the items which allow the users to have a detailed look of the items.	Since Live Home 3D is a free version so it has some limitations. As a result, there will be some restriction on export of 3-Dimensional (3D) models, if the users want to export the 3D models.
	Live Home 3D allows the users to see the whole design of the house included the rooms of the house.	Live Home 3D requires a stable and strong internet connection in order to allow the users to have a smooth AR experience.

2.4 Chapter Summary

In a conclusion, each existing systems have their own pros and cons since each of the existing system did help a lot of the users during their house or interior designing. Besides, the existing systems have the same function which is the Augmented Reality (AR) function. Which allows the users to place their items in their own room or house. Thus, we will need to develop a functional AR application for house interior design in order to help the people to have their desired design of house.

CHAPTER 3

METHODOLOGY

3.1   Introduction

This chapter will discuss on which method is suitable to use for the House Interior Design with Augmented Reality (AR) Technology application. In this chapter, the selected methodology will be explained. Besides, an activity diagram and storyboard of the project will be provided in this chapter. Moreover, the hardware and software that are used for this Augmented Reality (AR) application will be explained as well.

3.2   Methodology

The methodology for the development of this application will be the Rapid Application Development (RAD) model. Since the application needs to be tested for several times before it completely launches, which to ensure the application is running smoothly thus RAD model is suitable for the development of this application. The RAD model has four phase which is the requirements planning, user design, rapid construction and cutover.
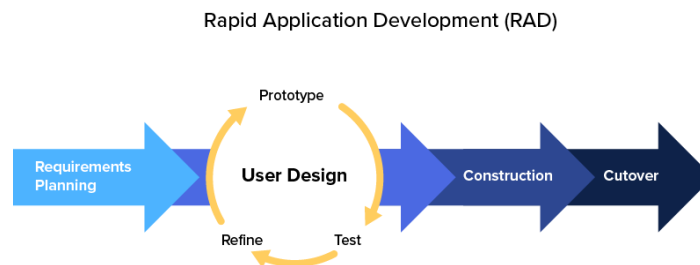

Figure 3.1: The Phases of Rapid Application Development (RAD) model.

3.2.1   Requirement Planning

Nowadays, the Augmented Reality (AR) technology in house interior design is become much more popular, since it will be very useful for those people who want to design their own house without hiring any interior designer. This application is expected to help the user in designing their room with AR technology. The target user for this application will be the users who want to design their room without hiring any interior designer. Besides, this application will be available in Android phone only and this application will be tested for several times during the development stage until the application is ready for the rapid construction.

3.3   User Design

The user design will be discussing on the House Interior Design with Augmented Reality (AR) application. The prototype will be built to test the user design of the application. The application will be developed in rapid construction if the prototype is ready. The use case diagram, storyboard and activity diagram will be included in this section.
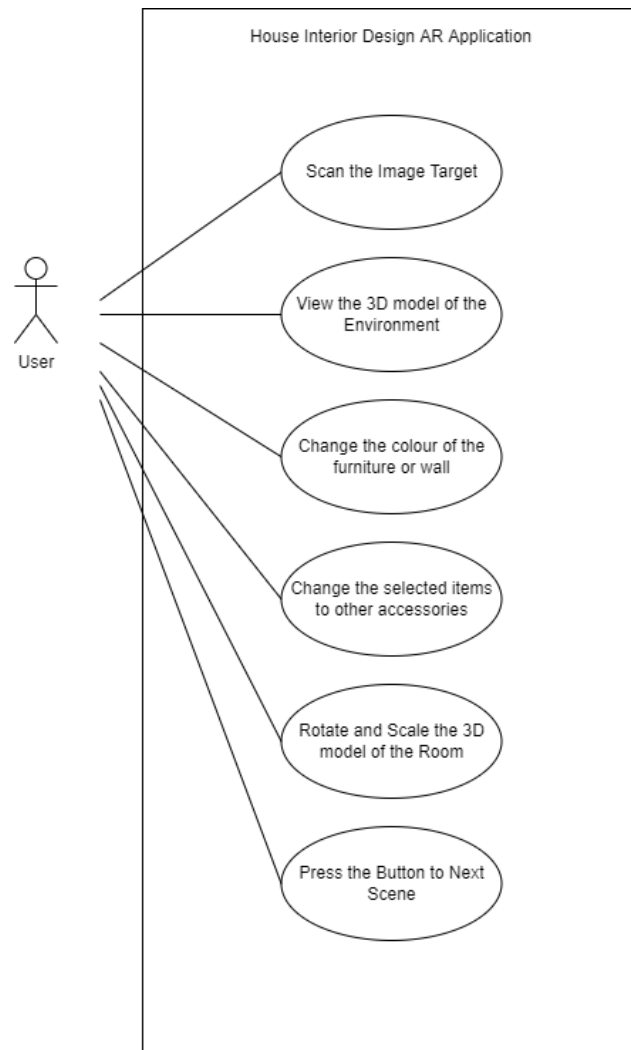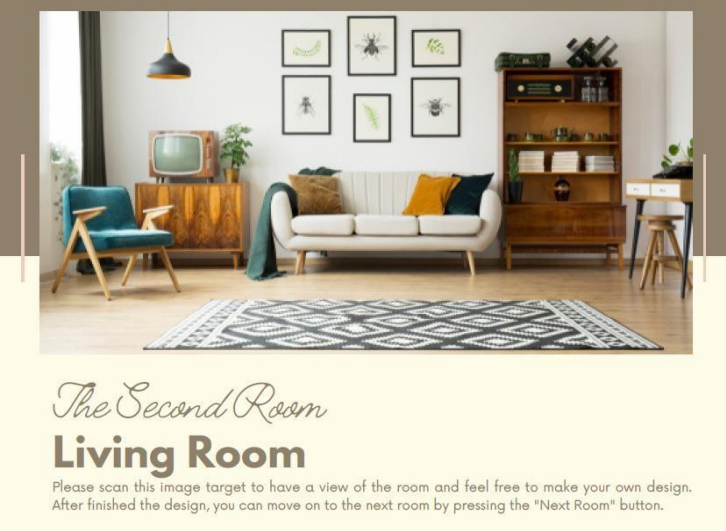
3.3.1 Use Case Diagram

Figure 3.2: Use Case Diagram of House Interior Design AR Application.

3.3.2 Storyboard

PROJECT TITLE: HOUSE INTERIOR DESIGN AR APPLICATION Page Title: Image Target of Bedroom	Page no.: 1
	The user will need to scan the image target on a flat surface. When the user successfully scans the image target of the bedroom, the AR application will show the 3D model of the bedroom.
Page Title: 3D model of the Bedroom	Page no.: 2
	After the user scans the image target of the bedroom. It will show the 3D model of bedroom and the buttons for the user to design the room. Besides, there will be two colour pickers for the selected the room.

	The usage of the colour pickers is to allow the user to change the colour of the wall and the floor. Furthermore, there will be a sound button that allows the user to mute the background music. Moreover, there will be two buttons which allow the user togo to the next room or go back to the previous room.
Page Title: Image Target of Living Room	Page no.: 3
 The Second Room **Living Room** Please scan this image target to have a view of the room and feel free to make your own design. After finished the design, you can move on to the next room by pressing the "Next Room" button.	The second room will be the living room. The user will need to scan the image target of the living room on a flat surface. When the user successfully scans the image target of the living room,

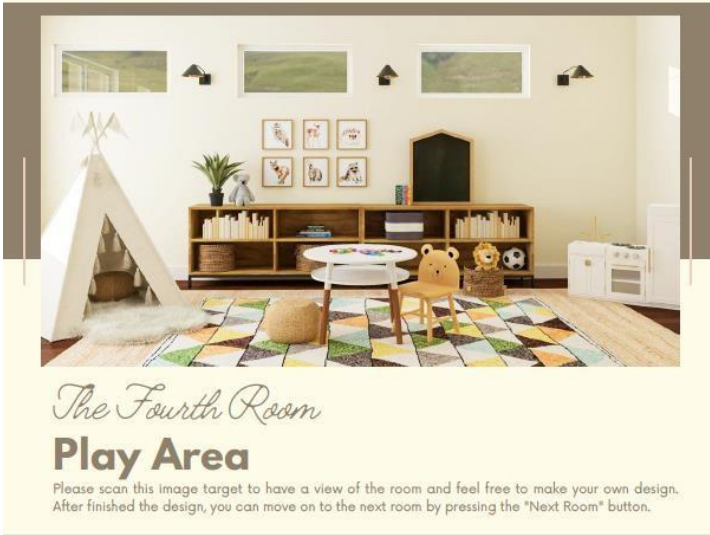|	the AR application will show the 3D model of the living room.
Page Title: 3D model of the Living Room	Page no.: 4
	After the user scans the image target of the living room. It will show the 3D model of living room andthe buttons for theuser to design the room.
	Besides, there will be two colour pickers for the selected the room. The usage of the colour pickers is to allow the user to change the colour of the wall and the floor.
	Furthermore, there will be a sound button that allows the user to mute the background music.

	Moreover, there will be two buttons which allow the user to go to the next room or go back to the previous room.
Page Title: Image Target of the Dining Room	Page no.: 5
	The third room will be the dining room. The user will need to scan the image target of the dining room on a flat surface. When the user successfully scans the image target of the dining room, the AR application will show the 3D model of the dining room.

Page Title: 3D model of the Dining Room	Page no.: 6
	After the user scans the image target of the dining room. It will show the 3D model of dining room and the buttons for the user to design the room. Besides, there will be two colour pickers for the selected the room. The usage of the colour pickers is to allow the user to change the colour of the wall and the floor. Furthermore, there will be a sound button that allows the user to mute the background music. Moreover, there will be two buttons which allow the user to go to the next

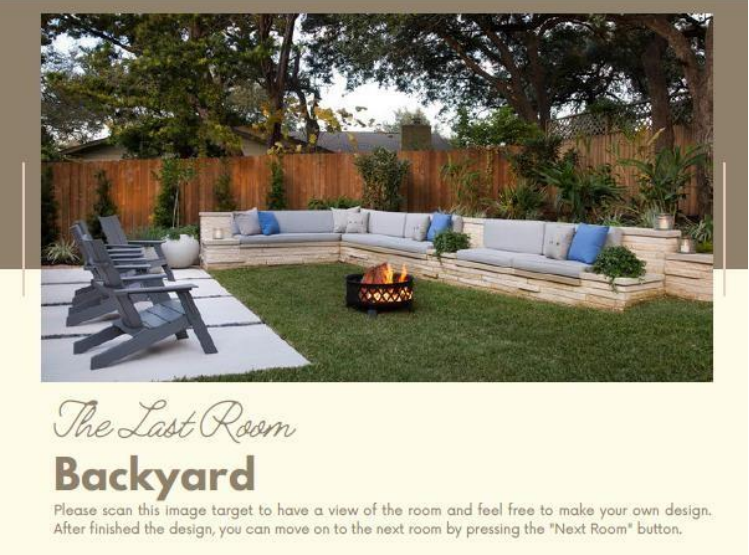|	
	room or go back to the previous room.
Page Title: Image Target of the Play Area	Page no.: 7
	The fourth room will be the play area. The user will need to scan the image target of the play area on a flat surface. When the user successfully scans the image target of the play area, the AR application will show the 3D model of the play area.
Page Title: 3D model of the Play Area	Page no.: 8
	After the user scans the image target of the play area. It will show the 3D model of play area and the buttons for the user to design the room. Besides, there will be two colour

| | pickers for the selected the room. The usage of the colour pickers is to allow the user to change the colour of the wall and the floor.

Furthermore, there will be a sound button that allows the user to mute the background music.

Moreover, there will be two buttons which allow the user togo to the next room or go back to the previous room. |
| --- | --- |
| | |

|	
Page Title: Image Target of the Backyard	Page no.: 9
	The last room will be the Backyard. The user will need to scan the image target of the backyard on a flat surface. When the user successfully scans the image target of the backyard, the AR application will show the 3D model of the backyard.
Page Title: 3D model of the Backyard	Page no.: 10
	After the user scans the image target of the backyard. It will show the 3D model of backyard and the buttons for the user to design the room. For this area, there will be no colour pickers for the user to change the colour of the floor and

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	wall. But it allows the user to design their backyard with more different furniture. Furthermore, there will be a sound button that allows the user to mute the background music. Moreover, there will be two buttons which allow the user togo to the next room or go back to the previous room.
26	

3.3.3 Activity Diagram
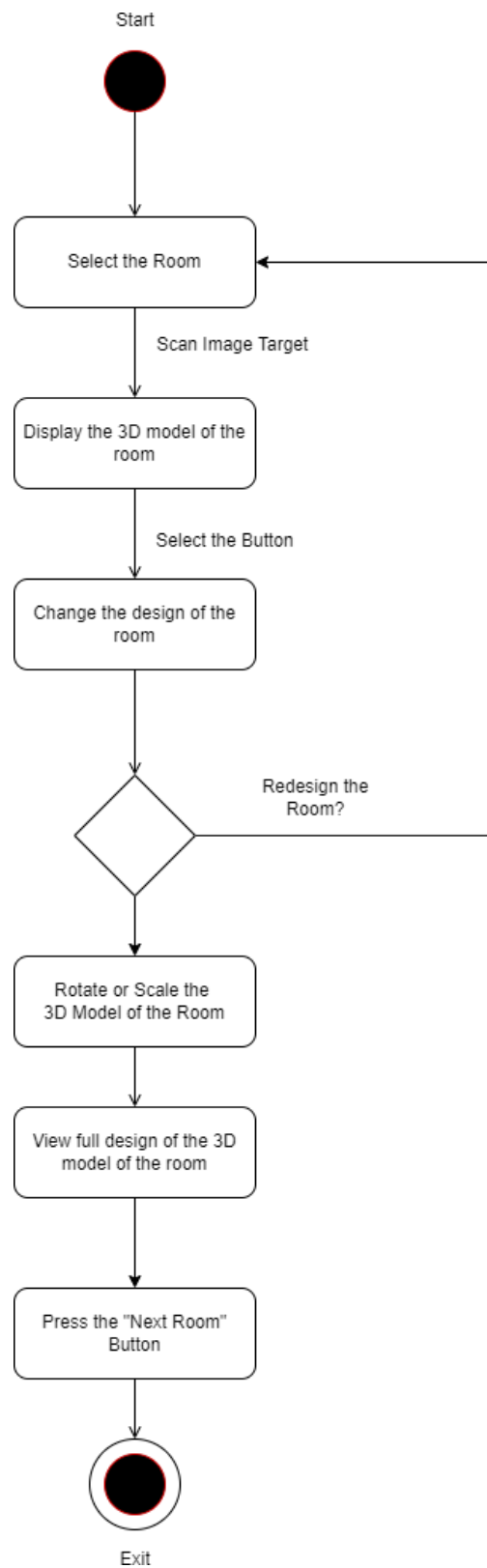
Figure 3.3: Activity Diagram of House Interior Design AR Application.

The flow of this application will be start by scanning the given image targets which is the image target of bedroom, living room, dining room, play area and backyard. After scanning the selected image target such as the bedroom, the application will show the 3D model of the bedroom and allow the user to change some of the design of the living room. For example, the user will be able to change the colour of the wall by using the colour picker that shows in the application. After finished designing the bedroom, the user will be able to select the "Next Room" Button to go to other room. Besides, the user will be able to use the Lean Touch function to rotate and scale the 3D model of the room.

3.4 Rapid Construction

During the rapid construction stage, after the basic prototype is ready, the selected software and hardware will be used to build the application. Moreover, developer is required to find the way and solution to solve the problems in order to develop a successful House Interior Design Augmented Reality (AR) application. The software and hardware, and their specification will be shown in the table below.

Software	Description	Purpose
Unity	Unity 2020 is a cross-platform game engine that is used for game or application development. Unity supports 2-Dimensional (2D) and 3-Dimensional (3D) graphics.	The overall application development will be using Unity such as the 3D environment, Augmented Reality (AR), graphics and other.
Vuforia	Vuforia Engine is a Software Development Kit (SDK) for the development of Augmented Reality (AR). Vuforia Engine is available for Android. iOS, Lumin and UWP devices.	To track a Vuforia target when the image target is scanned during the development of the AR application.

Microsoft Visual Studio	Microsoft Visual Studio is an Integrated Development Environment (IDE) that is used for the software development.	Insert and compile the codes that are required for the AR application.

Table 3.5.1: Software Specification for the Development of Application.

Hardware	Specification	Purpose
Laptop	Brand: Dell. Model: G7 15. Processor: Intel(R) Core i7-8750H CPU @ 2.20 GHz 2.21 GHz. Operating System: Window 10 Memory: 16GB	Build the AR application using the build-in software and tools.
Smartphone	Brand: Realme Model: Realme 5 Pro Operating System: Android 11. CPU: Qualcomm SDM715, Octa-core. RAM: 8.00GB	To run the application for testing purposes.

Table 3.5.2: Hardware Specification for the Development of Application.

In conclusion, the proposed application is developed by using Unity 3D, Vuforia and Microsoft Visual Studio. During the development of the application, Rapid Application Development (RAD) is used. The House Interior Design AR application is expected to function well under Android and can be an alternative way for people to design their desired room.

3.5   Cutover

While in the cutover phase, the developer should ensure the completed application meets all of the proposed objectives and the Augmented Reality (AR) application can run smoothly on Android build. After all of the bugs and errors are fixed by the developer, the application is ready to launch and start the testing phase.

3.6   Testing

This Augmented Reality (AR) application is evaluated using User Acceptance Test (UAT) in the form of questionnaire. The UAT test will be prepared for the feedback of the user. The expected respondent for this UAT test is 20 respondents. The UAT test is responsible to collect all of the feedback on the application about its functionality. This UAT test is distributed to the users after they used the application. The UAT test will be using Google form to collect all of the data. The feedbacks are collected since the developer need to check whether the application meets the criteria or not. The final and the expected result for the proposed application is the application will be able to help the users to design their own house or room without hiring any interior designer.

CHAPTER 4

IMPLEMENTATION, RESULT AND DISCUSSION

4.1 Introduction

This chapter discusses about the whole development and implementation process of the House Interior Design application with Augmented Reality (AR) technology. This process will be included the methodologies that used in this project such as the setup of the AR in Unity, User Interface (UI) Design, the features that apply in this project and the development process for the House Interior Design application.

4.2 Implementation

House Interior Design AR Application is developed by using Unity 3D with the combination usage of Vuforia. The application is able to run on Android that runs on the API level of 26.

4.2.1 User Interfaces and Assets

The User Interfaces (UI) of the AR application are using the Free Assets that available in Unity Asset Store, such as the button of "Mute" button and the "Next Room" button. While some of the 3D models are using the Free Assets from Unity Asset Store and Archive 3D. All of the assets that used in this project are free while the design of the image targets is made by using Canva.

4.2.2 Development Setup

First, I need to download Unity for the development of the Augmented Reality (AR) application. The Unity Hub (64 bit) can be downloaded from its official website.
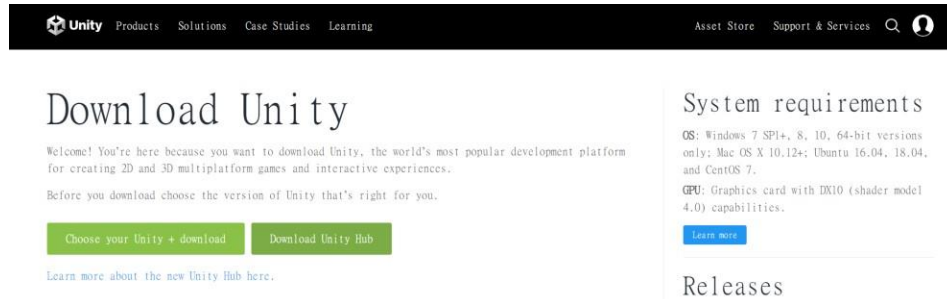
Figure 4.1: Download the Unity Hub from the Official Website.
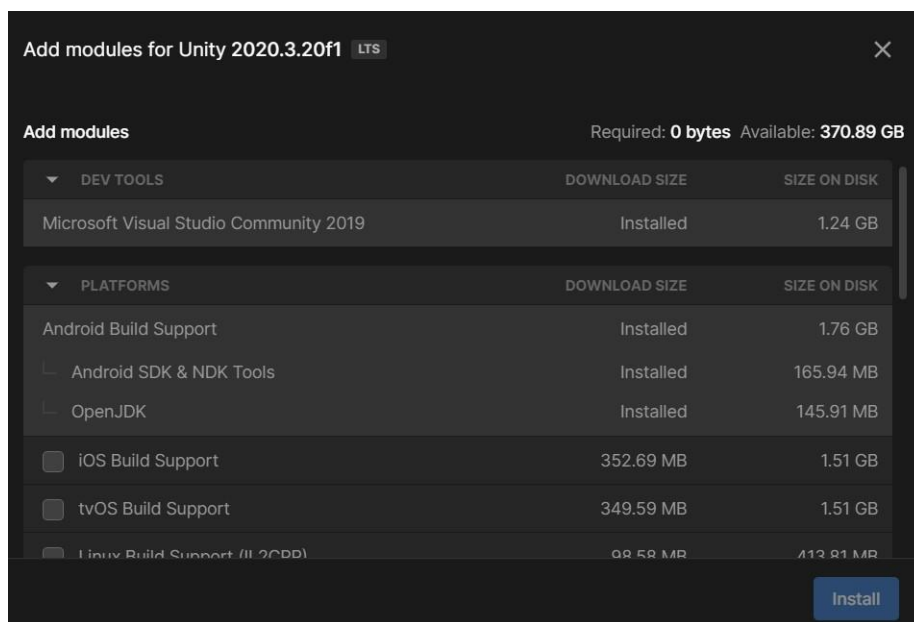
Figure 4.2: Install the Microsoft Visual Studio Community 2019 and the Android Build Support which is the Android SDK & NDK Tools and OpenJDK under the Add Modules option of Unity Hub.

After installed Unity Hub, I choose to install the version of 2020.3.20f1 which will be included with the tools like Microsoft Visual Studio Community 2019 and the Android Build Support for this version of Unity.

Figure 4.3: Download the Microsoft Visual Studio from its official website.

The latest version of Microsoft Visual Studio can be downloaded from its official website. The usage of Microsoft Visual Studio is to create the scripts for the development of the application.

Figure 4.4: Download and install the latest version of Vuforia Engine from its official website.

After successfully download the package of Vuforia Engine, I can import the Vuforia Engine package into Unity, in order to use the function of Augmented Reality (AR).
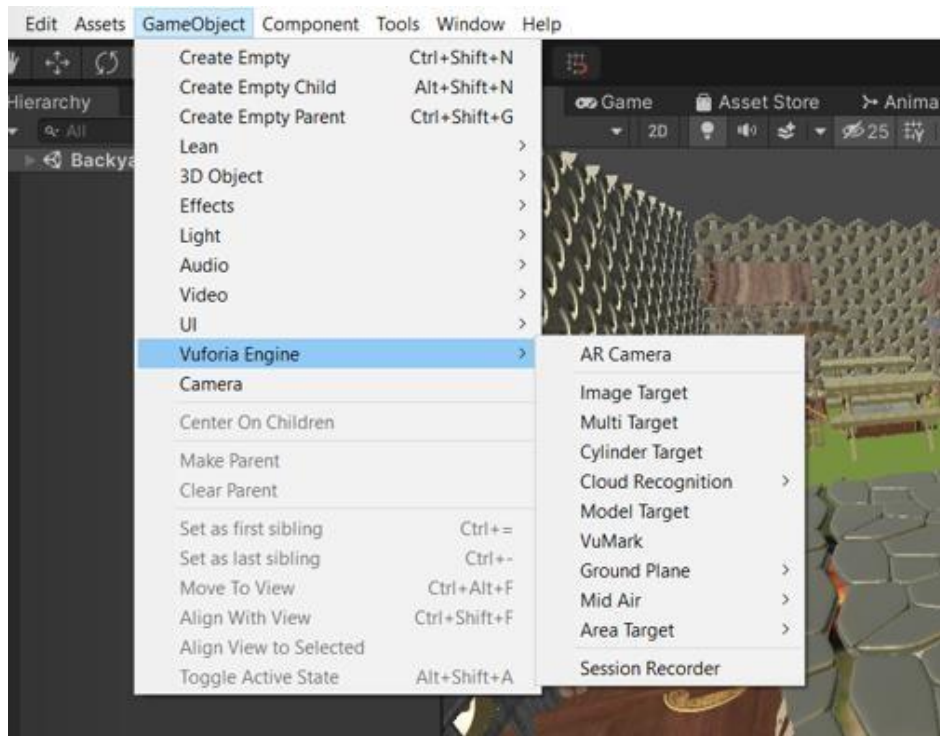
Figure 4.5: Method to check whether the Vuforia Engine is successfully installed in Unity.

After successfully installed the Vuforia Engine, by selecting the "Game Object" and look for "Vuforia Engine", this is to ensure the Vuforia Engine is successfully installed or not.

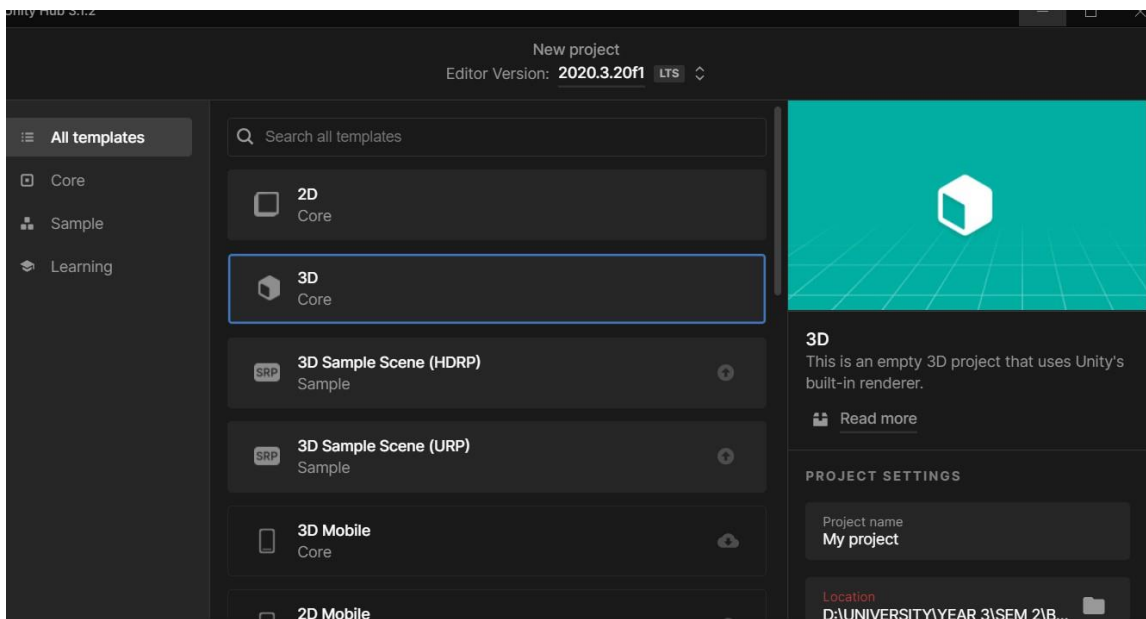### 4.2.3 Development of Augmented Reality (AR) Application

Figure 4.6: Open a new project in Unity.

Open a new project in Unity and select the 3D environment as the templates for this project.

4.2.4 Coding

This is an important part for the development of the AR application which the codes represent an important role for this application. Most of the code is the same, since all of the room has the same function. One of the sample codes will be shown as below, which is the bedroom.

First Room – Bedroom

Figure 4.7: The 3D model of the Bedroom and the functions of the application.

i. ChangeObject Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;


public class ChangeObject : MonoBehaviour
{
    public GameObject object1, object2, object3;
    public GameObject[] object3D = new GameObject[3];
    public int no = 1;

    public void Start()
    {
        object3D[0] = object1;
        object3D[1] = object2;
        object3D[2] = object3;
    }


    public void OnGUI()
    {
        GUIStyle ButtonStyle = new GUIStyle(GUI.skin.button);
        ButtonStyle.fontSize = 80;

        if (GUI.Button(new Rect(50, 40, 800, 100), "Change Armchair",
ButtonStyle))
        {
            nextObject();

        }
```

```
        }

    public void nextObject()
    {
        if (no == 3)
        {
            no = no-2;

        }

        else if (no > 0 && no < 3)
        {
            no++;

        }
    }



    public void Update()
    {
        if (no == 1)
        {
            object1.SetActive(true);
            object2.SetActive(false);
            object3.SetActive(false);
        }

        if (no == 2)
        {
            object1.SetActive(false);
            object2.SetActive(true);
            object3.SetActive(false);
        }

        if (no == 3)
        {
            object1.SetActive(false);
            object2.SetActive(false);
            object3.SetActive(true);

        }


    }
}
```

This code allows the user to change the armchair with 3 different objects which also
including the armchair itself.

ii. ChangeBed Script

```csharp
using System.Collections;
using System.Collections.Generic;
using UnityEngine;


public class ChangeBed : MonoBehaviour
{
    public GameObject object1, object2, object3;
    public GameObject[] object3D = new GameObject[3];
    public int no = 1;

    public void Start()
    {
        object3D[0] = object1;
        object3D[1] = object2;
        object3D[2] = object3;
    }


    public void OnGUI()
    {
        GUIStyle ButtonStyle = new GUIStyle(GUI.skin.button);
        ButtonStyle.fontSize = 80;

        if (GUI.Button(new Rect(50, 170, 800, 100), "Change Bed",
ButtonStyle))
        {
            nextObject();

        }


    }

    public void nextObject()
    {
        if (no == 3)
        {
            no = no-2;

        }

        else if (no > 0 && no < 3)
        {
            no++;

        }
    }


    public void Update()
    {
        if (no == 1)
        {
            object1.SetActive(true);
            object2.SetActive(false);
            object3.SetActive(false);
        }
```

```
        if (no == 2)
        {
            object1.SetActive(false);
            object2.SetActive(true);
            object3.SetActive(false);
        }

        if (no == 3)
        {
            object1.SetActive(false);
            object2.SetActive(false);
            object3.SetActive(true);


        }


    }
}
```

While this code allows the user to change 3 different styles of bed.

iii. ChangeLamp Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;


public class ChangeLamp : MonoBehaviour
{
    public GameObject object1, object2;
    public GameObject[] object3D = new GameObject[2];
    public int no = 1;

    public void Start()
    {
        object3D[0] = object1;
        object3D[1] = object2;


    }


    public void OnGUI()
    {
        GUIStyle ButtonStyle = new GUIStyle(GUI.skin.button);
        ButtonStyle.fontSize = 80;

        if (GUI.Button(new Rect(50, 300, 800, 100), "Change Lamp",
ButtonStyle))
        {
            nextObject();
```

```
            }


        }

        public void nextObject()
        {
            if (no == 2)
            {
                no = no-1;

            }

            else if (no > 0 && no < 2)
            {
                no++;

            }
        }



        public void Update()
        {
            if (no == 1)
            {
                object1.SetActive(true);
                object2.SetActive(false);

            }

            if (no == 2)
            {
                object1.SetActive(false);
                object2.SetActive(true);

            }



        }
    }
```

This code allows the user to change 2 different types of lamps.

iv. ChangePainting Script

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class ChangePainting : MonoBehaviour
{
    public GameObject object1, object2, object3;
    public GameObject[] object3D = new GameObject[3];
    public int no = 1;

    public void Start()
    {
        object3D[0] = object1;
        object3D[1] = object2;
        object3D[2] = object3;
    }


    public void OnGUI()
    {
        GUIStyle ButtonStyle = new GUIStyle(GUI.skin.button);
        ButtonStyle.fontSize = 80;

        if (GUI.Button(new Rect(50, 430, 800, 100), "Change Painting",
ButtonStyle))
        {
            nextObject();

        }


    }

    public void nextObject()
    {
        if (no == 3)
        {
            no = no - 2;

        }

        else if (no > 0 && no < 3)
        {
            no++;

        }
    }


    public void Update()
    {
        if (no == 1)
        {
            object1.SetActive(true);
            object2.SetActive(false);
            object3.SetActive(false);
        }
```

```
            if (no == 2)
            {
                object1.SetActive(false);
                object2.SetActive(true);
                object3.SetActive(false);
            }

            if (no == 3)
            {
                object1.SetActive(false);
                object2.SetActive(false);
                object3.SetActive(true);

            }


        }
    }
```

While this code allows the user to change 3 different types of painting.

v. SceneLoader Script

```
    using System.Collections;
    using System.Collections.Generic;
    using UnityEngine;
    using UnityEngine.SceneManagement;

    public class SceneLoader : MonoBehaviour
    {
        public void LoadScene()
        {
            SceneManager.LoadScene("LivingRoom");
        }
    }
```

This code allows the user to go to the next room which is Living Room, which living room is the second room after the bedroom by pressing the "Next Room" button.

vi. SceneLoaderP1 Script

```csharp
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.SceneManagement;

public class SceneLoaderP1 : MonoBehaviour
{
    public void LoadScene()
    {
        SceneManager.LoadScene("Backyard");
    }
}
```

This code allows the user to go to the previous room which is Backyard, which backyard is the last room. To go to the previous room, the user will need to press the "Previous Room" button.

vii. ExitApplication Script

```csharp
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;

public class ExitApplication : MonoBehaviour
{
    public Canvas start;
    public Button exit;

    public void Quit()
    {
        Application.Quit();
    }

}
```

This code allows the user to exit the application by pressing the "X" button.

4.2.5 Publish the Application
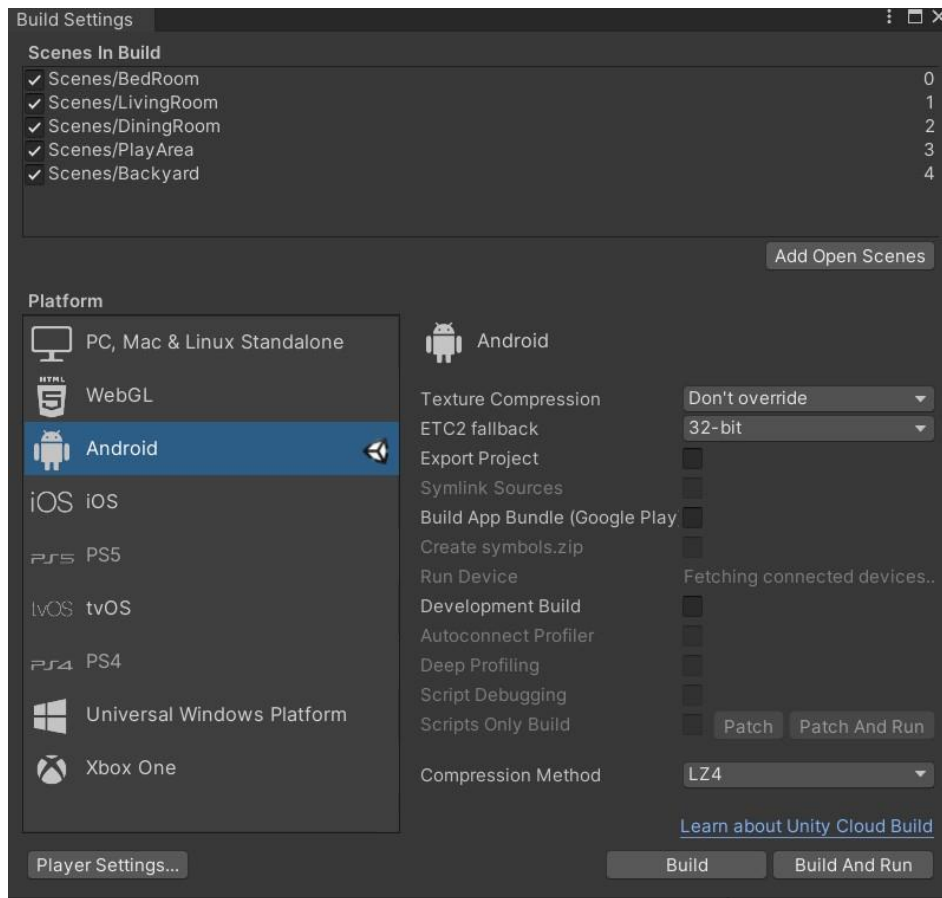
Figure 4.8: Build Setting for the AR Application.

Before publishing the application, all of the scenes should be added into the Build.
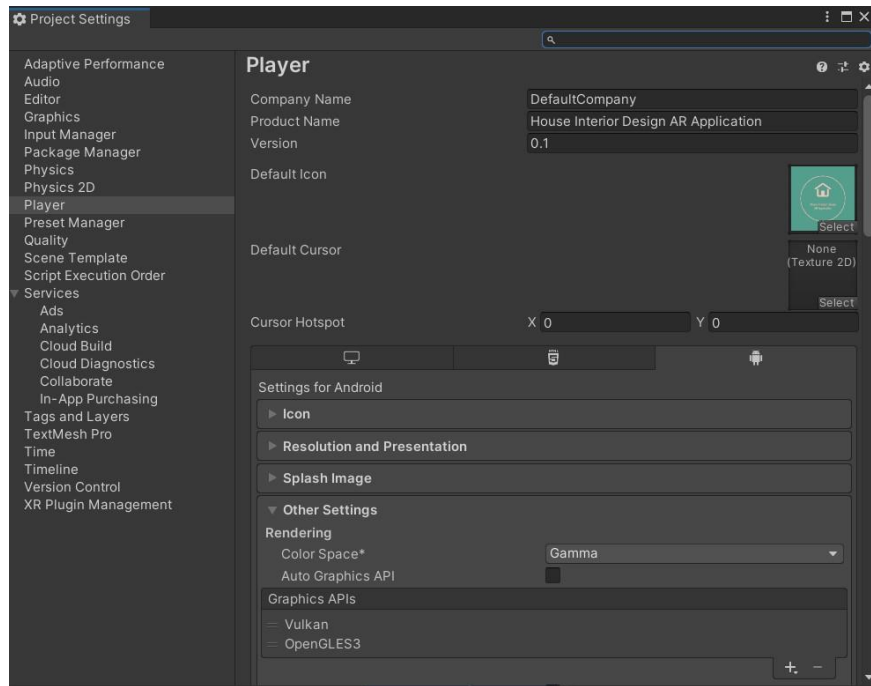
Figure 4.9: Player Setting for the AR Application.

Upload the logo and insert the application name for the AR application, then the application is ready to use.

4.3   Result
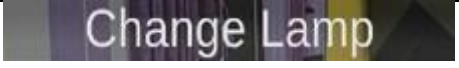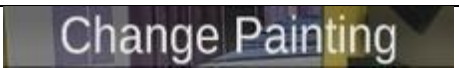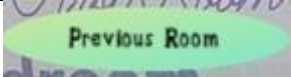
After successfully published the application on Android, now the House Interior Design AR application can be used and will be able to collect feedbacks from the users after the users have experienced the application.
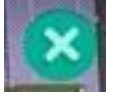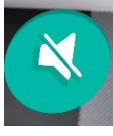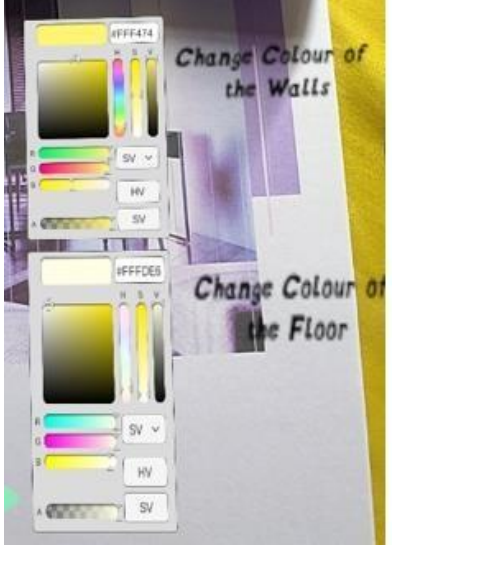
4.3.1 First Room - Bedroom

Figure 4.10: First Room, the bedroom of the AR Application.

Functionality Buttons:

Button	Function
Change Armchair	Press this button to change the armchair to other objects.
Change Bed	Press this button to change the types of bed.
Change Lamp	Press this button to change the types of lamp.
Change Painting	Press this button to change the paintings.
Previous Room	Press this button to go back to the previous room.
Next Room	Press this button to go to the next room.

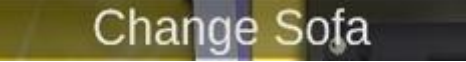|	
	Press this button to exit the application.
	Press this button to mute or unmute the background music.
	Press the area of the colour pickers to change the colour of the wall and the colour of the floor.

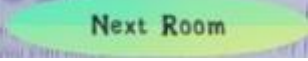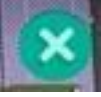### 4.3.2 Second Room – Living Room
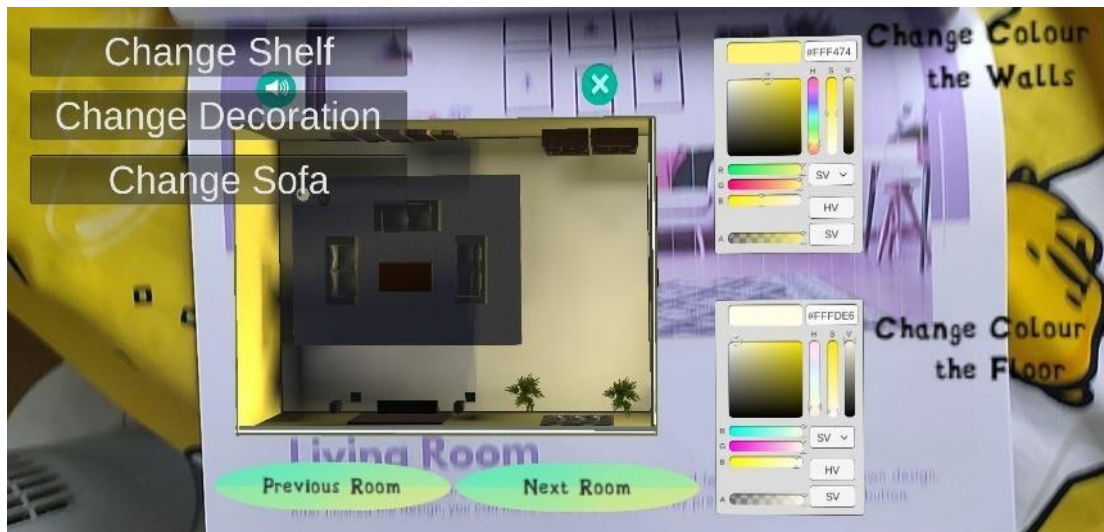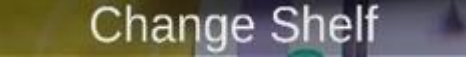
Figure 4.3.1.2: Second Room, the living room of the AR Application.

Functionality Buttons:

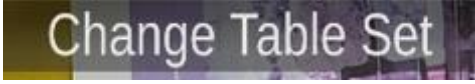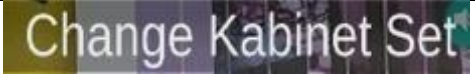| Button	Function
Change Shelf	Press this button to change the shelf to other design.
Change Decoration	Press this button to change the decoration.
Change Sofa	Press this button to change the types of the sofa.
Previous Room	Press this button to go back to the previous room.
Next Room	Press this button to go to the next room.
⊗	Press this button to exit the application.
🔇	Press this button to mute or unmute the background music.
Change Colour the Walls / Change Colour the Floor	Press the area of the colour pickers to change the colour of the wall and the colour of the floor.

4.3.3   Third Room – Dining Room

Figure 4.11: Third Room, the dining room of the AR Application.

Functionality Buttons:

Button	Function
Change Table Set	Press this button to change the table sets.
Change Bar Set	Press this button to change the bar sets.
Change Kabinet Set	Press this button to change the cabinet set.
Previous Room	Press this button to go back to the previous room.
Next Room	Press this button to go to the next room.
(X)	Press this button to exit the application.

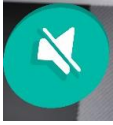|	
	Press this button to mute or unmute the background music.
	Press the area of the colour pickers to change the colour of the wall and the colour of the floor.

4.3.4 Fourth Room – Play Area

Figure 4.12: Fourth Room, the play area of the AR Application.
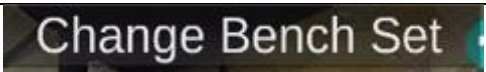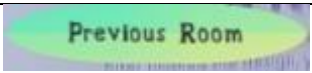
Functionality Buttons:

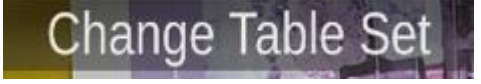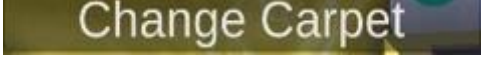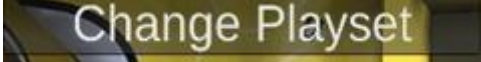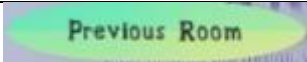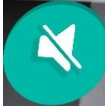| Button	Function
Change Table Set	Press this button to change the table sets.
Change Carpet	Press this button to change the carpets.
Change Playset	Press this button to change the playsets.
Previous Room	Press this button to go back to the previous room.
Next Room	Press this button to go to the next room.
	Press this button to exit the application.
	Press this button to mute or unmute the background music.
	Press the area of the colour pickers to change the colour of the wall and the colour of the floor.
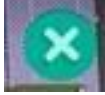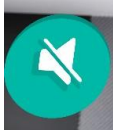
4.3.5   Last Room – Backyard

Figure 4.13: Last Room, the backyard of the AR Application.

Functionality Buttons:

Button	Function
Change Bench Set	Press this button to change the bench sets.
Change Table Set	Press this button to change the table sets.
Change Floor	Press this button to change the styles of the floor.
Change Grill Set	Press this button to change the grill sets.
Change Centre Table	Press this button to change the centre table.
Previous Room	Press this button to go back to the previous room.
Next Room	Press this button to go to the next room.

	Press this button to exit the application.
	Press this button to mute or unmute the background music.

4.4 Testing

The testing process is to ensure the objectives of the application is reached. The AR application is tested by the users and the users will be able to fill in a Google form and give their feedback about the application.

4.4.1 User Acceptance Test (UAT)

There will be 20 respondents are selected to test the application. There will be 8 questions about the specification of the application and 1 question for further improvement of the application.
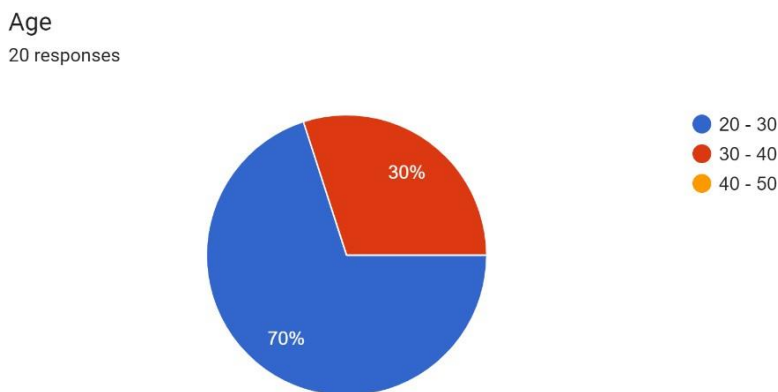
Figure 4.14: Age of respondents.

This pie chart shows 30% of the respondents are between 30 years old until 40 years old while there are 70% of the respondents are between 20 years old until 30 years old.

Gender

20 responses
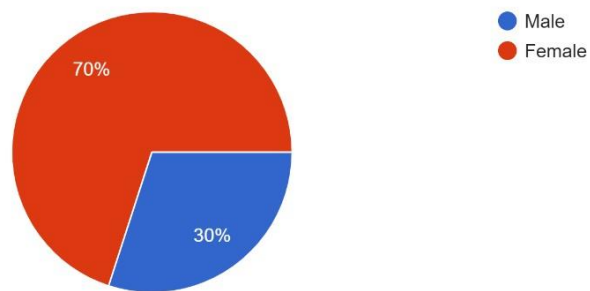
Figure 4.15: Gender of respondents.

This pie chart shows 30% of the respondents are male while there are 70% of the respondents are female.

Do you know what is Augmented Reality?

20 responses
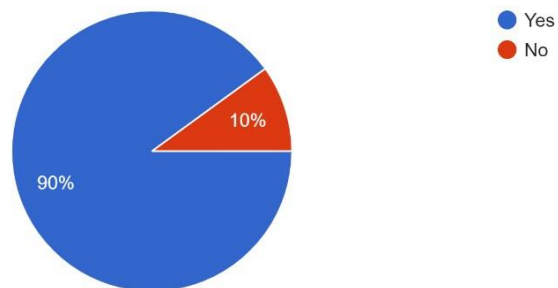
Figure 4.16: Knowledge of Augmented Reality of the respondents.

This pie chart shows 90% of the respondents which they know what Augmented Reality is, while there are 10% of the respondents does not know what Augmented Reality is.

This application is useful for designing the house or room.
20 responses
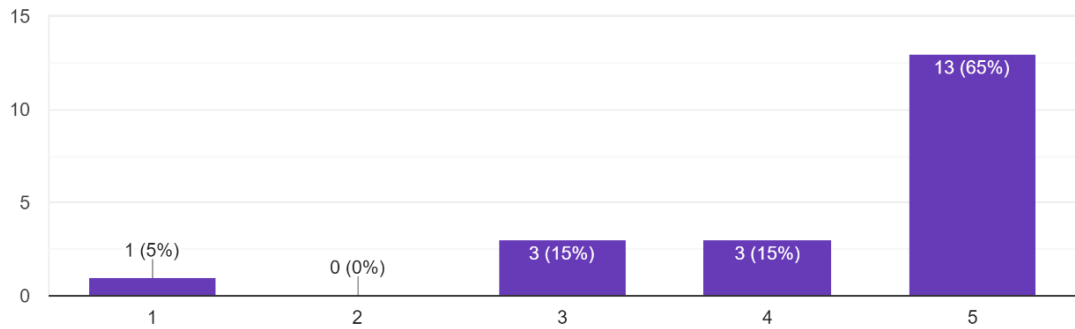
Figure 4.17: This application is useful for designing the house or room.

Based on the figure above, there are 13 respondents (65%) who strongly agree that the application is useful for designing the house or room. While there are 3 respondents (15%) who agree that the application is useful for designing the house or room and there are also 3 respondents (15%) feel neutral that the application is useful for designing the house or room. While there are only 1 respondent (5%) who strongly disagree that the application is useful for designing the house or room.

This application is easy to use and user-friendly.
20 responses
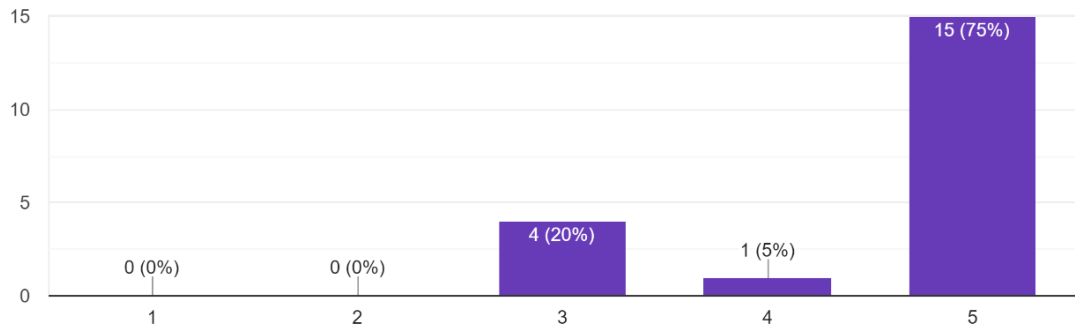
Figure 4.18: This application is easy to use and user-friendly.

Based on the figure above, there are 15 respondents (75%) who strongly agree that the application is easy to use and user-friendly and there are 4 respondents (20%) who stays neutral to the statement, while there are only 1 respondent (5%) agrees that the application is easy to use and user-friendly.

This application is functioning well and run without any errors.

20 responses
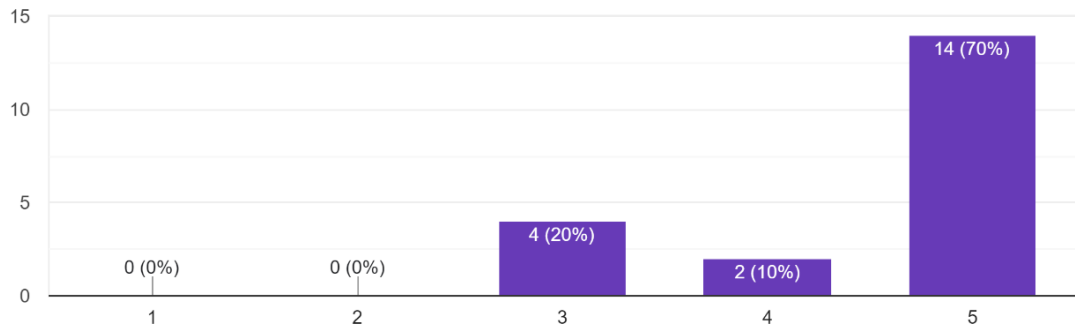
Figure 4.19: This application is functioning well and run without any errors.

Based on the figure above, there are 14 respondents (70%) who strongly agree that this application is functioning well and run without any errors and there are 4 respondents (20%) who stays neutral to the statement, while there are only 1 respondent (5%) agrees that this application is functioning well and run without any errors.

The 3D model in this application is detailed and clear to see.
20 responses
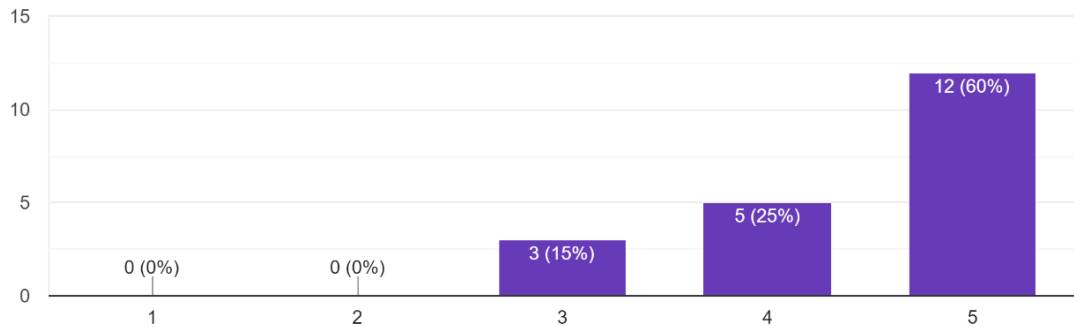
Figure 4.20: The 3D model in this application is detailed and clear to see.

Based on the figure above, there are 12 respondents (60%) who strongly agree that the 3D model in this application is detailed and clear to see and there are 5 respondents (25%) agree to the statement, while there are 3 respondent (15%) who stay neutral to this statement.

Please rate your satisfaction of this House Interior Design AR application.
20 responses
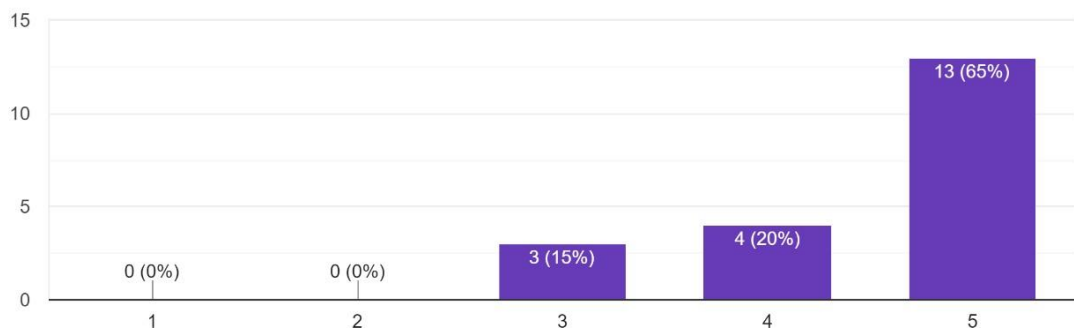
Figure 4.21: Please rate your satisfaction of this House Interior Design AR application.

Based on the figure above, there are 13 respondents (65%) who strongly agree that this application has reached their satisfaction and there are 4 respondents (20%) agree to the statement, while there are 3 respondent (15%) who stay neutral to this statement.

Is there any improvement needs to be done for this House Interior Design AR application? If yes, please state your reason.

20 responses
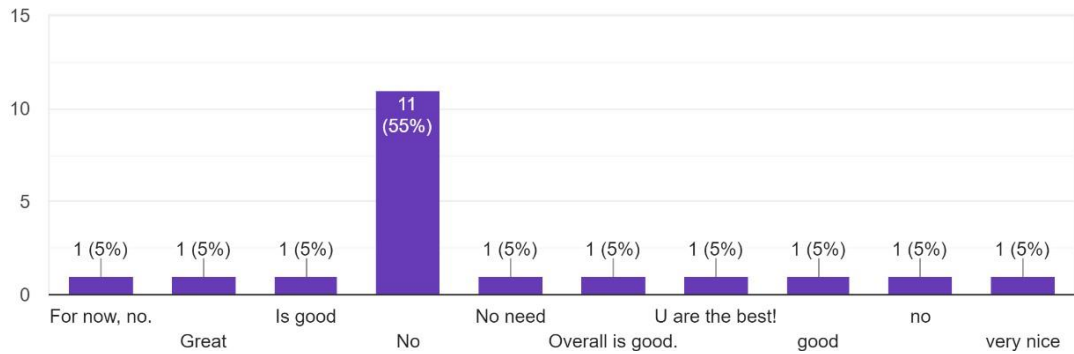
Figure 4.22: Any improvement that needs to be done to improve this application.

Based on the figure above, most of the respondents feel that the overall of the application is good.

CHAPTER 5

CONCLUSION

5.1   Introduction

In conclusion, House Interior Design Augmented Reality (AR) application is a marker-based House Interior Design AR application that developed to use without using any special equipment. The proposed AR application can help the users to design their own house without hiring any interior designers. The user feedback about the House Interior Design AR application generally agrees that the AR application has achieved its objectives. By using the AR technology, the users are able to know which features are available in this application. Besides, the features will help the users to have a better view of the room after the users have finished designing their room. The proposed AR application does not require any internet connection and it can be played by any Android phone user. The development of this application is helpful in filling up the experience of the House Interior Design AR application since the existing House Interior Design AR application still needs to be improved in each aspect.

5.2 Limitation

There are a lot of problems and obstacles occurred during the development phase of the AR application. The biggest problem during the development phase is to use the correct code and implement the code into the correct object since the coding process requires a lot of time to create a correct and functional code for the particular function. The debugging process is also required a lot of time to debug the potential situation because for the last environment which is the backyard, it contains too much of the 3D model, thus the process is become more lagging than the other environment. Furthermore, publishing the AR application is becoming a challenge of the whole project too. The exportation of the AR application to the mobile phone is taking much more time than I expected and sometimes Unity will crash during the exportation of the application, atlast, I need to restart Unity and export the application again. But fortunately, these problems can be overcome during the development of the application.

5.3 Future Work

There are a few future works that can be done to improve the AR application. This application can improve the user interface of the application which to allow the users to have better understanding about the interface. Besides, the AR application can be improved by adding some movable furniture for the users to move, which helps to enhance the experience of AR house interior design. Furthermore,by adding some instruction into the AR application can be an improvement for the users to understand easily about the features of the application. Moreover, since the current AR application only available in Android device, thus for the future work, the iOS version of the AR application should be build in order to increase the iOS users and improve their AR house interior design as well.

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APPENDIX A

GANTT CHART

Description	Start Date	End Date	Duration (Days)
Requirements planning			
Brainstorming	28 January 2022	28 February 2022	28
Set the Title, Objectives and Scope of the Project	28 March 2022	2 March 2022	5
Determine the Problem Statement	2 March 2022	3 March 2022	1
Do Research on the Topic	3 March 2022	7 March 2022	4
Compare the Existing Application	7 March 2022	11 March 2022	4
Identify the System Requirement and Development Process	11 March 2022	14 June 2022	3
User Design			
Use Case Diagram, Activity Diagram	14 March 2022	16 March 2022	2
Storyboard	16 March 2022	20 March 2022	4
Revise Prototype	20 March 2022	1 June 2022	73

Rapid Construction			
Import 3D Model and Fix Texture	1 June 2022	1 August 2022	61
Coding	1 August 2022	1 September 2022	31
Build Application	1 September 2022	10 September 2022	9
Cutover			
Fix Error and Bug	10 September 2022	10 October 2022	30
Evaluate			
UAT Test	10 October 2022	12 October 2022	2
Final Test	12 October 2022	16 October 2022	4

HOUSE INTERIOR DESIGN WITH AR TECHONOLOGY APPLICATION

Thursday, 28/01/2022

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TASK	PROGRESS	START	END
Requirement Planning		**28 Jan, 2022**	**14 Mar, 2022**
Brainstorming	100%	28 Jan, 2022	28 Feb, 2022
Set the Title, Objectives and Scope of the Project	100%	28 Mar, 2022	2 Mar, 2022
Determine the Problem Statement	100%	2 Mar, 2022	3 Mar, 2022
Do Research on the Topic	100%	3 Mar, 2022	7 Mar, 2022
Compare the Existing Application	100%	7 Mar, 2022	11 Mar, 2022
Identify the System Requirement and Development Process	100%	11 Mar, 2022	14 Mar, 2022
User Design		**14 Mar, 2022**	**1 Jun, 2022**
Use Case Diagram, Activity Diagram	100%	14 Mar, 2022	16 Mar, 2022
Storyboard	100%	16 Mar, 2022	20 Mar, 2022
Revise Prototype	100%	20 Mar, 2022	1 Jun, 2022
Rapid Construction		**1 Jun, 2022**	**10 Sep, 2022**
Import 3D Model and Fix Texture	0%	1 Jun, 2022	1 Aug, 2022
Coding	0%	1 Aug, 2022	1 Sep, 2022
Build Application	0%	1 Sep, 2022	10 Sep, 2022
Cutover		**10 Sep, 2022**	**10 Oct, 2022**
Fix Error and Bug	0%	10 Sep, 2022	10 Oct, 2022
Evaluate			
UAT Test	0%	10 Oct, 2022	12 Oct, 2022
Final Test	0%	12 Oct, 2022	16 Oct, 2022

APPENDIX B

USER FEEDBACK FORM (UAT)

APPENDIX C

CATALOG FOR HOUSE INTERIOR DESIGN AR APPLICATION

What is Augmented Reality (AR)

According to Adam Hayes, Augmented Reality (AR) is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound or other sensory stimuli delivered via technology (Hayes, A, 2022).

Note: You are highly recommended to download this PDF and print it out to experience the AR House Interior Design Application.

How to use this Application?

Colour Changes

You can change the colour of the walls and floor in each room **except** for the backyard.

Furniture and Decoration Changes

You can change some of the objects in each room by pressing the buttons.

Lean Touch

You can use your finger to scale and rotate the selected room to have a better vision of the room.

Mute Background Music

You can mute the background music by pressing the sound button on the top left side.

The First Room

Bedroom

Please scan this image target to have a view of the room and feel free to make your own design. After finished the design, you can move on to the next room by pressing the "Next Room" button.

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The Second Room

Living Room

Please scan this image target to have a view of the room and feel free to make your own design. After finished the design, you can move on to the next room by pressing the "Next Room" button.

The Third Room

Dining Room

Please scan this image target to have a view of the room and feel free to make your own design. After finished the design, you can move on to the next room by pressing the "Next Room" button.

The Fourth Room

Play Area

Please scan this image target to have a view of the room and feel free to make your own design. After finished the design, you can move on to the next room by pressing the "Next Room" button.

The Last Room

Backyard

Please scan this image target to have a view of the room and feel free to make your own design. After finished the design, you can move on to the next room by pressing the "Next Room" button.

Thank you

FOR USING THIS APPLICATION

Thank you so much for your support.