

UTAR Campus Tour Within Minutes via Augmented Reality (AR)

By

TEH WAN HUI

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF COMPUTER SCIENCE (HONOURS)

Faculty of Information and Communication Technology

(Kampar Campus)

JANUARY 2021

REPORT STATUS DECLARATION FORM

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Date : _____ 14th April 2021 _____

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ABSTRACT

Campus tour is one of the most exciting moments as well as one of the decision-making processes when students are looking for the right university. During the campus visit, students can grab the opportunities to explore the campus environment while the universities can take the chance to promote their campus. However, the traditional campus visits require visitors to be physically present in the campus. As UTAR Kampar campus is located far away from the city, this poses a great challenge for the visitors to visit the campus physically. In addition, as the campus size is up to 1300 acres, it can be tiring for the visitors to visit every single corner of the university during the campus tour.

The proposed project addresses these problems by developing an android mobile application that can provide the convenience and freedom for the users to visit the UTAR campus virtually. To enhance the user experience, markerless AR technology is chosen to deliver a 3D view of the campus to the users. The 3D models are designed and created through Blender, while the application is developed by using both Unity game engine and Android Studio. This project applied prototyping methodology by making improvements through collecting feedback from the users. The novelty of this project is that there is no existing work done on the markerless AR Tour to UTAR Kampar campus in Android. In a nutshell, this project enables users to explore and enjoy the full view of UTAR Kampar campus without the need of physical travel via augmented reality.

TABLE OF CONTENTS

FRONT COVER	i
REPORT STATUS DECLARATION FORM	ii
TITLE PAGE	iii
DECLARATION OF ORIGINALITY	iv
ACKNOWLEDGEMENTS	v
ABSTRACT	vi
TABLE OF CONTENTS	vii
LIST OF FIGURES	x
LIST OF TABLES	xiii
LIST OF ABBREVIATIONS	xiv
CHAPTER 1 INTRODUCTION	1
1.1 Problem Statement	1
1.2 Background	2
1.3 Motivation	5
1.4 Project Objectives	5
1.5 Project Scope.....	6
1.6 Proposed Approach for AR Module.....	7
1.7 Highlight of What Have Been Achieved.....	8
1.8 Report Organization	8
CHAPTER 2 LITERATURE REVIEW	9
2.1 USM Virtual Tour	9
2.2 SB Sanal Tur	11
2.3 RIT AR.....	13
2.4 Sahmyook University AR Tour.....	15
2.5 Fu- Jen University Mobile Campus Touring System.....	16

2.6 Comparison Between Reviewed Systems and Proposed System	17
2.7 Summary	19
CHAPTER 3 SYSTEM DESIGN	20
3.1 System Module.....	20
3.2 Use Case Diagram.....	22
3.3 System Flowchart.....	23
CHAPTER 4 DESIGN SPECIFICATION.....	30
4.1 Methodology	30
4.2 Development Tools	32
4.3 User Requirements	34
4.3.1 Connectivity Requirements for Users.....	34
4.3.2 Hardware Requirements for Users	34
4.3.3 Software Requirements for Users.....	35
4.4 Survey Analysis.....	35
4.5 Verification Plan	37
4.6 Implementation Issues and Challenges	40
4.7 Project Timeline	41
CHAPTER 5 SYSTEM IMPLENTATION AND TESTING	43
5.1 Building of 3D model in Blender.....	43
5.2 Implementation of AR module in Unity	44
5.2.1 Set Up of Vuforia engine in Unity.....	44
5.2.2 Development of AR Module	45
5.3 Export of AR module in Unity to Android Studio	53
5.4 Import of AR module from Unity to Android Studio	54
5.5 Functionalities Testing	56
5.6 User Acceptance Testing.....	63
CHAPTER 6 CONCLUSION.....	65

6.1 Project Review, Discussion and Conclusions	65
6.2 Novelties and Contribution of Work.....	65
6.3 Future Work	66
BIBLIOGRAPHY	67
APPENDIX.....	A
LIST OF DEVICES SUPPORTED BY VUFORIA	A
POSTER.....	B
PLAGIARISM CHECK RESULT.....	C
BIWEEKLY REPORT.....	D
FYP CHECKLIST	E

LIST OF FIGURES

Figure Number	Description	Page
Figure 1-1-1	UTAR Kampar Campus Map	1
Figure 1-2-1	Example of Instagram AR Effect	3
Figure 1-2-2	Example of Snapchat AR Effect	3
Figure 1-2-3	IKEA PLACE Application	3
Figure 1-6-1	Flow of Proposed Approach for AR Module	7
Figure 2-1-1-1	Logo of USM Virtual Tour Application	9
Figure 2-1-1-2	Main page of USM Virtual Tour Application	9
Figure 2-1-1-3	List of point of interest provided by the application	10
Figure 2-1-1-4	AR navigation to the destination	10
Figure 2-2-1-1	SB Sanal Tur Application Logo	11
Figure 2-2-1-2	Main Page of SB Sanal Tur	11
Figure 2-2-1-3	Marker inside SB Sanal Tur <i>Campus</i>	12
Figure 2-2-1-4	Content Trigger by Marker	12
Figure 2-3-1-1	RIT AR Logo	13
Figure 2-3-1-2	Main Page RIT AR	13
Figure 2-3-1-2	Highlighted Events in Rochester Institute of Technology	14
Figure 2-4-1-1	Sahmyook University AR Tour Logo	15
Figure 2-4-1-2	Main Page Sahmyook University AR Tour	15
Figure 3-1-1	System Module	20
Figure 3-2-1	Use Case Diagram for UTAR Campus Tour Application	22
Figure 3-3-1	First Part of the System Flow Chart	23
Figure 3-3-2	Second Part of the System Flow Chart	24
Figure 3-3-3	Third Part of the System Flow Chart	25
Figure 3-3-4	Fourth Part of the System Flow Chart	26
Figure 3-3-5	Fifth Part of the System Flow Chart	27
Figure 3-3-6	Sixth Part of the System Flow Chart	28
Figure 3-3-7	Last Part of the System Flow Chart	29
Figure 4-1-1	Prototyping Methodology	30
Figure 4-7-1	Gantt chart for FYP 1 October 2020 Session	41
Figure 4-7-2	Gantt chart for FYP 2 January 2021 Session	42

Figure 5-1-1	Development of 3D model in Blender	43
Figure 5-1-2	Development of 3D Terrain in Blender	43
Figure 5-2-1	Development of AR Module in Unity	44
Figure 5-2-2-1	Specifications of AR Camera	45
Figure 5-2-2-2	Specifications of Plane Finder	45
Figure 5-2-2-3	Specifications of Ground Plane Stage	46
Figure 5-2-2-4	Objects Located under Ground Plane Stage	46
Figure 5-2-2-5	Main Page of AR Module	47
Figure 5-2-2-6	Guideline for AR Module	47
Figure 5-2-2-7	Orange Button Shown on Screen	48
Figure 5-2-2-8	Orange Button Hide on Screen	48
Figure 5-2-2-9	Script for Show & Hide Button	49
Figure 5-2-2-10	Script for Button to Follow the Objects	49
Figure 5-2-2-11	Main Page of AR Module	50
Figure 5-2-2-12	Script to Change Scene	50
Figure 5-2-2-13	Interior View with Description Panel	51
Figure 5-2-2-14	Interior View without Description Panel	51
Figure 5-2-2-15	Simulation of Individual Building	52
Figure 5-3-1	Specification in Player Settings	53
Figure 5-4-1	Code to Add in setting.gradle file	54
Figure 5-4-2	Code to Add in build.gradle file	54
Figure 5-4-3	Code to Add in build.gradle file	55
Figure 5-4-4	Code to Add in AndroidManifest.xml	55
Figure 5-5-1	Splash Screen of the Application	56
Figure 5-5-2	Home Page of the Application	57
Figure 5-5-3	Navigation Drawer of the Application	58
Figure 5-5-4	Alert Message Shown When User Selects Exit	58
Figure 5-5-5	User Interface for Programme Module	59
Figure 5-5-6	User Interface for FAQ Module	59
Figure 5-5-7	System Prompt for Location Access	60
Figure 5-5-8	User Interface for Map Module	60
Figure 5-5-9	User Interface for Video Tour Module	60

Figure 5-5-10	System Prompt for Camera Access Permission	62
Figure 5-5-11	User Interface for AR Tour Module	62

LIST OF TABLES

Table Number	Description	Page
Table 2-6-1	Comparison of Existing System with Proposed System	18
Table 4-2-2-1	Laptop Model for Development	33
Table 4-2-2-2	Mobile Device Model for Development	33
Table 4-3-1-1	Connectivity Requirements for Users	34
Table 4-3-2-1	Hardware Requirements for Users	34
Table 4-3-3-1	Software Requirements for Users	35
Table 4-4-1	Interview Questions for Survey Analysis	35
Table 4-4-2	Summary of User Requirements	36
Table 4-5-1	Verification Plan for Application Splash Screen	37
Table 4-5-2	Verification Plan for Application Home Page	37
Table 4-5-3	Verification Plan for Navigation Drawer	38
Table 4-5-4	Verification Plan for Programmes & FAQ Module	39
Table 4-5-5	Verification Plan for Map Module & Video Module	39
Table 4-5-6	Verification Plan for AR Tour Module	40
Table 5-5-1	Test Result for Application Splash Screen	56
Table 5-5-2	Test Result for Application Home Page	57
Table 5-5-3	Test Result for Navigation Drawer	59
Table 5-5-4	Test Result for Programmes Module & FAQ Module	60
Table 5-5-5	Test Result for Map Module & Video Module	61
Table 5-5-6	Test Result for AR Tour Module	63
Table 5-6-1	Summary Feedbacks of User Acceptance Testing	64

LIST OF ABBREVIATIONS

Abbreviation	Full Text
AR	Augmented Reality
GPS	Global Positioning System
IDE	Integrated Development Environment
RAM	Random Access Memory
UAT	User Acceptance Testing
UTAR	University Tunku Abdul Rahman
VR	Virtual Reality
XML	Extensible Markup language
3D	Three-dimensional

CHAPTER 1 INTRODUCTION

1.1 Problem Statement

Unable to be physically present in the actual campus.

Campus visit is an important part of the decision-making process as this decision will affect one's whole life. One can get the chance to evaluate the details of the campus environment as well as facilities during campus visit. Nevertheless, UTAR Kampar campus is located far away from the city which requires two hours'-drive by car from Kuala Lumpur. Although there are bus station and train station in Kampar town, however, without a car, it is yet a challenge for the visitor to reach to the campus. Thus, this poses a great hindrance, in terms of time, distance and money for visitors from other states or countries to be physically present in the campus.

Lost in the university

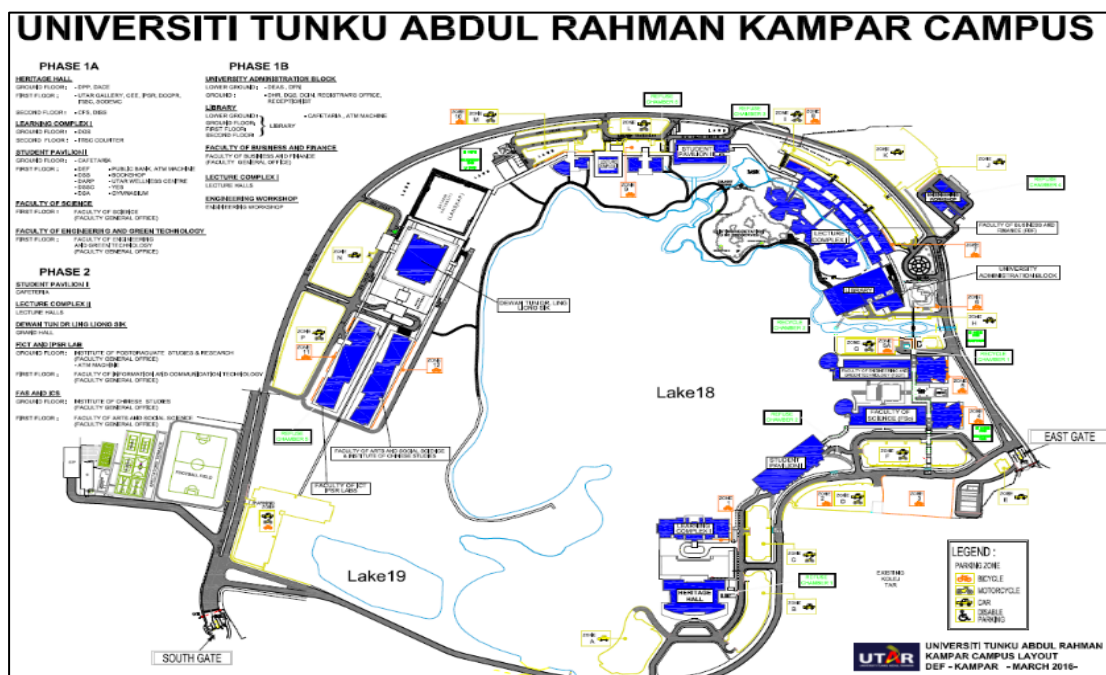


Figure 1-1-1: UTAR Kampar Campus Map (UTAR,2021)

As UTAR Kampar campus was built on a 1300 acres piece of land, even if the visitor is able to visit the campus physically, due to the campus' complex structures and path, one might get lost in the campus without a proper facilitator. Although the UTAR Kampar campus map can be easily found on the Internet, however, as shown in the Figure 1-1-1, the map provided by the UTAR official website is difficult to read and understand.

Fail to visit and understand the function of every buildings

UTAR Kampar campus consists of 15 buildings, each with different purposes and functionalities. As the campus is very wide, it can be tiring for the visitors to visit every single corner of the university in one day, especially under a hot weather. In addition, the visitors might not be able to instantly understand the functions of every building during their first visit.

1.2 Background

With the improvement of technology, something that lines between the imagination and real world no longer seems to be unrealistic. The existence of Augmented reality (AR) technology has fulfilled human's dreams, making it possible. AR is an area of computer research which aims at supplementing reality by mixing computer generated data and real-world environments in real-time (Nithin & Bhooshan 2016). Instead like Virtual Reality (VR) that replaces the real world and immerses users in the virtual world, AR blends into our environment and links the virtual world and real world together. Ideally, AR would seem like the virtual and real objects coexisted in the same space. A basic AR system requires minimum three items, which are a camera, a computational unit, and a display to work (Siltanen 2012). With the advancement of technology, current smartphones managed to fulfil these requirements. This implies that unlike VR that requires headsets, goggles, or other extra equipment, with existing technology, users do not have to purchase extra equipment to use the AR system. According to (O'Dea 2020), the number of smartphone users worldwide today surpasses 3 billion and it is predicted to further grow by few hundred million in the next few years.

Currently, there are many mobile applications that utilize the AR technology to enhance user experience while using the technology. One of the famous AR mobile applications that have gotten into the public eye during years ago is the Pokemon GO. It has been downloaded over 1 billion times on Google Play Store. (Niantic 2016). Besides that, the famous social mobile application, Instagram and Snapchat also utilized this technology into their application to make it more interesting and funnier.



Figure 1-2-1: Example of Instagram AR Effect.

Figure 1-2-2: Example of Snapchat AR Effect (Racette, 2015).

The application of AR technology is not only limited in the entertainment field, but it is also applicable in various fields too, for instance education, interior design, advertisement, and others. The integration of AR with mobile applications has brought lots of convenience to the users. For example, in 2017, IKEA launched the “IKEA PLACE”, a mobile AR application that enables users to design their room with the furniture sold by the company (IKEA 2017). Instead of worrying that the furniture does not fit the room, IKEA PLACE provides the convenience to the users to design and place the digital furniture in the room before purchasing the products.



Figure 1-2-3: IKEA PLACE Application (IKEA 2017).

CHAPTER 1 INTRODUCTION

Currently, there are a few types of AR technology, each with different functions to meet their objectives and application usage.

i) Marker-based augmented reality

Marker-based augmented reality requires user to scan a marker with a device camera. A marker can be anything, but images with lots of edges and corners work especially well. However, every marker must be unique for decoding the marker and cross-matching with it. After successfully cross-matching with the marker in the database, the additional contents, like images, videos or 3D objects will be triggered.

ii) Markerless augmented reality

Markerless AR works by scanning the surrounding environment and depends on the natural features of the surrounding. It can work without prior knowledge of the user's environment. Users are not restricted where to use the AR application, and have the freedom to enjoy it anywhere. In order to start the AR experience, users will be asked to find a flat surface, such as a table or floor for placing the AR elements. This is because it will not always make sense for the objects to float in the air. Markerless AR uses a combination of camera systems, dedicated sensors, and complex math to accurately detect and map the real-world environment, such as the locations of walls and points of intersection.

(iii) Location-based augmented reality

Location-based AR, also known as GPS-based AR relies on the sensors of the user's mobile phone. In order to place the AR contents in the right place, the embedded device sensors such as digital compass, GPS and accelerometer play a vital role to provide data based on the user's location. This AR technology is commonly used in navigation and tourism.

1.3 Motivation

The motivation of this proposed project is to utilize the technology to solve the problems encountered. An application that can provide the convenience for users to virtually visit the campus is needed. By that, users will no longer be restricted by distance and time to visit the campus. To make the virtual tour more interesting and more realistic, stimulation of the 3D campus is needed. In addition, details of significant buildings should be presented in videos, images, and texts so that users will have a thorough understanding towards UTAR Kampar campus without being there physically.

1.4 Project Objectives

The purpose of this project is to solve the problems encountered by developing a mobile platform in Android, namely UTAR campus tour within minutes via Augmented Reality. The main objectives of developing this project are as below:

To provide a convenient platform for users to visit the campus without the need to physically present to the campus.

The project aims to utilize the technology so that users can virtually visit the UTAR Kampar campus at any time and at anywhere. It tends to show the significant buildings, facilities, and the surroundings in UTAR Kampar campus to the users through an interactive approach. To blend and link the virtual campus with users' real environment, AR technique is needed to stimulate the campus in real world.

In addition, since the target users of this project are the users that have not been to UTAR Kampar campus before, the project aims to promote the university by providing basic information about UTAR to the users. The programmes offered by UTAR should be found in the application. If users are interested to know more about the programme details, the UTAR official link should be provided to them for further exploration.

To provide a 3D view of the campus to the users.

It is insufficient for the users to have only one angle view of the campus. They should be able to view the campus from multiple angles and perspectives. Therefore, to provide a greater impression and understanding of the campus layout to the users, this project aims to deploy an AR module that can stimulate a 3D overview of the campus to the users. As UTAR Kampar was built on a 1300-acre piece of land, therefore, the 3D

campus will be very wide. Hence, the function to rotate and scale the 3D model should be included so that users manage to look at every details of the campus.

To deliver the basic details of significant building to the users.

To improve the understanding of users towards UTAR Kampar campus, description and details about the significant buildings should be included. By that, users can have a better understanding about the basic information of the buildings, including operating hours and functions while virtually visiting the campus. Furthermore, to leave a deeper impression of the structures of the buildings to the users, the interior view and the exterior view of all the significant buildings should be shown to users. Moreover, routes from the campus entrance to each building should be presented to users to help them familiarized with the location of each building.

1.5 Project Scope

This project intends to develop an Android application that uses AR technology to provide a different kind of campus tour to the users. The target audience of this project are the Android users that have never been to UTAR Kampar campus before.

This project will be focused on providing a virtual campus tour for visitors to UTAR Kampar campus, Perak. The major functionalities of this proposed project include simulation of a 3D layout of UTAR Kampar campus via AR.

Besides that, information regarding each building will be provided. The interior view of the significant buildings will be presented in 360-degree panoramic image, which can leave a greater impression of the design of the buildings to the users. The route from the UTAR Kampar campus entrance to the significant buildings will be displayed in videos and maps, so that users can have a better overview of the campus layout. In addition, this project intends to introduce and promote the university at the same time. Therefore, brief information about UTAR and courses offered by UTAR will be included.

In a nutshell, this project tends to provide a convenient way for users to virtually visit the campus in a fun and interactive way through AR technology.

1.6 Proposed Approach for AR Module

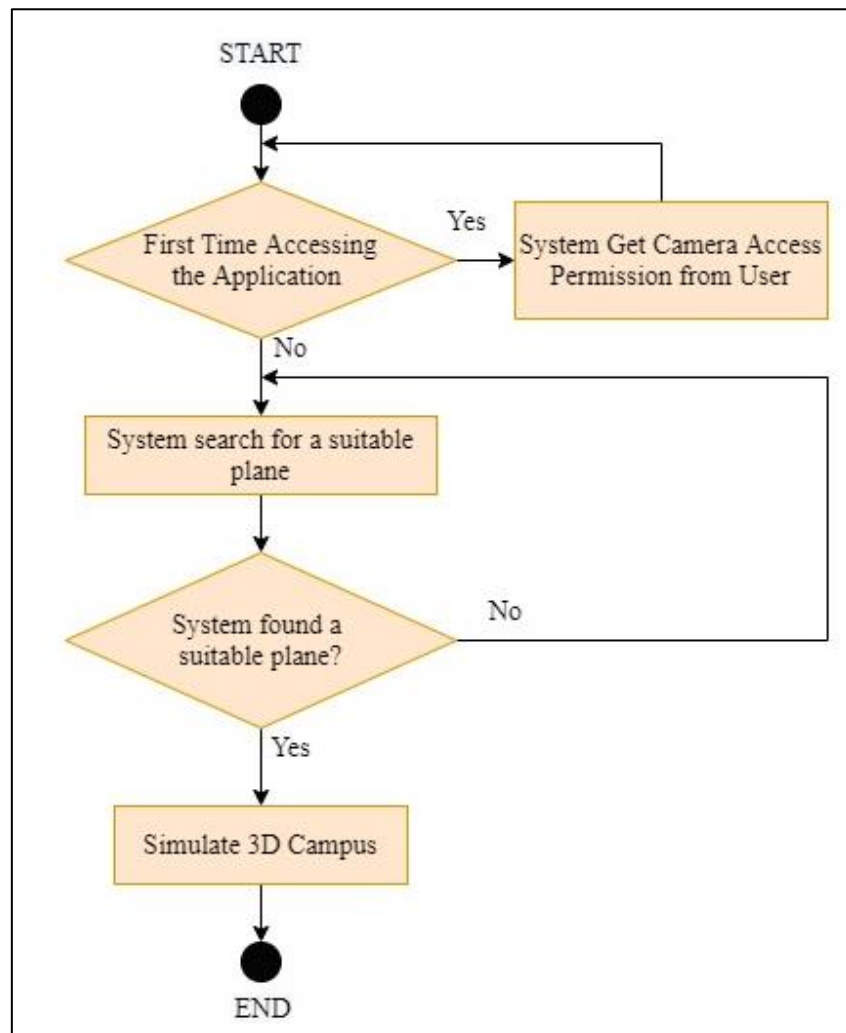


Figure 1-6-1: Flow of Proposed Approach for AR Module

The proposed approach to build the AR module is by using markerless AR to simulate the 3D model. This is due to markerless AR does not require any target image and does not require users to be presented at any specific location to work. Markerless AR can work without prior knowledge of the user's environment. Thus, it matches the objective of this project that users are not restricted where to use the proposed application and have the freedom to use it anywhere.

Figure 1-4-1 portrays the flow of the proposed approach for the AR module. Firstly, the system will prompt the user for camera access permission. This is due to markerless AR relies on camera system to scan and detect the user's environment. Once the system successfully analyses the environment and is able to find a suitable plane, the 3D model will be simulated automatically.

1.7 Highlight of What Have Been Achieved

All the objectives of this project have been successfully achieved. Firstly, users are no longer limited by distance and time to pay a visit to the UTAR Kampar campus. They can visit the UTAR Kampar campus via markerless AR at any time and at anywhere. Moreover, this application has exposed users with the 3D layout of campus as well as interior view and exterior view of each building. Furthermore, the function to check for the routes from the campus entrance to the buildings has been included as well. With all the functions available in the application, students can pay a visit to the UTAR Kampar campus without the need of physical travel and at the same time, receive all the useful information about UTAR.

1.8 Report Organization

The organization of this report is divided into the following chapters. Chapter 1 explains the background, purpose, and objectives of this project. Literature review of the existing work done by other developers are summarized in Chapter 2. Next, Chapter 3 uses diagrams and flowcharts to give an overview of the system. For Chapter 4, the system specifications including analysis, more detailed design and verification plan are provided. Furthermore, implementation and testing of the system is presented in Chapter 5. Finally, the conclusion along with discussion, novelties and contributions, and future work are reviewed in Chapter 6.

CHAPTER 2 LITERATURE REVIEW

2.1 USM Virtual Tour

2.1.1 Introduction



Figure 2-1-1-1 : Logo of USM Virtual Tour Application

Figure 2-1-1-2: Main page of USM Virtual Tour Application

USM Virtual Tour is a campus tour guide application that is available on the Google Play Store. USM Virtual Tour helps users to locate their destination in USM campus in Penang, Malaysia by using GPS and AR technology (Multimedia Computing Research Group USM 2018). It is a location-based AR application that requires users to be present in the campus to utilize the AR navigation. As shown in Figure 2-1-1-3, it provides a list of points of interest to users, which ranges from lecture hall to cafeteria to ATM machine. Other than that, it also contains the location of the hostel, museum, and service centre. Basically, it almost covers all the hotspots in the university. Through this application, users able to explore the university without any facilitator.



Figure 2-1-1-3: List of point of interest provided by the application

Figure 2-1-1-4: AR navigation to the destination

2.1.2 Strengths

- Cover all the hotspots of the university to guide the user.
- Every user can contribute to the application by filling in the new point of interest form. This eases the workload of the admin and the application can be updated all the time.
- Provide estimation distance to reach the destination to the user.
- Provides guidance to the user to the next point of interest.
- Provide detailed information about the place of interest.

2.1.3 Weaknesses

- Require users to be physically present in the campus to use the AR function.
- Unfriendly user interface.
- Weak WIFI or mobile data signals will affect the accuracy of the touring system.

2.2 SB Sanal Tur

2.2.1 Introduction

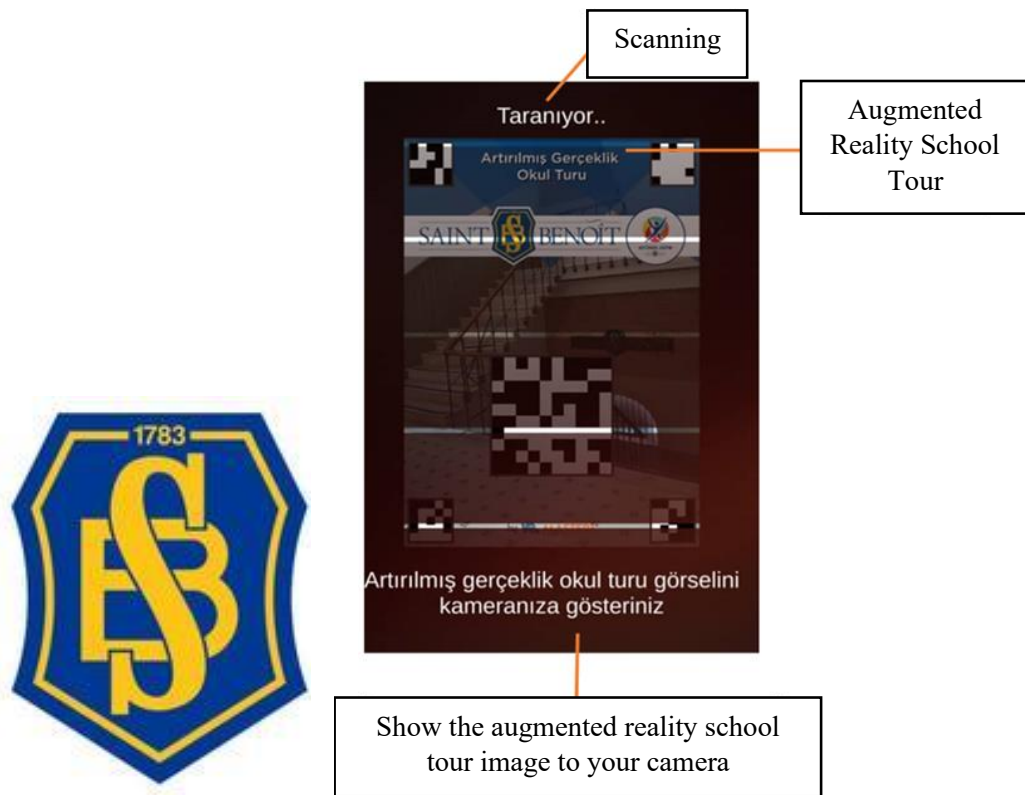


Figure 2-2-1-1:SB Sanal Tur Application Logo

Figure 2-2-1-2:Main Page of SB Sanal Tur

SB Sanal Tur is an application that is available in both android and IOS platforms. SB Sanal Tur provides Augmented Reality School Tour at Saint Benoit High School in Turkey (CDRN Lycée Saint Benoît 2019). It is a fully marker-based AR Campus Navigation application, which allows users to take a campus tour through scanning the markers located at different places of interest in the campus. Each marker will trigger different contents, which includes images, audios as well as trackers to guide the user. Although users can explore the campus alone without any facilitator, however, users will have to discover the markers themselves as the application does not provide any hints on the location of markers.



Figure 2-2-1-3: Marker inside SB Sanal Tur Campus (Masters 2019).

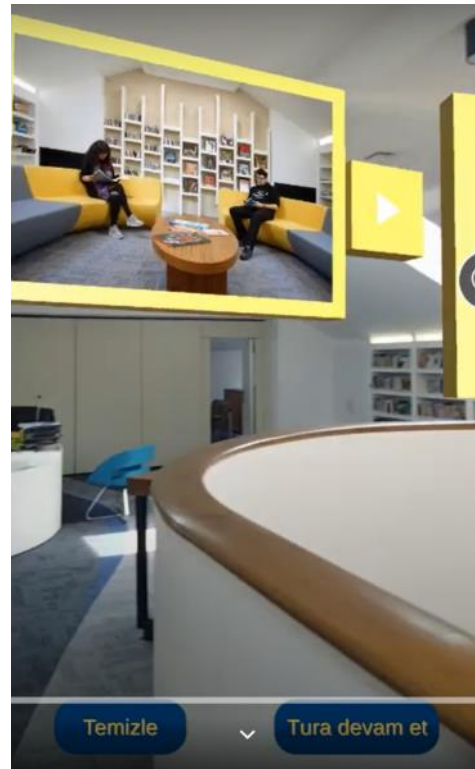


Figure 2-2-1-4: Content Trigger by Marker (Masters 2019).

2.2.2 Strengths

- Provides detailed information about the place of interest.
- Provides marker to guide the user to the next point of interest
- High quality of display images.
- No internet connection required to use the application
- Ease to use

2.2.3 Weaknesses

- Require users to be physically present in the campus.
- Application does not provide the location of marker. Users have to discover by themselves.
- Application is only available in Turkish, which is not user friendly to the foreign user.
- Application does not contain exit application function.

2.3 RIT AR

2.3.1 Introduction

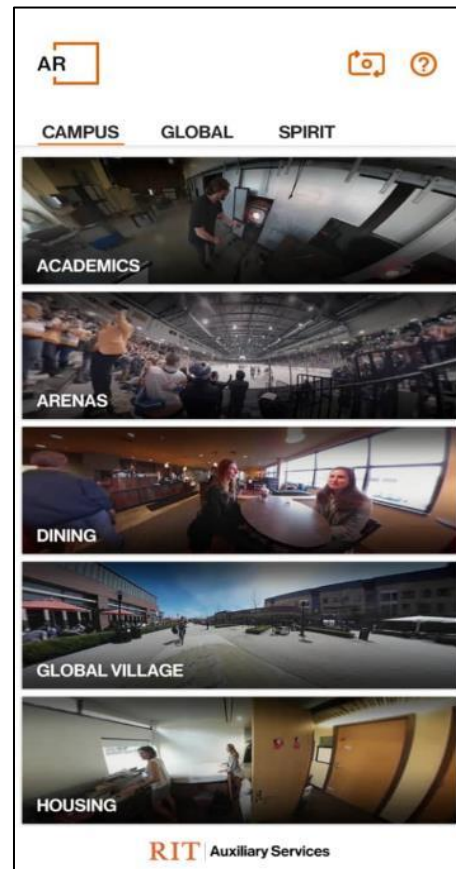


Figure 2-3-1-1: RIT AR Logo

Figure 2-3-1-2: Main Page RIT AR

RIT AR is a mobile application that is available in both Android and IOS platforms. This application allows users to visit the Rochester Institute of Technology in New York, United States without being physically present in the campus (Rochester Institute of Technology 2020). RIT AR utilized markerless Augmented Reality technology to provide a virtual tour to the campus. Users from any side of the world could pay a virtual visit at any time and at anywhere through the application. RIT AR enhances the user experience by adding the highlighted events into the AR feature. This allows users to immerse themselves in the scenes and feel like they are also presented in the events. However, RIT AR does not provide the layout and overview of the institute. To have a basic understanding about the institute, users still need to browse the Internet to look for more information.

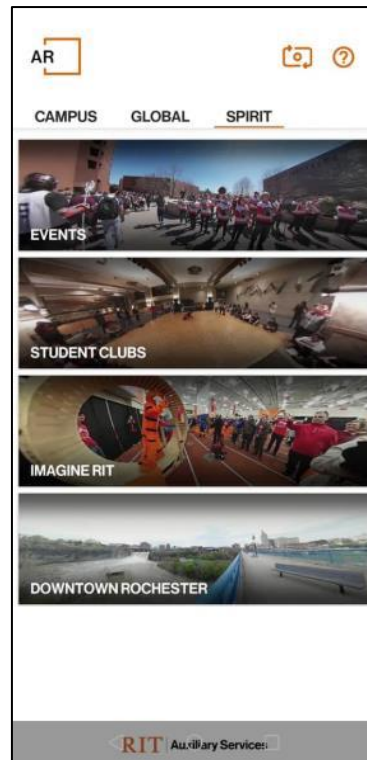


Figure 2-3-1-3: Highlighted Events in Rochester Institute of Technology

2.3.2 Strengths

- Provide user interaction with the system
- Able to work without user being present in the campus
- Ease to use
- Interesting events are included in the application

2.3.3 Weaknesses

- Limited explanation about each point of interest.
- The scenes in Augmented Reality mode switch too fast. Users might miss out the interesting parts.
- Does not provide any explanation about the institute.
- Does not provide the layout of the campus.

2.4 Sahmyook University AR Tour

2.4.1 Introduction



Figure 2-4-1-1: Sahmyook University AR Tour Logo

Figure 2-4-1-2: Main Page Sahmyook University AR Tour

Sahmyook University AR Tour is an application that is available in both android and IOS platforms. This application offers users a virtual tour to Sahmyook University in Korea within a few clicks (LiveABC 2020). It offers up to four languages, which is very foreigner friendly. As the university consisted of 38 buildings, it might be a bit difficult for the users to understand the function of every building. Yet, the application has utilized many videos to provide detailed explanation. In addition, it also utilized a lot of images in 360-degree panoramic view. This allows users to move around the camera without limits and immerse themselves in the ambiance of the campus. Nevertheless, the dark side of this application is it consumes a lot of storage. In addition, as the application utilized the AR marker-based technology, for users who would like to use the AR feature, they need to be physically present in the campus to experience it.

2.4.2 Strengths

- Ease to use
- Provide lots of useful information.
- Good in graphical interface
- Available in multiple language

CHAPTER 2 LITERATURE REVIEW

2.4.3 Weaknesses

- Use of marker-based technology which required users to be physically present in the University.
- Large Application Size, which is 1.09GB

2.5 Fu- Jen University Mobile Campus Touring System

2.5.1 Introduction

The prototype of the Fu-Jen mobile campus touring system was designed and developed in 2010 (Chou & ChanLin 2012). As every year, there are around 5500 freshmen enrolled in Fu-Jen University, and it took a lot of time for them to be familiar with the 86-acre campus. Therefore, a personal and portable location-based augmented reality system was developed to aid the Fu-Jen freshman.

This application developed by using the freeware tool, Layar and remote data server through Hoppala. The development teams utilized the Google Sketchup to create the 3D icon and used of Photoshop to modify the 2D photo. The application works by requiring users to be physically present in the campus. It provides the functionalities for users to set the search range within 5 meters and choose the locations to visit. After confirming the destination, users will then receive the direction guidance with audio touring and building information.

2.5.2 Strengths

- Ease to use
- Provides detailed information about each building.

2.5.3 Weaknesses

- Required user to be physically present in the university
- Require Internet connection
- Weak WIFI or mobile data signals will affect the mobility and accuracy of the mobile touring system.

CHAPTER 2 LITERATURE REVIEW

2.6 Comparison Between Reviewed Systems and Proposed System

Features	USM Virtual Tour	SB Sanal Tur	RIT AR	Sahmyook University AR Tour	Fu-Jen University Mobile Campus Touring System	Proposed System
Augmented reality feature	Yes	Yes	Yes	Yes	Yes	Yes
Typed of AR technology applied	Location-based	Marker-Based	Markerless	Marker-Based	Location-based	Markerless
Able to work without user physically present in the campus	No	No	Yes	No	No	Yes
Able to work without marker	Yes	No	Yes	No	Yes	Yes
Graphic Interface	Poor	Good	Good	Good	Poor	Good
Simulation of 3D Campus Layout	No	No	No	No	No	Yes
Simulation of 3D Individual Building	No	No	No	No	No	Yes

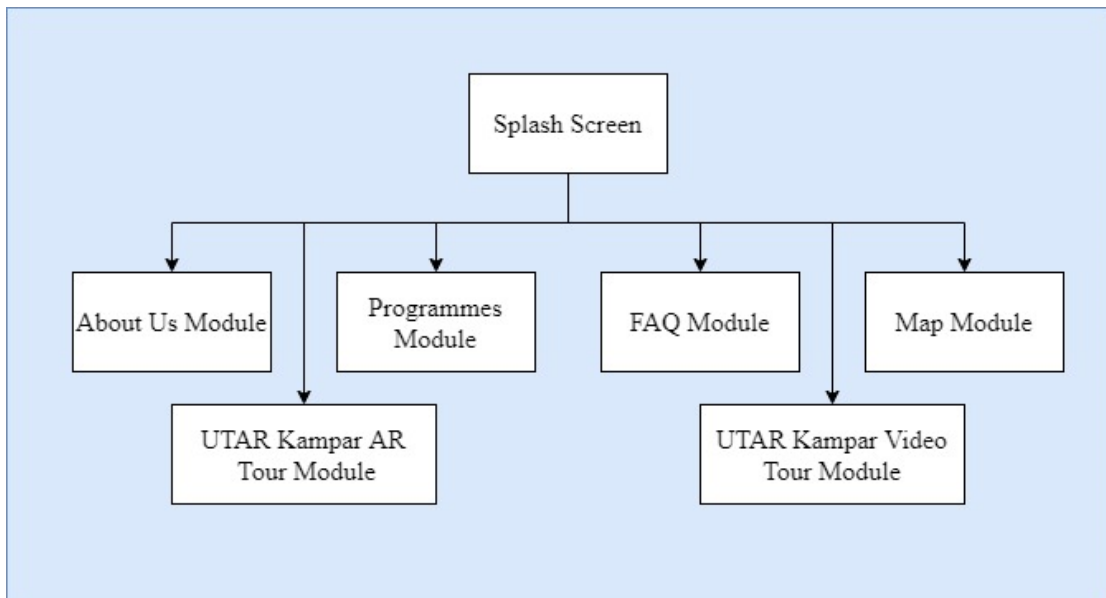
CHAPTER 2 LITERATURE REVIEW

Provides 360-degree panoramic view	No	No	Yes	Yes	No	Yes
Details information about each place of interest	Yes	Yes	No	Yes	Yes	Yes
Provide program offered by the institute	No	No	No	No	No	Yes

Table 2-6-1: Comparison of Existing System with Proposed System

2.7 Summary

The use of Augmented Reality is common in most of the fields, including entertainment, advertisement, tourism, and others. However, AR technology is rarely applied in the application for campus tour. The existing campus tour applications mainly utilized the location-based AR and marker-based AR which require users to be physically present in the campus. This causes trouble to the users who are located far away from the campus. The problem encountered can be solved if users can visit the campus virtually. There are also applications that offer the virtual campus tour, but those applications do not offer the AR feature. This reduces the connectivity of the application with the users. Therefore, by concluding the problems encountered above, an application that can provide a virtual AR campus tour is needed to solve all the encountered problems.

CHAPTER 3 SYSTEM DESIGN**3.1 System Module***Figure 3-1-1: System Module*

The proposed project consists of 6 modules, each with different functions and purposes. Table 3-1-1 shows the overview of the system module.

About Us Module

This module provides a brief description about UTAR. As the system's target users are the users that have not been to UTAR, therefore, this module plays an important role in providing fundamental information about UTAR.

Programmes Module

Programmes module has listed out all the programmes offered by UTAR. Users will be able to have a quick glance for all the programmes. If they are interested in any of the courses, they can look for further information in the browser through the provided hyperlink.

FAQ Module

This module provides information related to frequent asked questions by users, including accommodation, top destinations in UTAR Kampar and clubs and society offered by UTAR.

CHAPTER 3 SYSTEM DESIGN

Map Module

Map module enables users to find the route, estimated time, and estimated distance from their current location to UTAR Kampar and UTAR Sungai Long. Besides that, users will be able to view the route and distance from the nearby public transportation station to the campus.

UTAR Kampar AR Tour Module

This module is one of the highlighted parts in this system. It enables users to simulate the 3D overview of campus layout. Furthermore, details of the buildings, including interior and exterior view of significant buildings are provided.

UTAR Kampar Video Tour Module

Video tour module enables users to take a tour in UTAR Kampar campus via video. Besides that, the route, time taken, and distance needed from the gate of UTAR to all the buildings are provided in this module as well.

3.2 Use Case Diagram

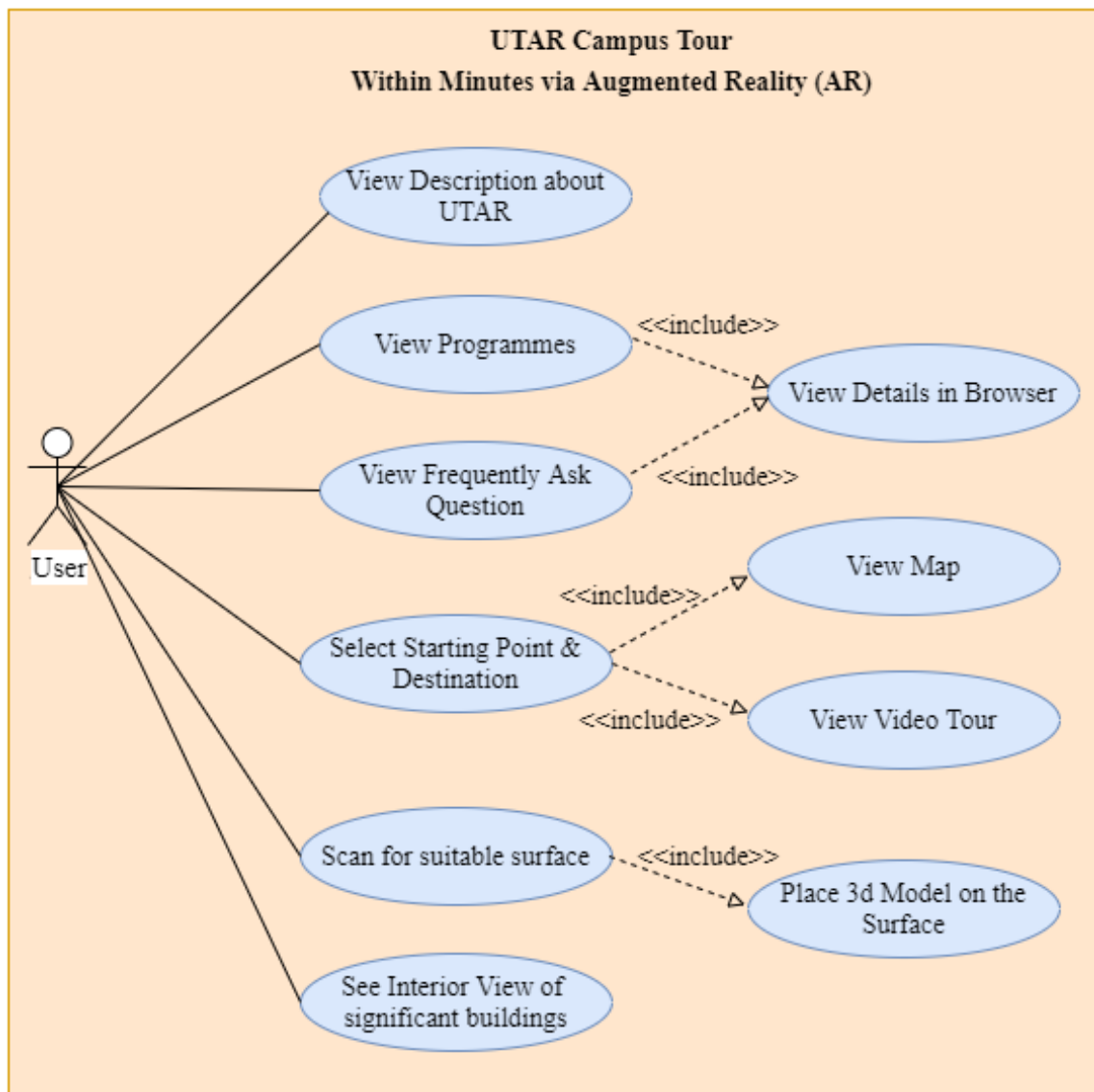


Figure 3-2-1: Use Case Diagram for UTAR Campus Tour Application

3.3 System Flowchart

To illustrate the system workflow, a flowchart has been drawn. For better illustration, the flowchart is split into seven parts. The first part of the flowchart shows the overall process flow of the system.

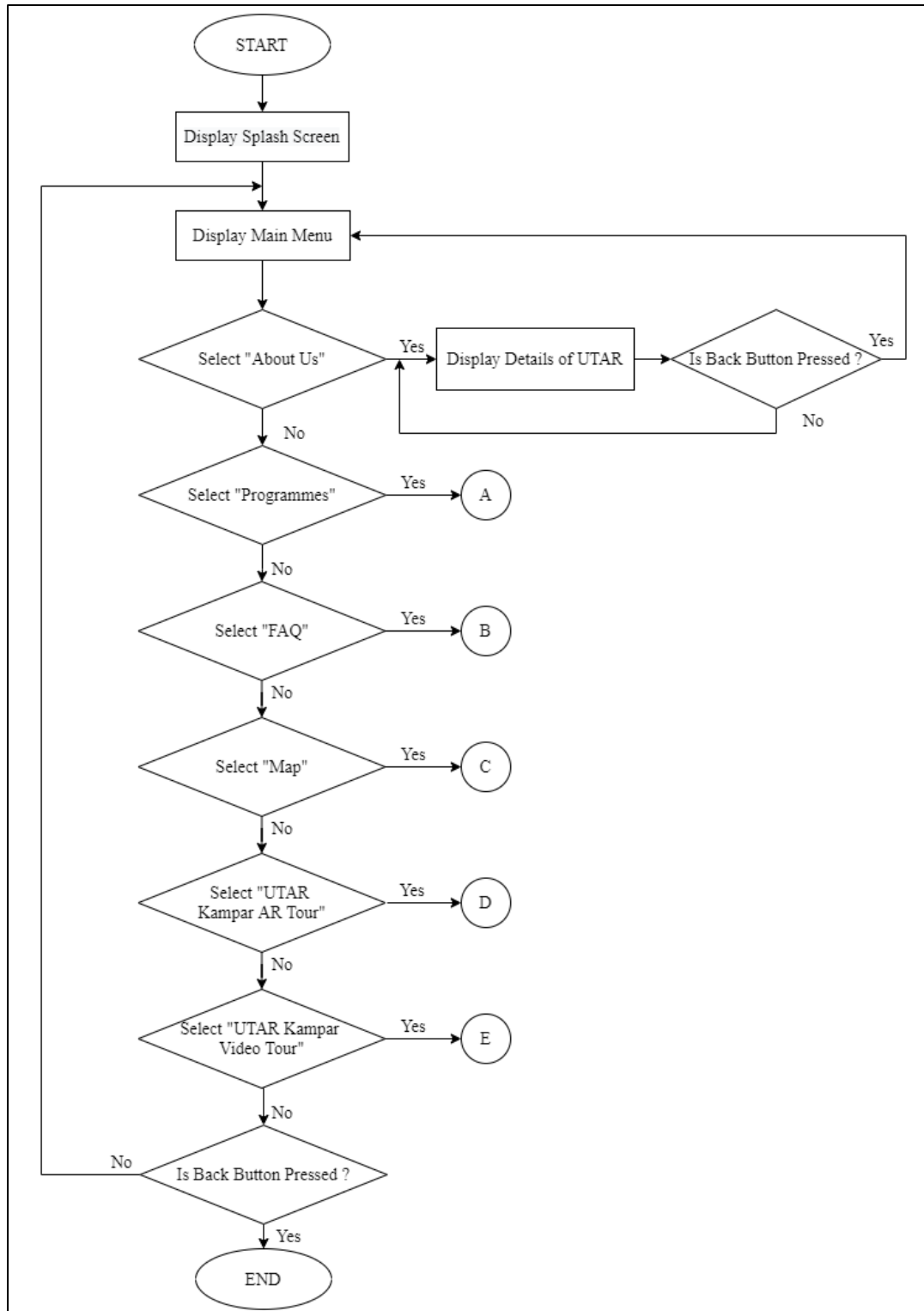


Figure 3-3-1: First Part of the System Flow Chart

The second part of the flowchart explains the process for “Programmes Module”.

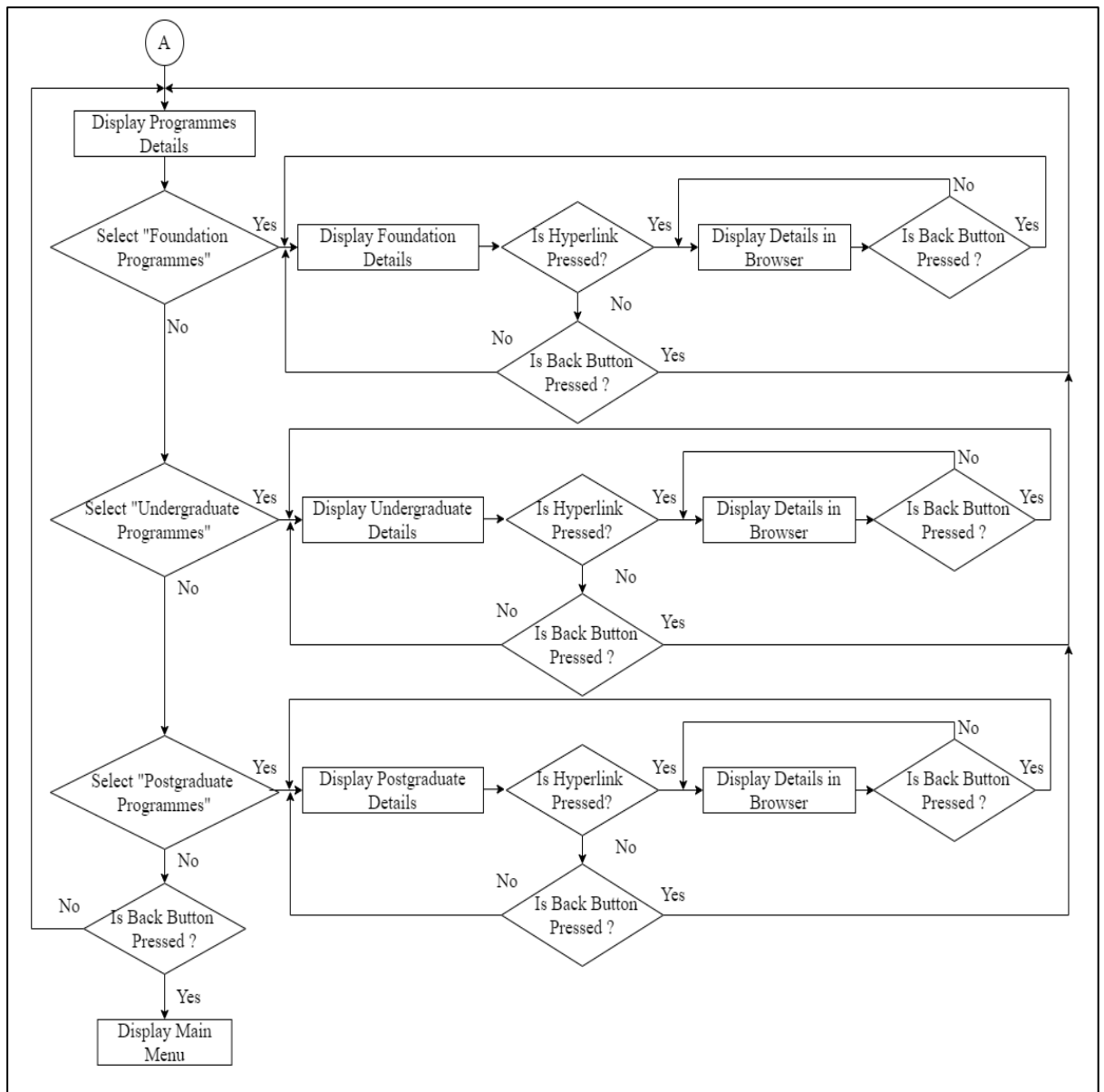


Figure 3-3-2: Second Part of the System Flow Chart

The third part of the flowchart illuminates the process for “FAQ Module”.

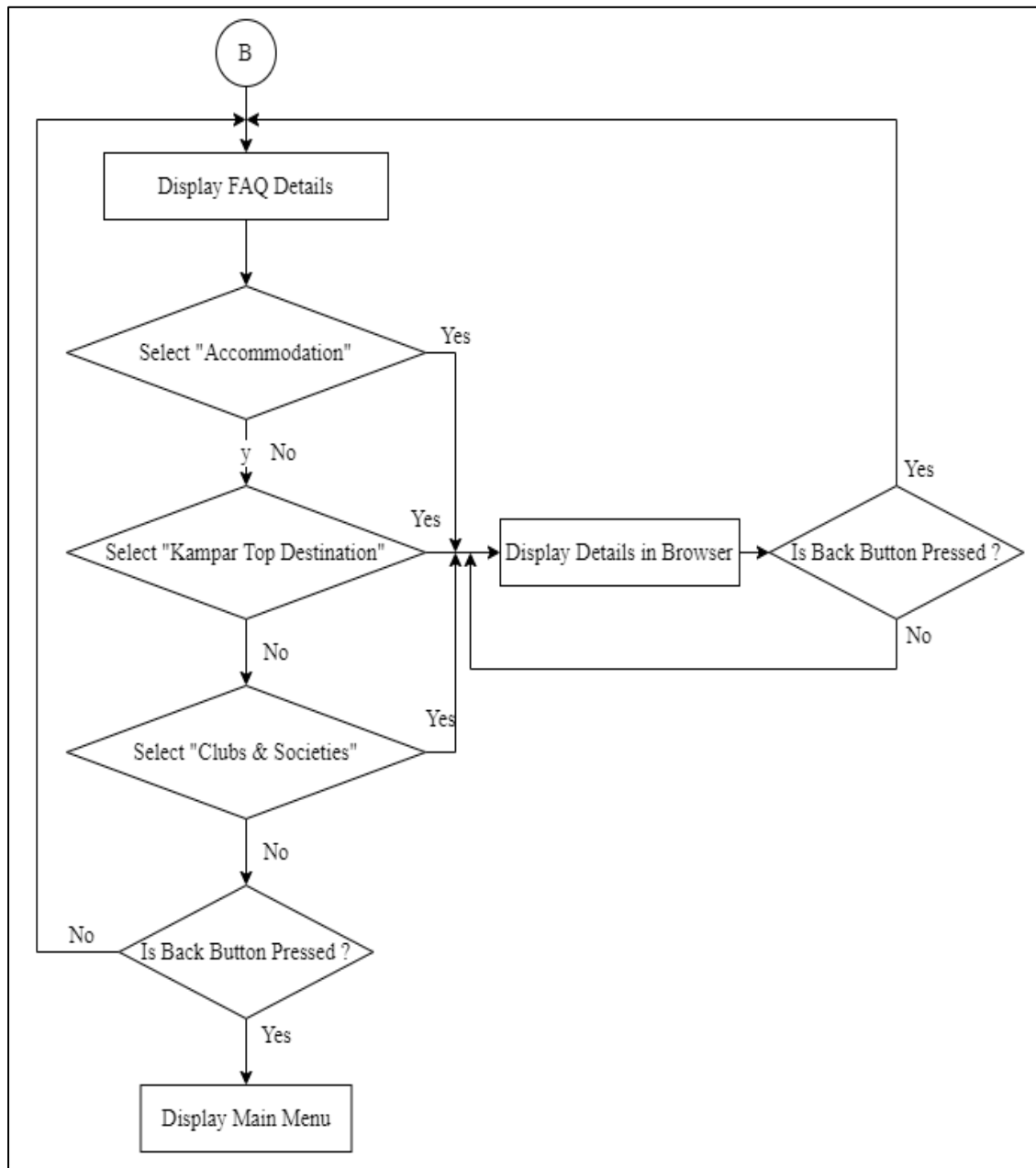


Figure 3-3-3: Third Part of the System Flow Chart

The fourth part of the flowchart explains the process for “Map Module”.

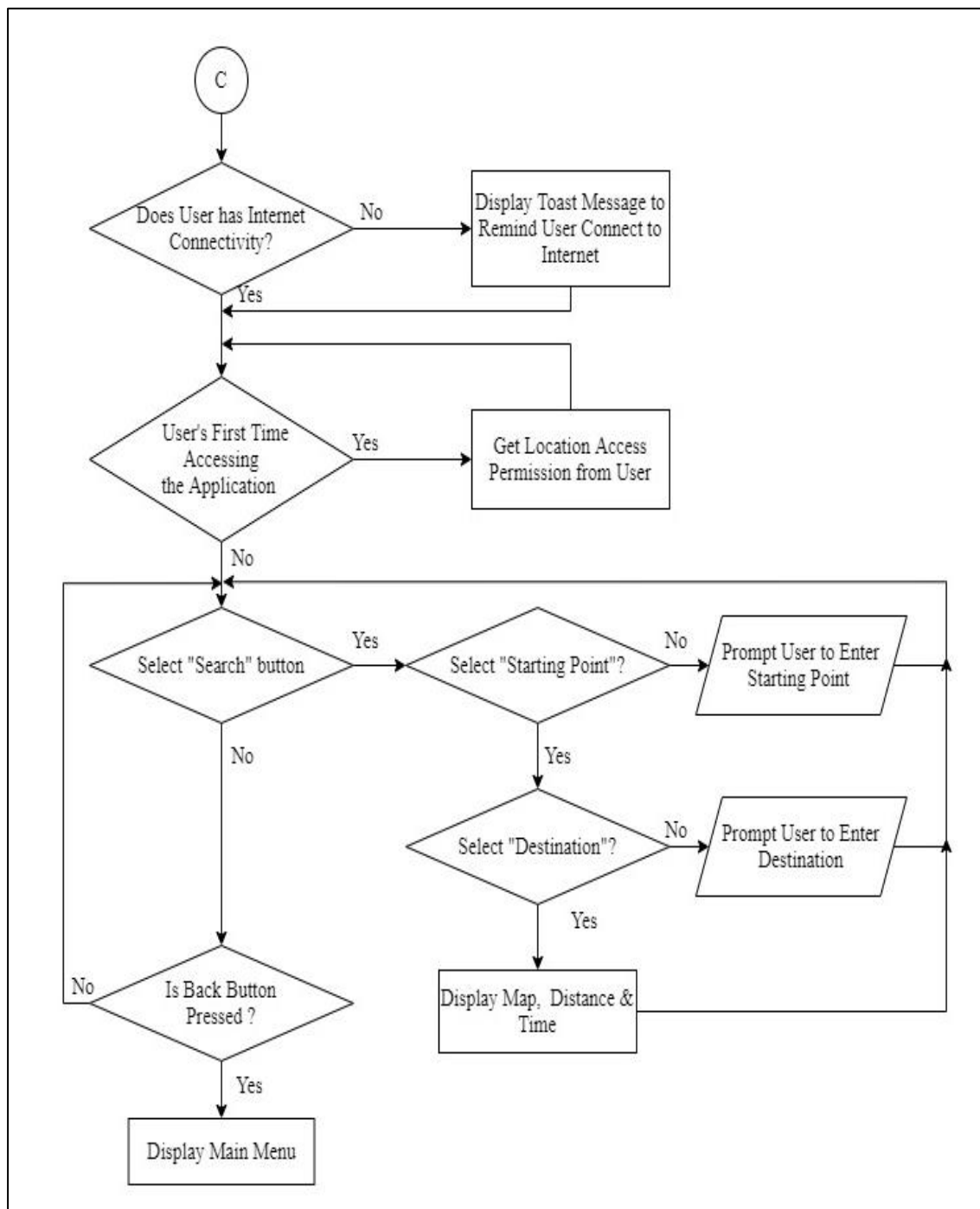


Figure 3-3-4: Fourth Part of the System Flow Chart

The fifth part of the flowchart illuminates the flow for “AR Tour Module”.

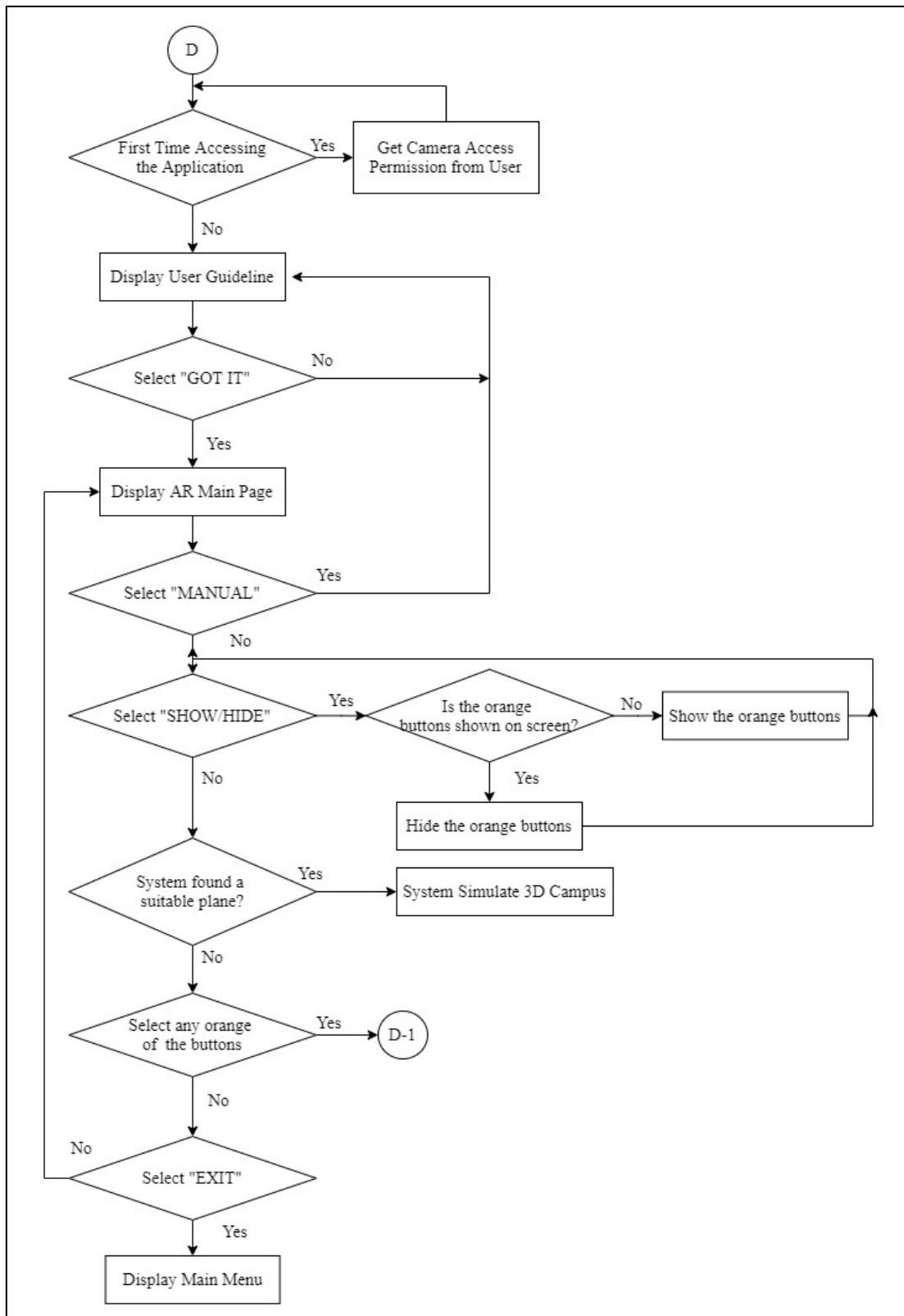


Figure 3-3-5: Fifth Part of the System Flow Chart

The sixth part of the flowchart continues to explain the flow for “AR Tour Module”.

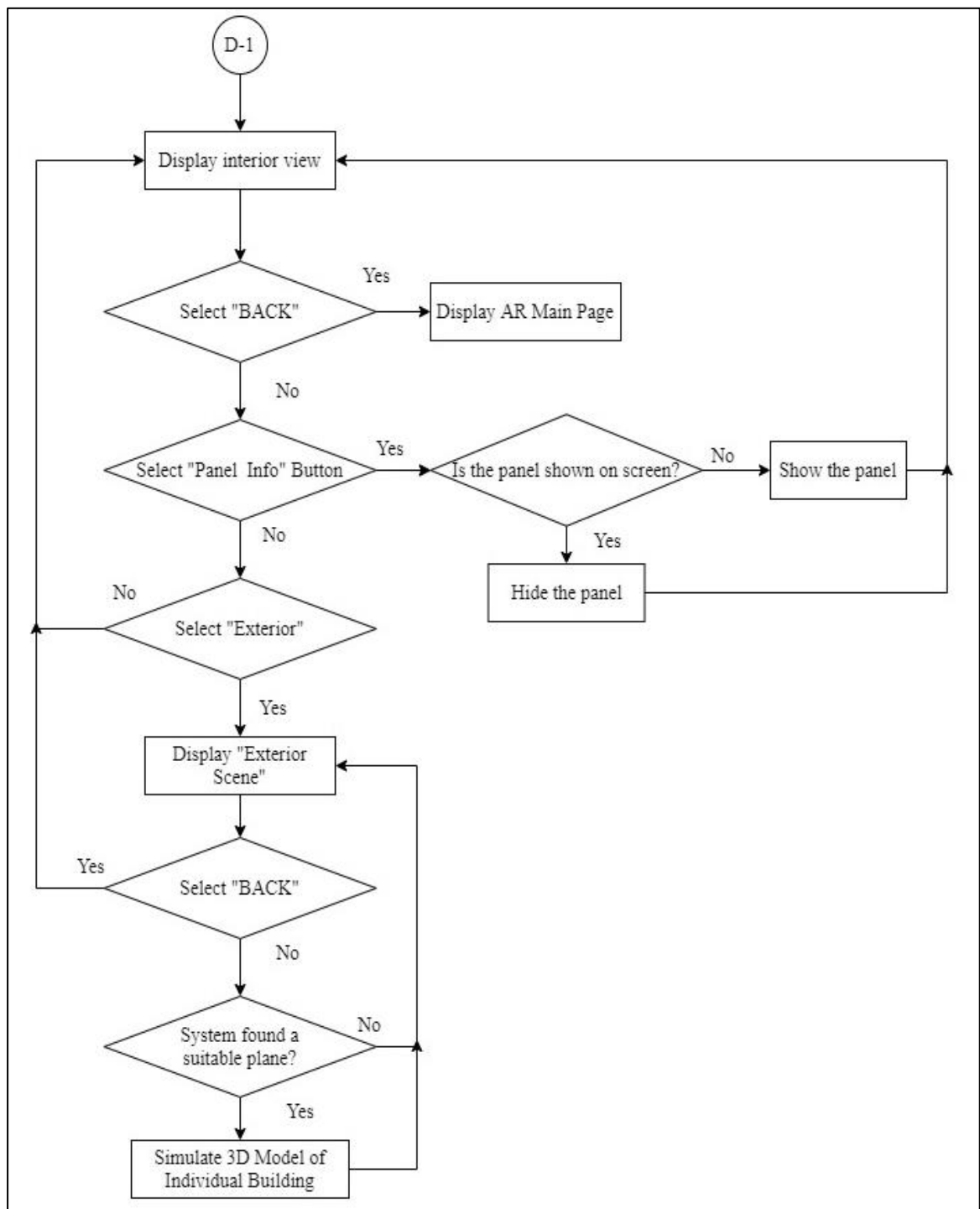


Figure 3-3-6: Sixth Part of the System Flow Chart

The last part of the flowchart illuminates the flow for “Video Tour Module”.

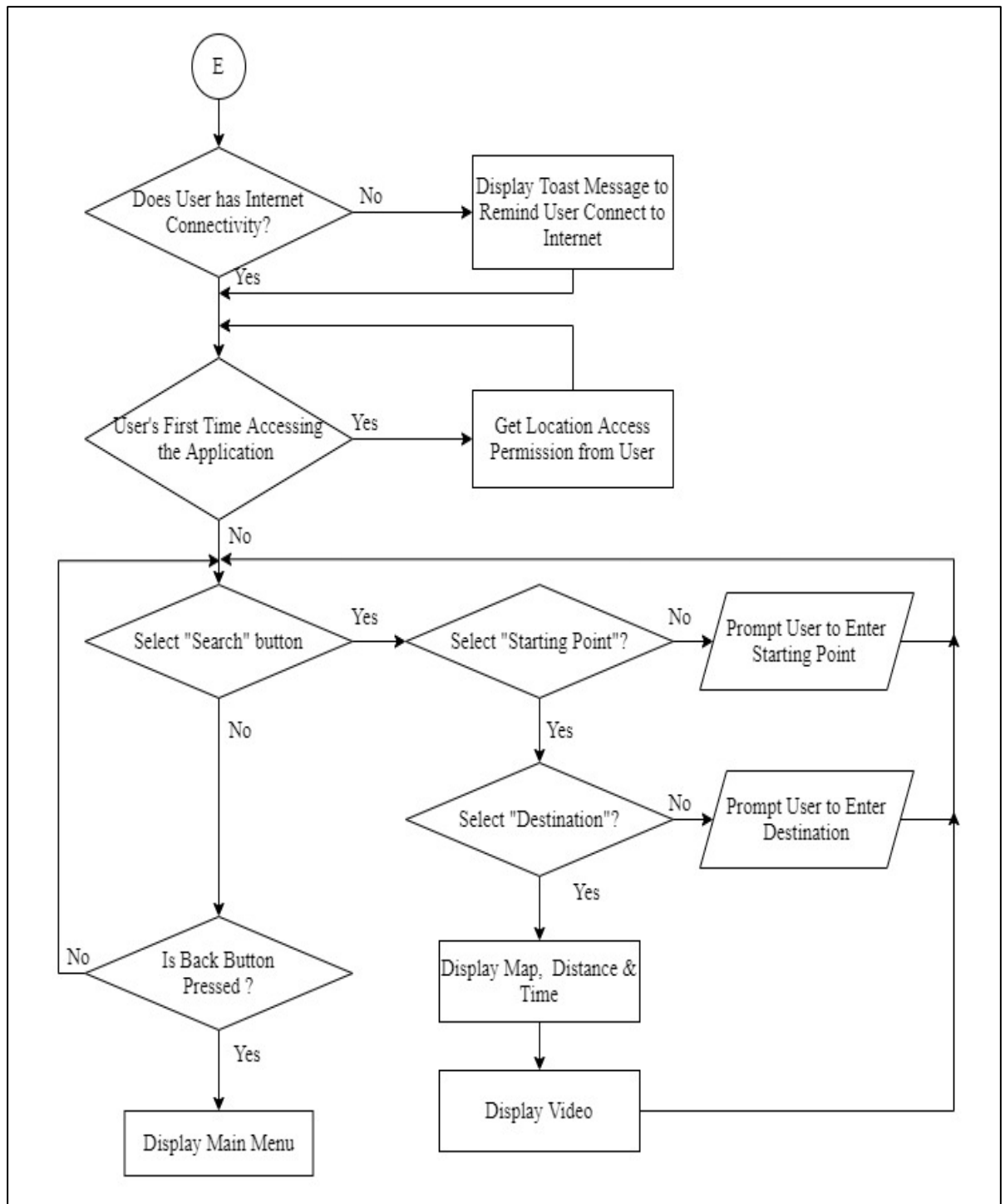


Figure 3-3-7: Last Part of the System Flow Chart

CHAPTER 4 DESIGN SPECIFICATION**4.1 Methodology**

The methodology chosen for this proposed application is the prototype approach, which is part of the Rapid-Application Development. The overall process is as shown in Figure 4-1-1. The basic features and functionalities in the AR campus tour will first be analysed, designed and developed into the first prototyping model. These three processes will keep repeating in a cycle to make improvement until the system has completely delivered. Any improvements will be reflected on the next iteration development process. The prototyping methodology consisted of few processes, which includes planning, analysis, design and implementation.

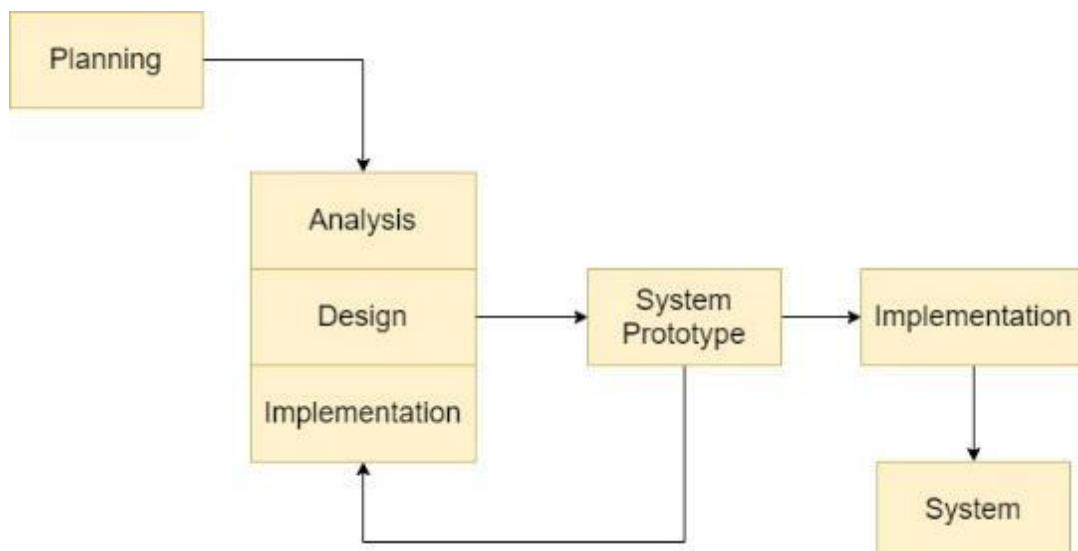


Figure 4-1-1: Prototyping Methodology

- **Planning Phase**

User requirements are being identified and understood during this stage. Project scope and project objectives will then be determined based on the problem statement. A work plan is then scheduled out to estimate the project duration.

- **1st System Prototype**

Analysis, design and implementation are performed concurrently to build the first version of prototype. The basic analysis includes identifying the software and hardware needed and programming language involved. User interface, coding structure and setting up of database is done during the design phase. The implementation phase will be based on the work done earlier. The prototype only consisted of the basic functionalities as well as simple graphic interface of the system. The prototype is immediately undergone testing to make improvements.

- **Next Prototype Development (Iteration)**

After undergoing testing and obtaining the user evaluation and feedback, the analysis, design and implementation phase will be repeated to perform modification. Changes and refinement of the system based on the user feedback will be reflected in the next prototype. The iteration will keep on repeating by referring to the user's response. The process will only be terminated after all the functionalities and design have reached user's satisfaction as well as the system is bug and error free.

After the system has been successfully developed, a survey test will be conducted. Users will be given the opportunity to use and evaluate it. The feedback and understanding of users about UTAR Kampar campus will be able to determine the successfulness of the project. It can also reflect whether the objective of the object has been achieved.

4.2 Development Tools

4.2.1 Software Specifications

Blender

Blender is a free open-source software for 3D model creation. Blender offers a lot of great features which can be utilized while building and rendering the 3D model. This software is used to build the 3D terrain and buildings that will be displayed in AR module.

Unity

Unity is a cross-platform game engine that gives users the platform to build games and experiences in both 2D and 3D graphics. The software is used to build the scene and manipulate the 3D objects while users are using the AR module.

Vuforia Engine

Vuforia is a free and open-source software development kit for creating Augmented reality applications. It can be integrated together with the Unity game engine. It is used to build the augmented reality features in identifying the plane and place the 3D model on top of it.

Android Studio

Android Studio has been selected as the Integrated Development Environment (IDE) to develop the android mobile application. Android Studio offers the layout editor that is helpful in designing and building the user interface. Except the AR module, the rest of the interface and functions are built by using Android Studio.

Google API & Maps SDK for Android

Google API is an application programming interface that is developed by Google that allows communication with the Google Services. The Google Services used in this project is the Maps SDK for Android. Maps SDK for Android allows the google maps to be added and shown in the application. Moreover, it is used to retrieve the user's location and display user's location by adding marker on the map.

Programming language

- C#

For the development of AR module in Unity, C# language is used. It is mainly used for creating and controlling the behaviour of the system.

- Java

Java programming language is one of the official languages for android development. It is supported by Android Studio and is used in this project to build the android mobile application.

- XML

Extensible Markup language (XML) is used to design the user interface of the mobile application in Android Studio.

4.2.2. Hardware Specifications

The hardware requires to develop this project is as below:

(i) Laptop Model: HP Pavilion - 14-al103tx

Components	Specifications
Operating System	Window 10 Home (64-bit)
Processor	Intel® Core™ i5-7200U
Memory (RAM)	12GB
Graphic Card	NVIDIA® GeForce® 940MX

Table 4-2-2-1: Laptop Model for Development

(ii) Mobile Device Model: Huawei P20

Components	Specifications
Operating System	Android
Android version	9.0.0
Screen Size	5.8 inches
Memory (RAM)	4GB
CPU	Octa-core
Phone Storage	128GB

Table 4-2-2-2: Mobile Device Model for Development

4.3 User Requirements

4.3.1 Connectivity Requirements for Users

Description	Requirement
WIFI/Data Connection	Yes
Bluetooth	No
GPS service	Yes

Table 4-3-1-1: Connectivity Requirements for Users

The connectivity requirements for users are shown in Table 4-3-1-1. WIFI or data connection is needed to enable users to look for further details about the programme offered by UTAR in the browser. Moreover, internet connection and GPS service are needed so that the system can retrieve the information from google services displayed them on the map.

4.3.2 Hardware Requirements for Users

Description	Requirement
RAM	2GB or higher
Storage	900 MB or higher
CPU	4.0GHz or higher

Table 4-3-2-1: Hardware Requirements for Users

The hardware requirements for users are shown in Table 4-3-2-1. To ensure that the application will operate smoothly, the basic requirements for a user's device are 2GB RAM and 4.0Ghz of CPU. Moreover, to ensure that the application can be installed successfully, users should have at least 900MB of storage in their device.

CHAPTER 4 DESIGN SPECIFICATION

4.3.3 Software Requirements for Users

Description	Requirement
Android Version	6.0 (Marshmallow) or higher
Vuforia Engine	Refer to Appendix A

Table 4-3-3-1: Software Requirements for Users

For software requirements, the minimum Android version of user's mobile device has to be Android 6.0 or above. Moreover, user's device must be able to support Vuforia Engine. The list of android devices that is supported by Vuforia is attached in Appendix A. Basically, Vuforia supports almost all the latest devices, including multiple brands, for example, Samsung, Google Pixel, Huawei, Xiaomi, OnePlus and Motorola.

4.4 Survey Analysis

A survey is carried out among 10 users who have not been to UTAR. The purpose of carry out this survey is to collect the user's requirements and their expectation towards the application. The survey is conducted through phone interview. Questions asked during the interview are listed in the Table 4-4-1:

Interview Questions

1. Have you ever been to UTAR Kampar Campus?
2. Have you ever experienced using Augmented Reality features before? (For example, Instagram Filters)
3. If yes, what do you think the benefits of AR have brought to you?
4. If UTAR launched an AR Campus application, are you interested to visit the campus via the application?
5. What is your expectation towards the application?

Table 4-4-1: Interview Questions for Survey Analysis

All the 10 interviewees that have been contacted have not been to UTAR Kampar Campus before. Nine out of ten of the interviewees have experienced using the AR feature in social media or games. Their feedback for AR is positive and stated that it is fun and interesting. This is due to AR able to simulate something that does not exist in the real world. Besides that, some answered that AR has helped them to visualize an

CHAPTER 4 DESIGN SPECIFICATION

object better. All the interviewees are interested to try out the AR Campus application. Besides curiosity, some of the interviewees are interested due to trying out the application does not require them to purchase any additional gadget. For the interviewee that has not experienced in using AR, he is willing to try out something new and hopes that there will be a guideline on how to use the function. Expectations from all the interviewees are summarized and listed down in Table 4-4-2.

Respondents	User Expectation/Requirement
User1	As a user, I wish to know the basic information of UTAR through the application.
User2	As a user, I wish to know the programmes offered by UTAR.
User3	As a user, I wish to explore the UTAR Kampar campus virtually through Augmented Reality.
User4	As a user, I need a tutorial before using the AR module.
User5	As a user, I wish I could rotate the 3D model so that I can have a better look of the UTAR Kampar campus.
User6	As a user, I wish to know the campus environment.
User7	As a user, I wish to know the basic information about the buildings.
User8	As a user, I wish to view the exterior and interior view of the buildings.
User9	As a user, I wish to know the route from my current location to UTAR campus.
User10	As a user, I wish to know the distance from the nearby public transport station to UTAR campus.

Table 4-4-2: Summary of User Requirement

CHAPTER 4 DESIGN SPECIFICATION

4.5 Verification Plan

Verification plan is undergone to check whether the implemented functions have met the expected result.

Splash Screen

Test Action	Expected Result	Meet Expectation (√/×)
User launches the application.	System displays the splash screen upon launching.	

Table 4-5-1: Verification Plan for Application Splash Screen

Application Home Page

Test Action	Expected Result	Meet Expectation (√/×)
User taps on <i>About Us</i> button.	System directs the user to the <i>About Us</i> interface.	
User taps on <i>Programmes</i> button.	System directs the user to the <i>Programmes</i> interface.	
User taps on <i>FAQ</i> button.	System directs the user to the <i>FAQ</i> interface.	
User taps on <i>Map</i> button.	System directs the user to the <i>Map</i> interface.	
User taps on <i>AR Tour</i> button.	System directs the user to the <i>AR Tour</i> interface.	
User taps on <i>Video Tour</i> button.	System directs the user to the <i>Video Tour</i> interface.	
User taps on <i>Navigation Drawer</i>	System displays the application Navigation Drawer.	

Table 4-5-2: Verification Plan for Application Home Page

Navigation Drawer

Test Action	Expected Result	Meet Expectation (√/×)
User taps on <i>About Us</i> button.	System directs the user to the <i>About Us</i> interface.	
User taps on <i>Programmes</i> button.	System directs the user to the <i>Programmes</i> interface.	
User taps on <i>FAQ</i> button.	System directs the user to the <i>FAQ</i> interface.	
User taps on <i>Map</i> button.	System directs the user to the <i>Map</i> interface.	
User taps on <i>AR Tour</i> button.	System directs the user to the <i>AR Tour</i> interface.	
User taps on <i>Video Tour</i> button.	System directs the user to the <i>Video Tour</i> interface.	
User taps on <i>Exit</i> button.	System prompts an alert dialog to ensure user would like to exit the application.	
User selects “No” at the alert dialog.	The alert dialog will disappear, and user will remain at the same page.	
User selects “Yes” at the alert dialog.	The application will exit programmatically. User will arrive at the device home screen.	

*Table 4-5-3: Verification Plan for Navigation Drawer***Programmes & FAQ Module**

Test Action	Expected Result	Meet Expectation (√/×)
User taps on the <i>Foundation</i> button.	System directs the user to the <i>Foundation</i> interface	
User taps on the <i>Undergraduate</i> button.	System directs the user to the <i>Undergraduate</i> interface	
User taps on the <i>Postgraduate</i> button.	System directs the user to the <i>Postgraduate</i> interface	

CHAPTER 4 DESIGN SPECIFICATION

User taps on the <i>hyperlink</i> .	<p>If user's has Internet connectivity: System displays the additional information in browser.</p> <p>Else, system display an error message.</p>	
-------------------------------------	--	--

Table 4-5-4: Verification Plan for Programmes & FAQ Module

Map Module & Video Module

Test Action	Expected Result	Meet Expectation (√/×)
User reaches this module without Internet connection.	System displays toast message to advice user to connect to WIFI/data.	
User taps the <i>Search</i> button for the first time after application installation.	System gets access location permission from the user.	
User taps the <i>Search</i> button without selecting starting point.	System prompts the user to select the starting point.	
User taps the <i>Search</i> button without selecting destination.	System prompts the user to select the destination.	
User taps the <i>Search</i> button after selecting starting point and destination	<p>System displays the route and distance from the starting point to destination, and the estimated time needed on the map.</p> <p>**Only for Video Module</p> <p>Video from the starting point to the destination will be displayed.</p>	

Table 4-5-5: Verification Plan for Map Module & Video Module

AR Tour Module

Test Action	Expected Result	Meet Expectation (√/×)
Users deny the Camera Access Permission.	System prompt for the permission again.	
User taps the <i>Exit</i> button	System will exceed the AR module and back to the application home page.	
User taps the <i>Manual</i> button	System will display the manual to use the AR feature.	
User taps the <i>Show/Hide Interior View</i> Button	System will hide the buttons if they are shown on screen. Else, the buttons will be shown.	
User taps the buttons in orange colour.	System will change the scene and displayed the interior view according to the selected button.	
User taps the <i>exterior</i> button.	System will direct user to another scene that will display the exterior view of the building through AR.	

*Table 4-5-6: Verification Plan for AR Tour Module***4.6 Implementation Issues and Challenges**

There are some difficulties faced while implementing the proposed system. One of the most challenging parts is to learn and utilize the Unity engine. It is undeniable that Unity is powerful as it offers lots of features to create augmented reality effects. However, it is also complicated in terms of operating. Therefore, lots of time is needed to study and understand the features offered by Unity.

Furthermore, since it is impossible to get the 3D models of the UTAR Kampar buildings from the Internet, therefore, it poses a great challenge to build all the buildings in UTAR Kampar into 3D models through Blender. Moreover, the layout of Blender is much more complicated than other software and requires lots of hands-on experience to get familiarized with it.

CHAPTER 4 DESIGN SPECIFICATION

4.7 Project Timeline

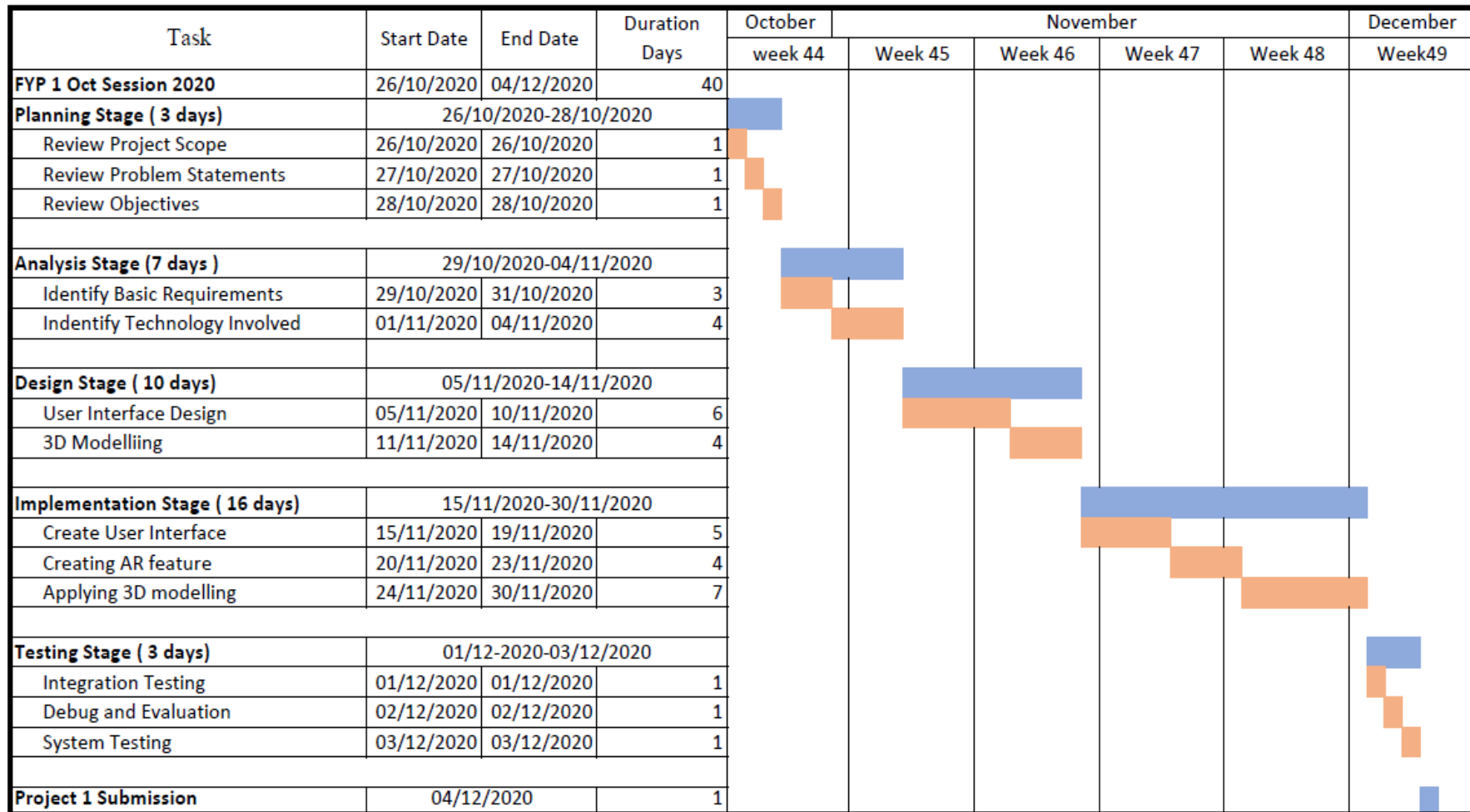


Figure 4-7-1: Gantt chart for FYP 1 October 2020 Session

CHAPTER 4 DESIGN SPECIFICATION

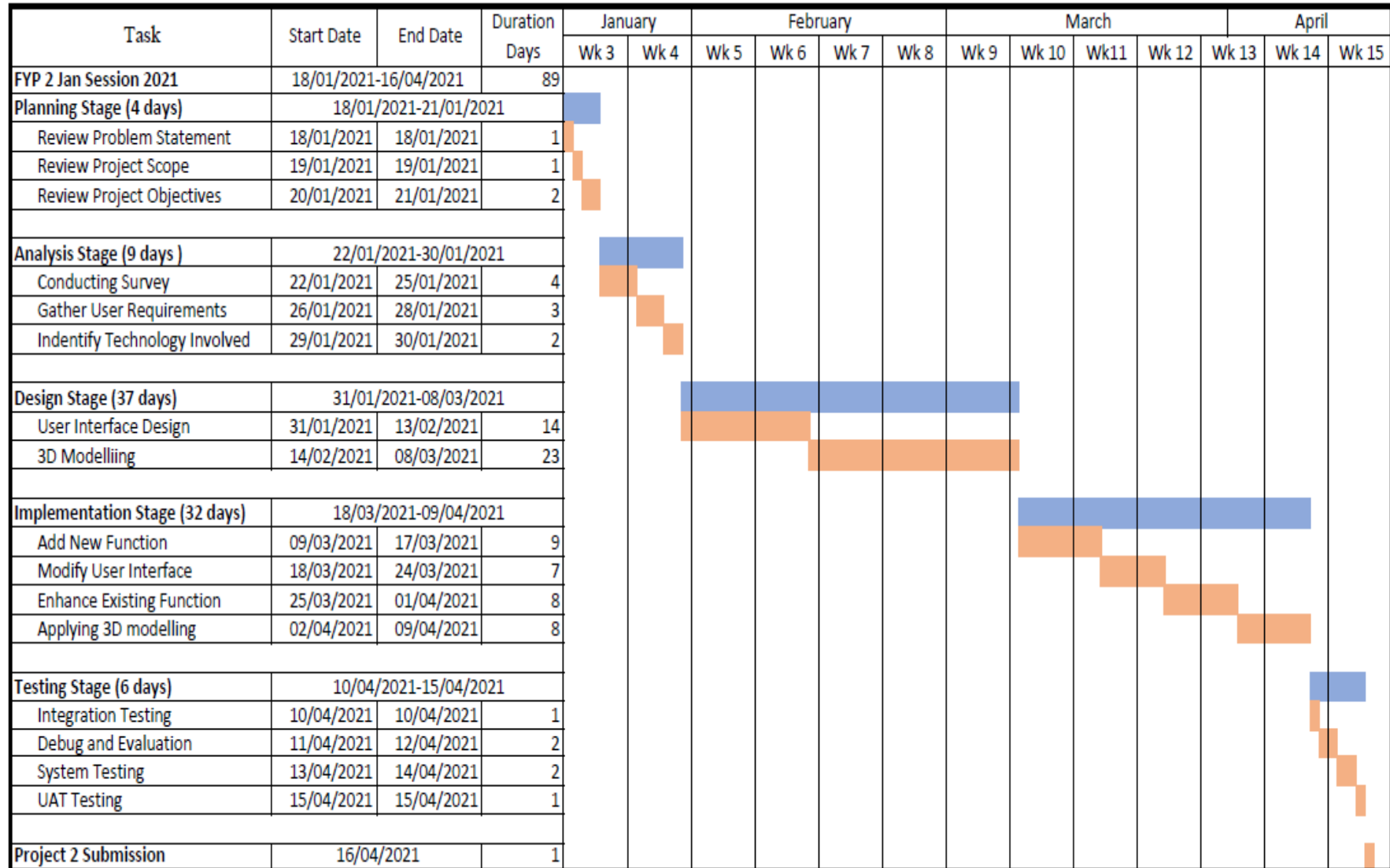


Figure 4-7-2: Gantt chart for FYP 2 January 2021 Session

5.1 Building of 3D model in Blender

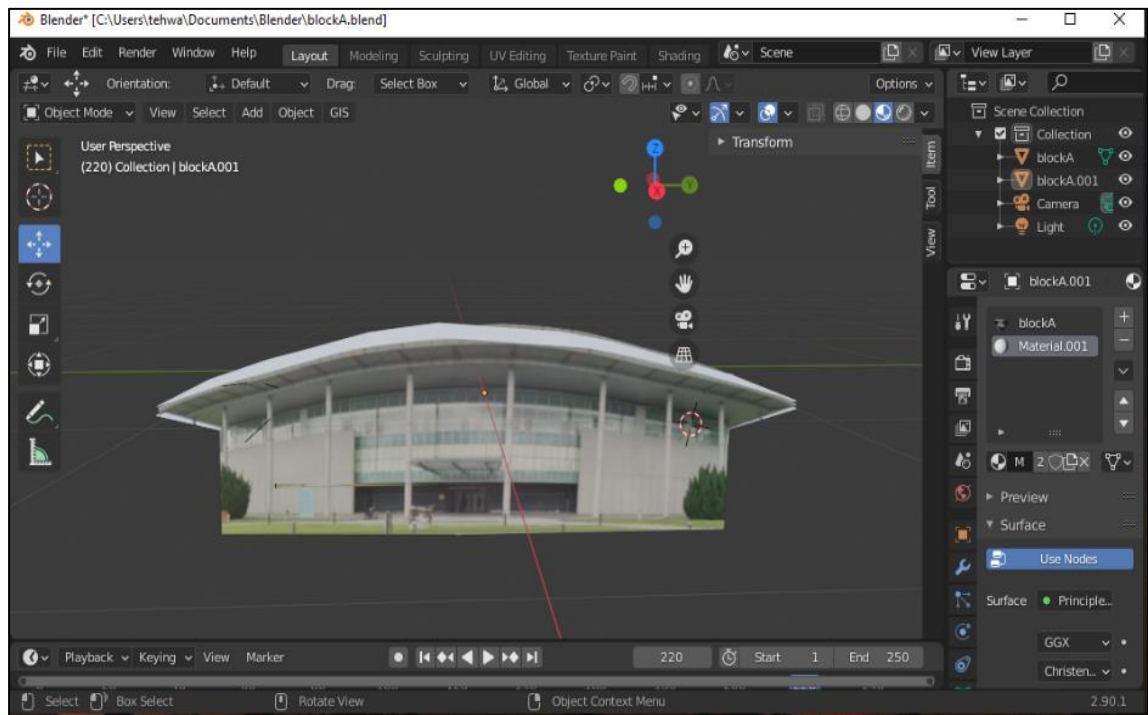


Figure 5-1-1: Development of 3D Building in Blender

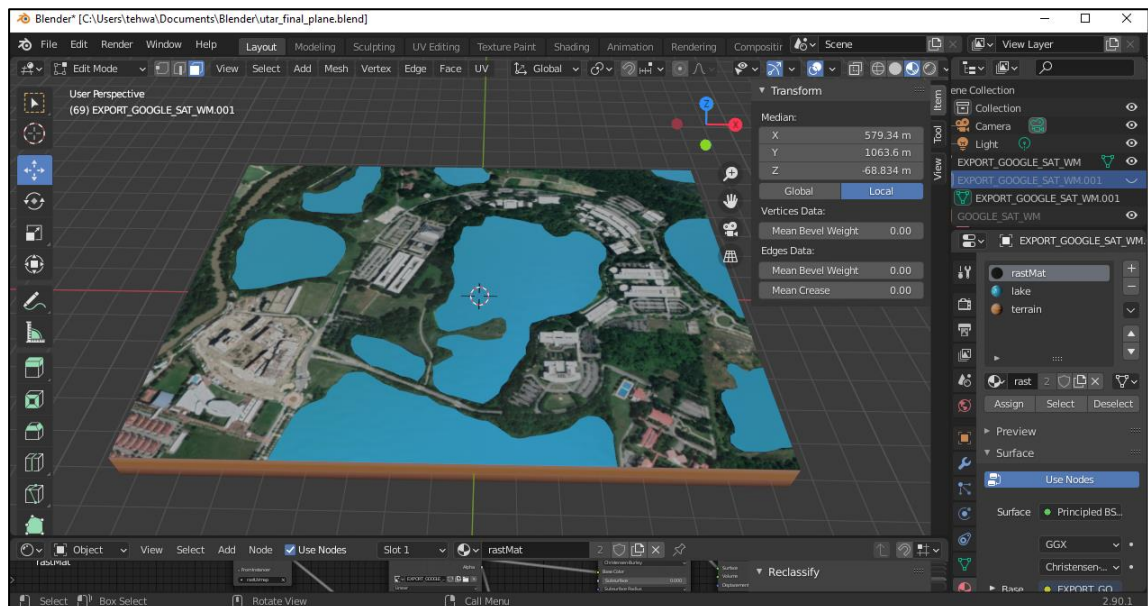


Figure 5-1-2: Development of Terrain in Blender

The 3D model that was simulated in the AR module was built by using Blender. All the 3D models, including the terrain and buildings are designed and constructed in Blender. After creating and building the 3D model, the models were exported as FBX file to import into Unity.

5.2 Implementation of AR module in Unity

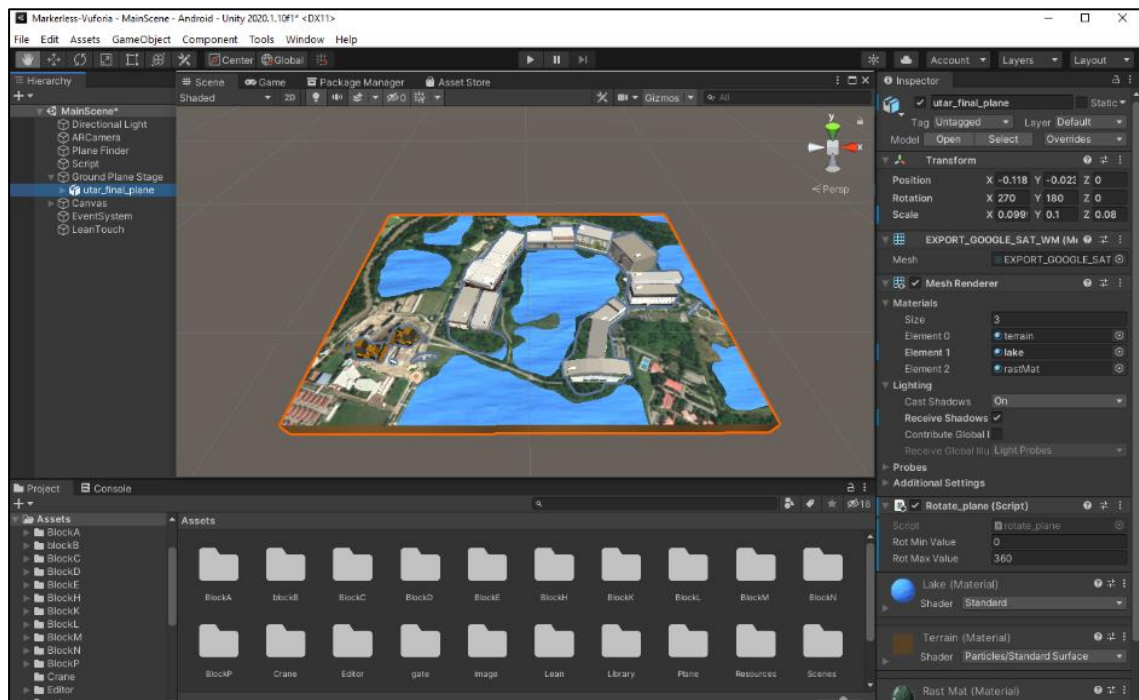


Figure 5-2-1: Development of AR Module in Unity

The AR module in this system is developed by using Unity. It is then exported as a project and then integrated together with the Android Studio Project. The steps of developing and exporting the AR module are explained below.

5.2.1 Set Up of Vuforia engine in Unity

1. First, download the “Vuforia Engine for Unity Project Package” from Vuforia Developer Portal.
2. Import the package and the Vuforia AR feature is ready to use.

5.2.2 Development of AR Module

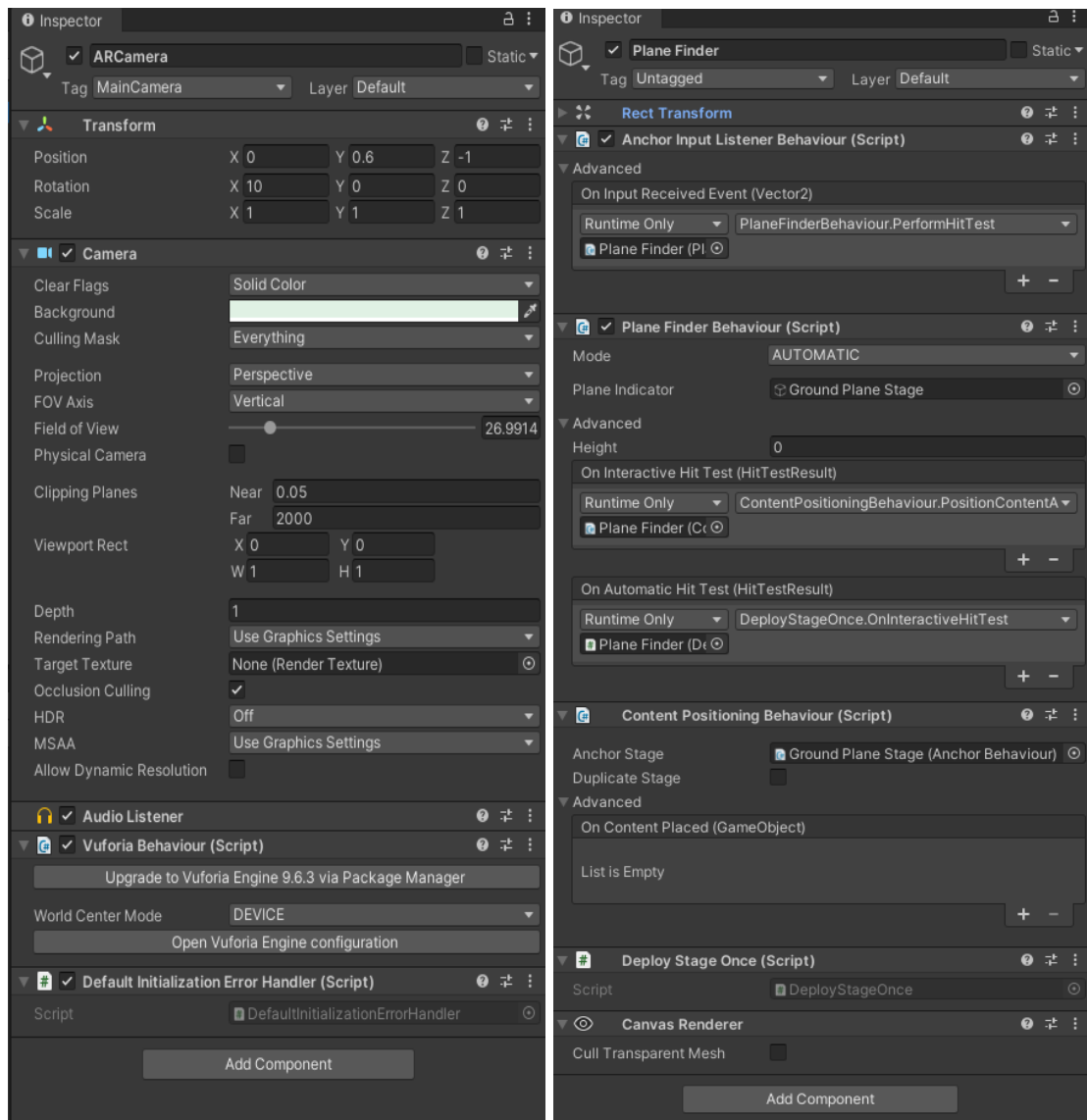


Figure 5-2-2-1: Specifications of AR Camera

Figure 5-2-2-2: Specifications of Plane Finder

To develop the AR function, an AR Camera and a Plane Finder are needed to scan the user's environment and look for a suitable plane to place the 3D content. Automatic mode is selected as the Plane Finder Behaviour so that the 3D content will be automatically triggered once the Plane Finder found a suitable plane. Although the 3D content has been placed automatically, users can still move and the 3D content. The inspection of the AR Camera and plane finder are shown in the Figure 5-2-2-1 and Figure 5-2-2-2.

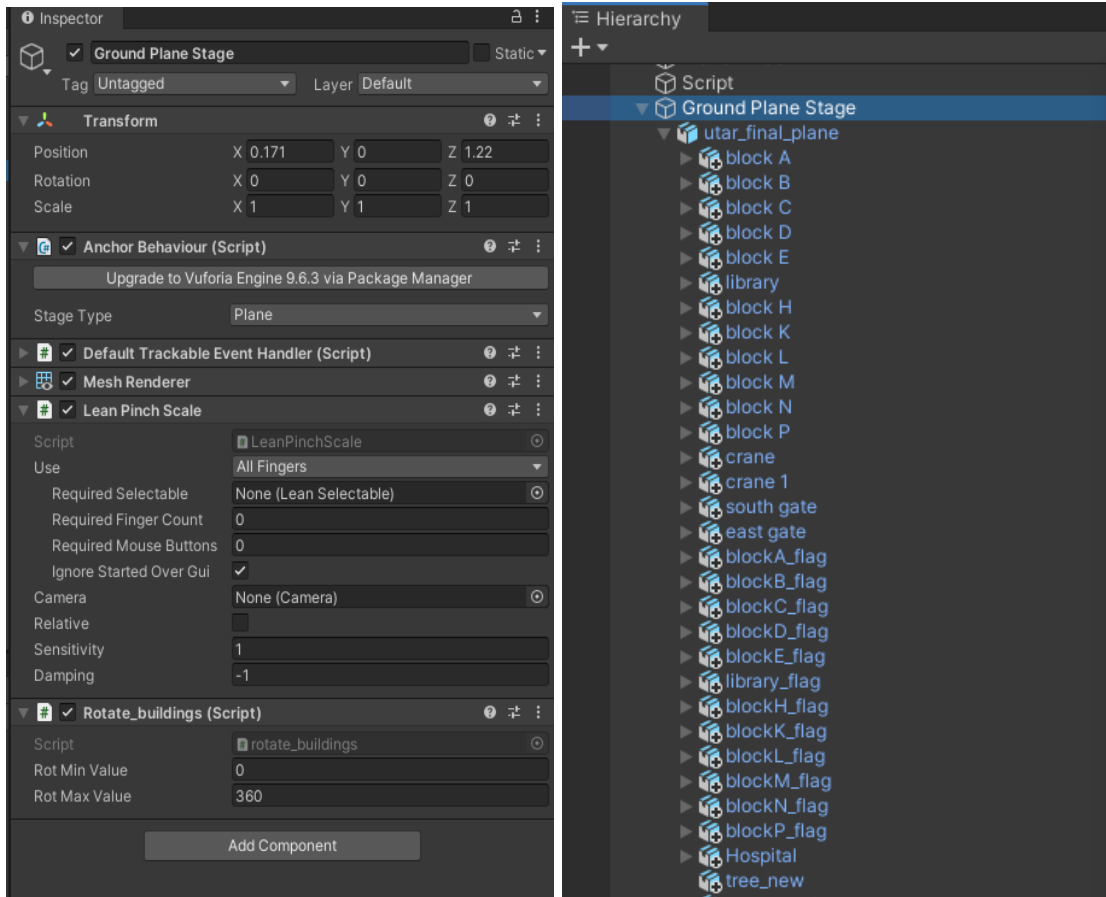


Figure 5-2-2-3: Specifications of Ground Plane Stage

Figure 5-2-2-4: Objects Located under Ground Plane Stage

When the plane finder finds a suitable plane, it will automatically call the ground plane stage. Ground plane stage serves as a parent game object, and the 3D content that will be triggered is placed as it's child. Ground Plane Stage consists of additional scripts, such as “Lean Pinch Scale” and “Rotate_buidlings” Script. These scripts were written and added to control the 3D content, so that the content can be scaled and rotated according to user's input.

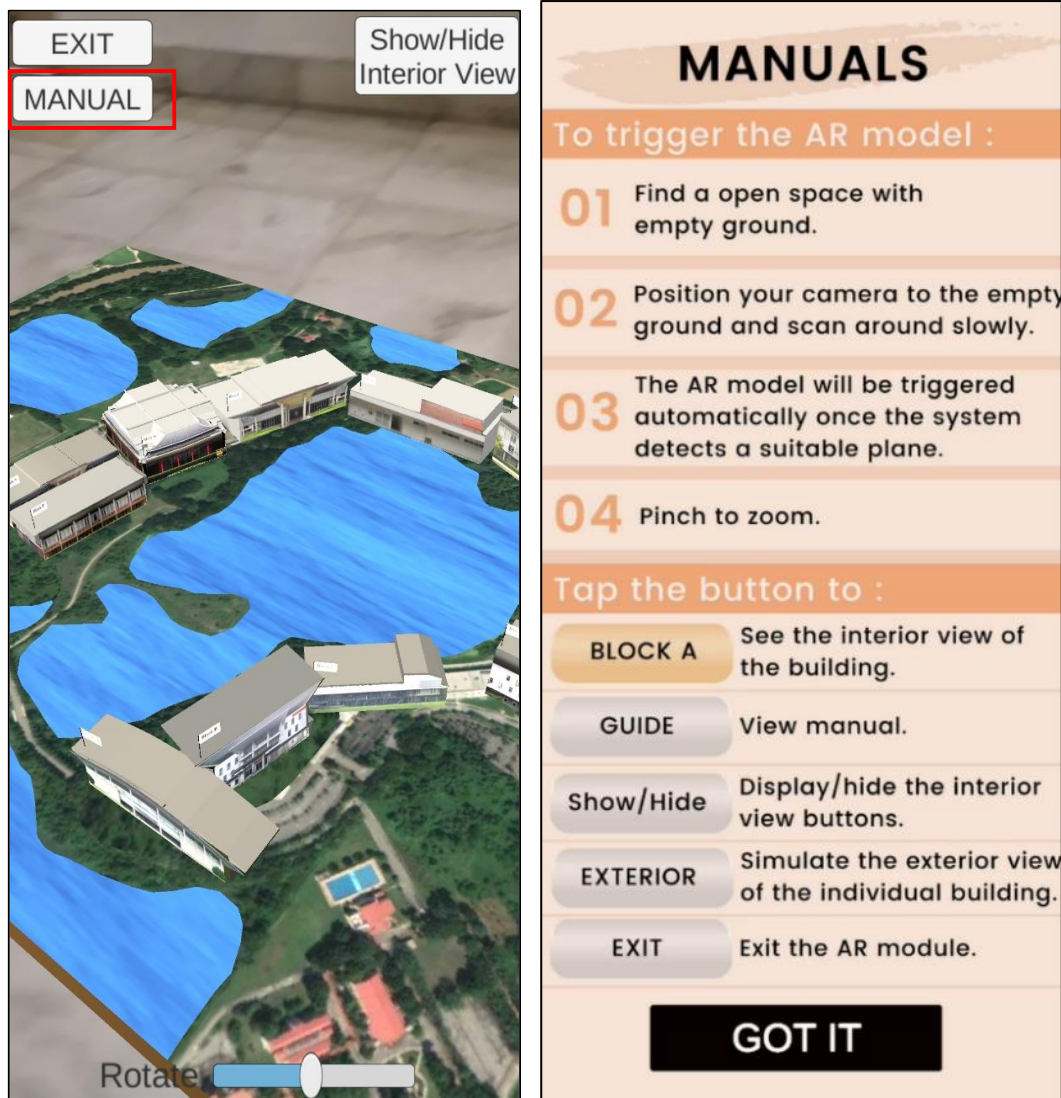


Figure 5-2-2-5: Main Page of AR Module

Figure 5-2-2-6: Guideline for AR Module

A user manual on how to use this AR module will be shown when users select the MANUAL button. The user manual has listed out the functions of every button. Meanwhile, selection of the EXIT button will exit the AR module and back to the application home page.

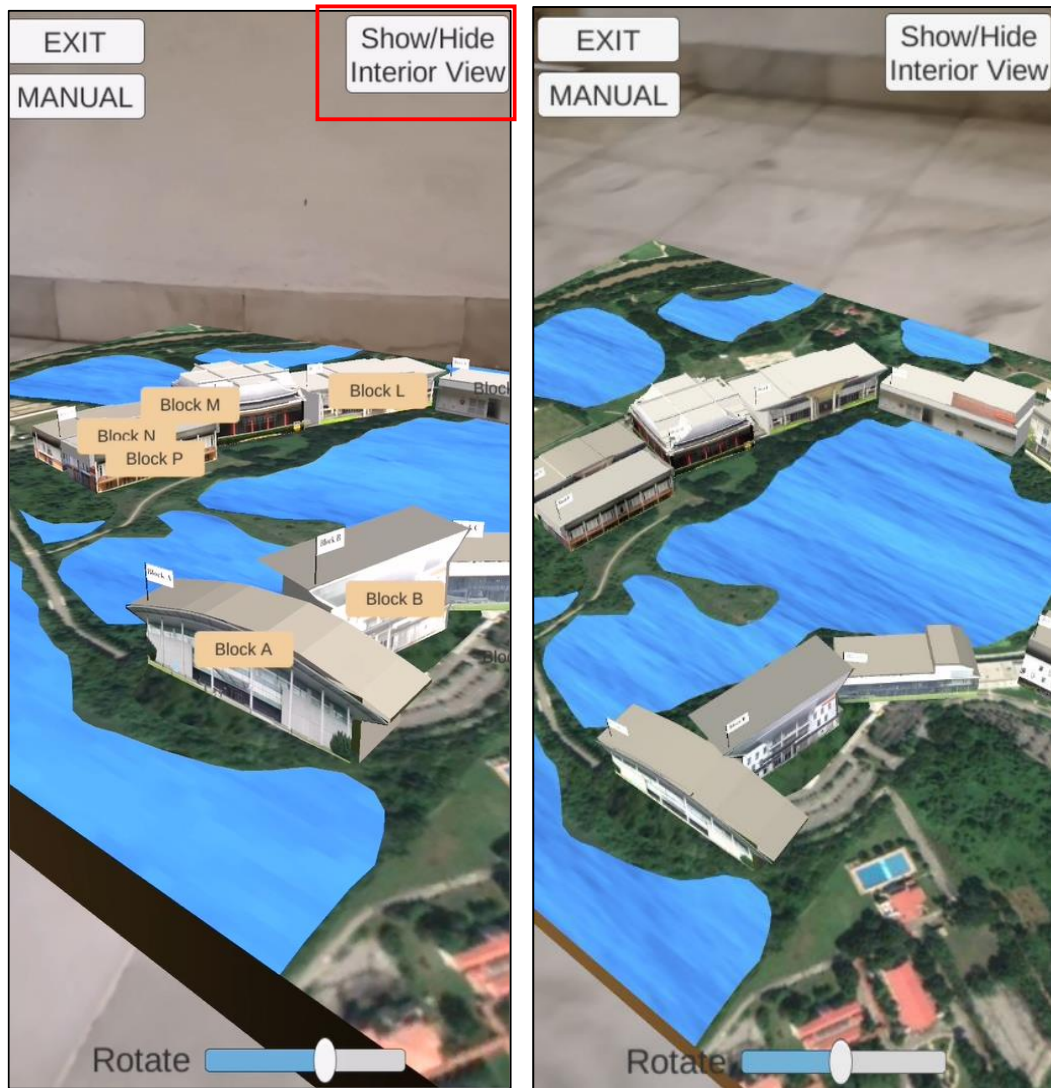


Figure 5-2-2-7: Orange Button Shown on Screen

Figure 5-2-2-8: Orange Button Hide on Screen

The difference between Figure 5-2-2-7 & Figure 5-2-2-8 is that the first figure consists of buttons that lead to the interior scene of the respective building. When the “Show / Hide Interior View” button is pressed, the system will check whether the Block A- P buttons are shown on scene. If the buttons in orange colour are displayed on the screen, the system will hide the buttons. Else, the buttons will be displayed. The purpose of hiding the buttons is to enable users to enjoy a better overview of the campus layout. Moreover, when the plane is rotated, the orange buttons will follow the buildings that they belong to. The script to hide the buttons and instruct the buttons to move according to the displacement of the buildings is shown in Figure 5-2-2-9 and Figure 5-2-2-10.

```

public void showHideButton()
{
    //check if button A is active on screen or not
    if (buttonA != null )
    {
        bool isActive = buttonA.activeSelf;
        buttonA.SetActive(!isActive);
    }

    if (buttonB != null)
    {
        bool isActive = buttonB.activeSelf;
        buttonB.SetActive(!isActive);
    }
}

```

```

public class Hos_Button : MonoBehaviour
{
    [SerializeField]
    private new Transform transform;

    private RectTransform rectTransform;
    private Image image;

    private void Awake()
    {
        //RectTransform component of canvas button
        rectTransform = GetComponent<RectTransform>();
        image = GetComponent<Image>();
    }

    private void Update()
    {
        //calculate the position of the UI element
        //0,0 for the canvas is at the center of the screen
        // whereas WorldToViewportPoint treats the lower left corner as 0,0.
        //subtract the height / width of the canvas * 0.5 to get the correct position.
        var screenPoint = Camera.main.WorldToScreenPoint(transform.position);
        rectTransform.position = screenPoint;

        var viewportPoint = Camera.main.WorldToViewportPoint(transform.position);
        var distanceFromCenter = Vector2.Distance(viewportPoint, Vector2.one * 0.5f);

        var show = distanceFromCenter < 0.3f;

        image.enabled = show;
    }
}

```

Figure 5-2-2-9: Script for Show & Hide Button

Figure 5-2-2-10: Script for Button to Follow the Objects

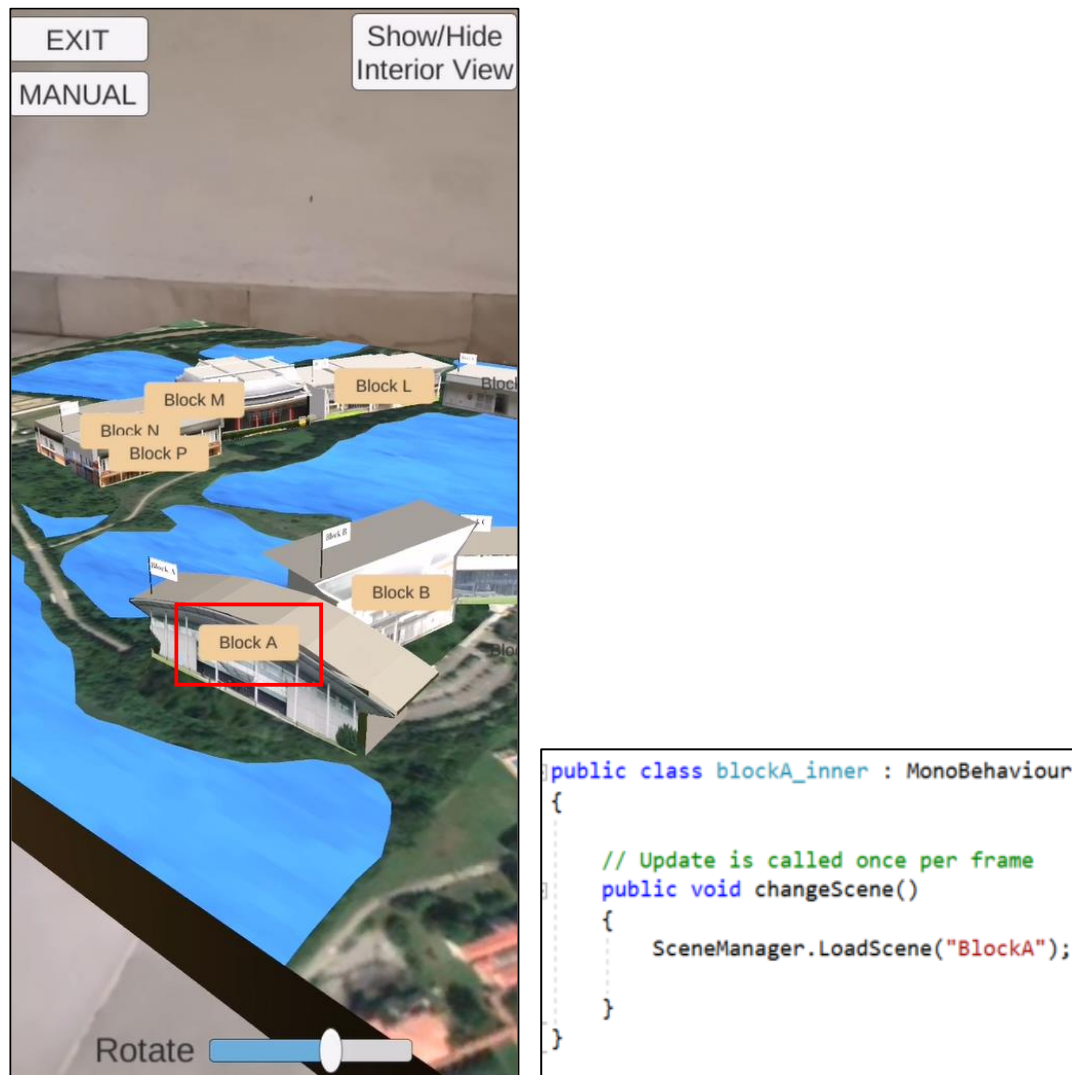


Figure 5-2-2-11: Main Page of AR Module

Figure 5-2-2-12: Script to Change Scene

When the orange button in the Main Scene is pressed, the interior view of the corresponding scene will be displayed, as shown in Figure 5-2-2-13. The script for scene changing is revealed in Figure 5-2-2-12.

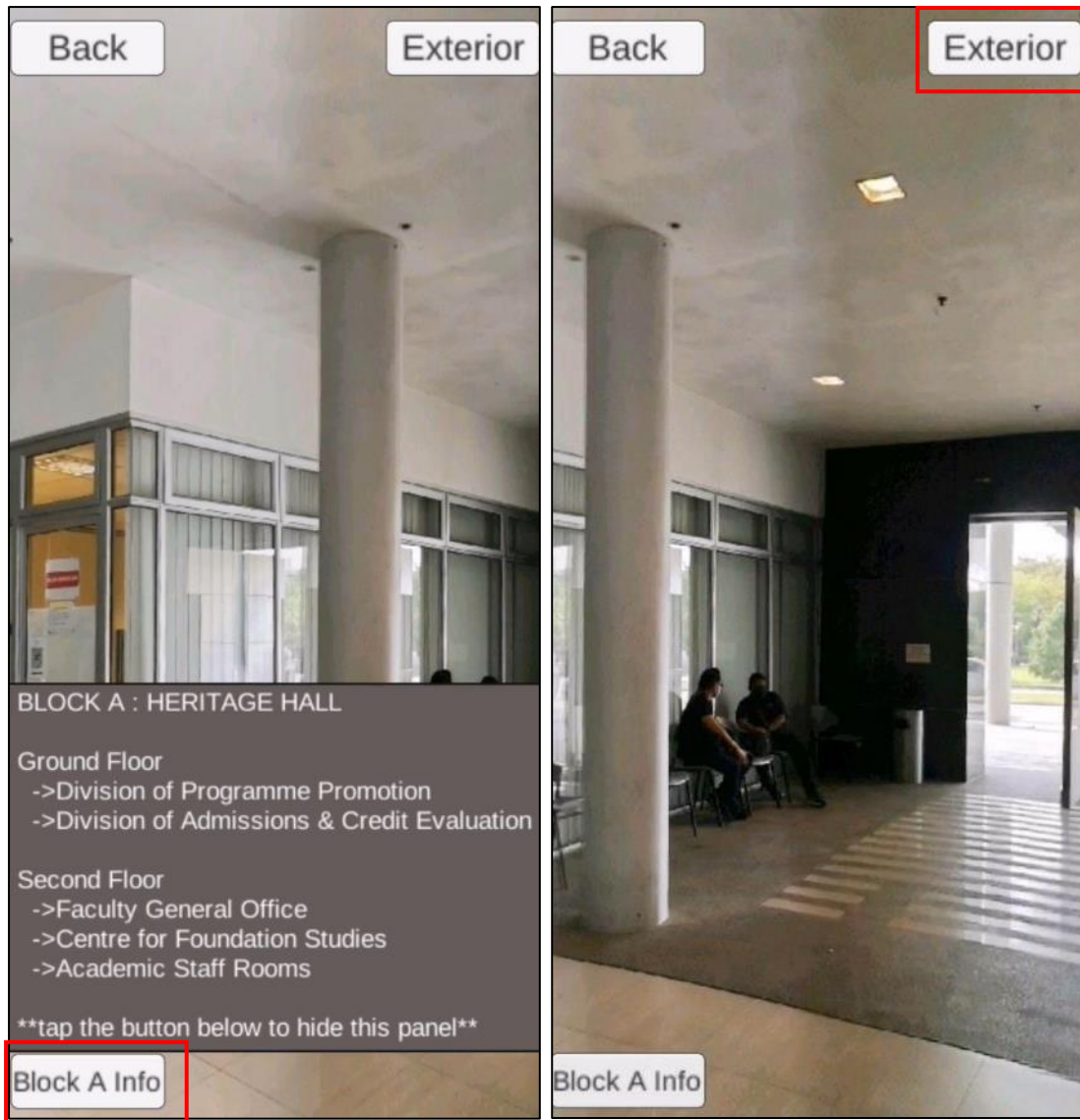


Figure 5-2-2-13: Interior View with Description Panel

Figure 5-2-2-14: Interior View without Description Panel

Description of the corresponding building will be displayed in the interior view. However, the description panel can be hidden by selecting the “Block A Info” button. If the “Exterior” button is pressed, users can simulate the individual exterior view of the building via Augmented Reality, as shown in Figure 5-2-2-15. The building is rotatable and scalable.



Figure 5-2-2-15: Simulation of Individual Building

5.3 Export of AR module in Unity to Android Studio

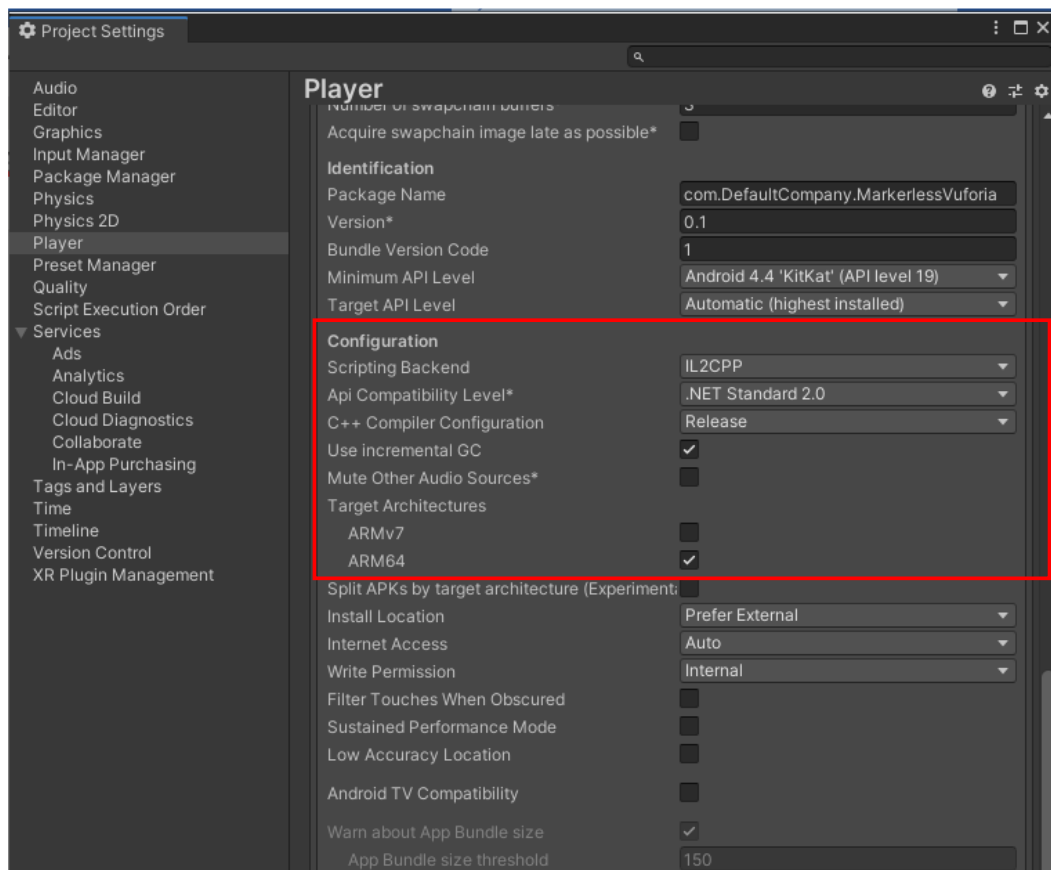


Figure 5-3-1: Specification in Player Settings

1. Select File > Build Settings.
2. Select Android as deployment platform.
3. Install the Android with Unity Hub by selecting Android Build Support.
4. Back to Build Setting, select Player Settings > Player > Other Settings
5. Select the Minimum API Level & Target API Level.
6. The configuration in other settings has to be same as Figure 5-3-1.
7. Back to Build Settings, select Export Project > Export

5.4 Import of AR module from Unity to Android Studio

1. In the Android Studio Project, drag the folder name unityLibrary from the exported Unity file.
2. Include the following code in the android native settings.gradle file.

```
include ':unityLibrary'
project(':unityLibrary').projectDir=new File('C:\\Users\\tehma\\AndroidStudioProjects\\UTAR\\unityLibrary')
```

Figure 5-4-1: Code to Add in setting.gradle file

3. In build.gradle(Module: app) file, add the code that is wrapped in the red box in Figure 5-4-2.

```
android {
    compileSdkVersion 30
    buildToolsVersion "30.0.2"

    defaultConfig {
        applicationId "com.example.utar"
        minSdkVersion 19
        targetSdkVersion 30
        versionCode 1
        versionName "1.0"

        testInstrumentationRunner "androidx.test.runner.AndroidJUnitRunner"
    }

    ndk {
        abiFilters 'arm64-v8a', 'x86'
    }

    buildTypes {
        release {
            minifyEnabled false
            proguardFiles getDefaultProguardFile('proguard-android-optimize.txt'), 'proguard-rules.pro'
        }
    }

    aaptOptions {
        noCompress '.unity3d', '.ress', '.resource', '.obb'
    }
}

dependencies {
    implementation fileTree(dir: "libs", include: ["*.jar"])
    implementation project(':unityLibrary')
    implementation fileTree(dir: project(':unityLibrary').getProjectDir().toString() + ('\\libs'), include: ['*.jar'])
}
```

Figure 5-4-2: Code to Add in build.gradle file

4. In the build.gradle(Project: NativeAndroidApp) file, add the highlighted code in all projects.

```
allprojects {
    repositories {
        google()
        jcenter()
    }
    flatDir {
        dirs "${project(':unityLibrary').projectDir}/libs"
    }
}
```

Figure 5-4-3: Code to Add in build.gradle file

5. Select SDK Manager > SDK Tools and download NDK(Side by side)
6. In unityLibrary > src > main > res > AndroidManifest.xml, change the intent filter from LAUNCHER to DEFAULT. This is to prevent the system from installing two times during the installation of application.
7. Moreover, when returning from AR module to android application, to prevent the whole application being killed, in the same xml file, add the following code.

```
<application>
    <activity android:name="com.unity3d.player.UnityPlayerActivity"
        android:launchMode="singleTask" android:process=":unityplayer"
        <intent-filter>
            <action android:name="android.intent.action.MAIN" />
            <category android:name="android.intent.category.DEFAULT" />
        </intent-filter>
```

Figure 5-4-4: Code to Add in AndroidManifest.xml

8. The integration of Unity with Android Studio has completed.

5.5 Functionalities Testing

Functionalities testing is carried out in each module respectively. The testing is carried out according to the verification plan that was designed earlier. This is to ensure that the system is able to work properly and able to meet the expected result.

Splash Screen

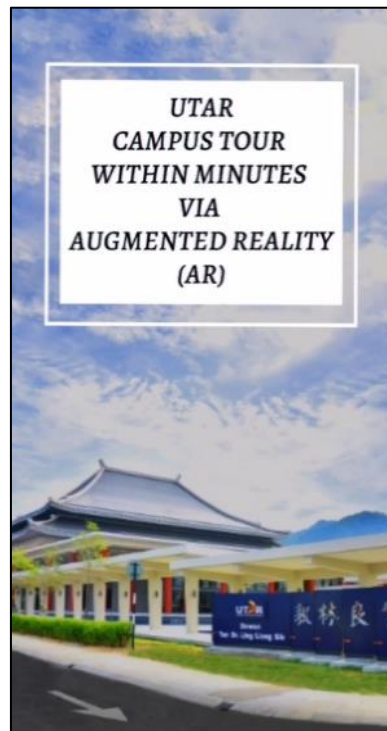


Figure 5-5-1: Splash Screen of the Application

Upon launching the application, the system should display a splash screen that portrays the landmark of UTAR Kampar campus, Dewan Tun Dr Ling Liong Sik before entering to the home page.

Test Action	Expected Result	Meet Expectation (√/×)
User launches the application.	System displays the splash screen upon launching.	√

Table 5-5-1: Test Result for Application Splash Screen

Application Home Page*Figure 5-5-2: Home Page of the Application*

This application home page consisted of all the modules. The system should respond based on the user's input.

Test Action	Expected Result	Meet Expectation (√/×)
User taps on <i>About Us</i> button.	System directs the user to the <i>About Us</i> interface.	√
User taps on <i>Programmes</i> button.	System directs the user to the <i>Programmes</i> interface.	√
User taps on <i>FAQ</i> button.	System directs the user to the <i>FAQ</i> interface.	√
User taps on <i>Map</i> button.	System directs the user to the <i>Map</i> interface.	√
User taps on <i>AR Tour</i> button.	System directs the user to the <i>AR Tour</i> interface.	√
User taps on <i>Video Tour</i> button.	System directs the user to the <i>Video Tour</i> interface.	√
User taps on <i>Navigation Drawer</i>	System displays the application <i>Navigation Drawer</i> .	√

Table 5-5-2: Test Result for Application Home Page

Navigation Drawer

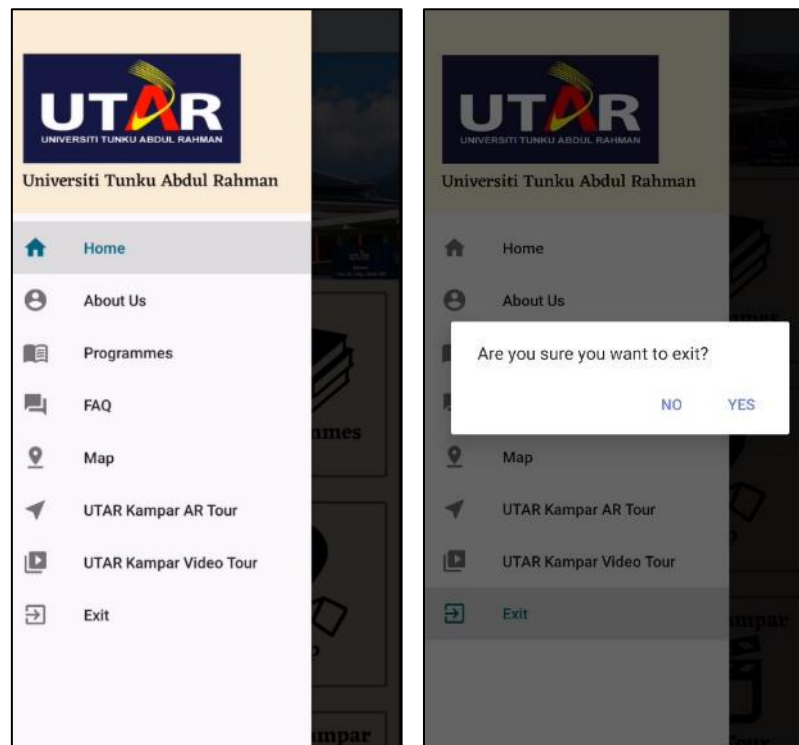


Figure 5-5-3: Navigation Drawer of the Application

Figure 5-5-4: Alert Message Shown When User Selects Exit

The navigation drawer contained all the modules and an exit function. The system should respond based on the user's input. When user has selected the exit button, an alert message dialog should popup to confirm for user's leaving.

Test Action	Expected Result	Meet Expectation (√/×)
User taps on <i>About Us</i> button.	System directs the user to the <i>About Us</i> interface.	√
User taps on <i>Programmes</i> button.	System directs the user to the <i>Programmes</i> interface.	√
User taps on <i>FAQ</i> button.	System directs the user to the <i>FAQ</i> interface.	√
User taps on <i>Map</i> button.	System directs the user to the <i>Map</i> interface.	√
User taps on <i>AR Tour</i> button.	System directs the user to the <i>AR Tour</i> interface.	√
User taps on <i>Video Tour</i> button.	System directs the user to the <i>Video Tour</i> interface.	√

User taps on <i>Exit</i> button.	System prompts an alert dialog to ensure user would like to exit the application.	√
User selects “No” at the alert dialog.	The alert dialog will disappear, and user will remain at the same page.	√
User selects “Yes” at the alert dialog.	The application will exit programmatically. User will arrive at the device home screen.	√

Table 5-5-3: Test Result for Navigation Drawer

Programmes Module & FAQ Module

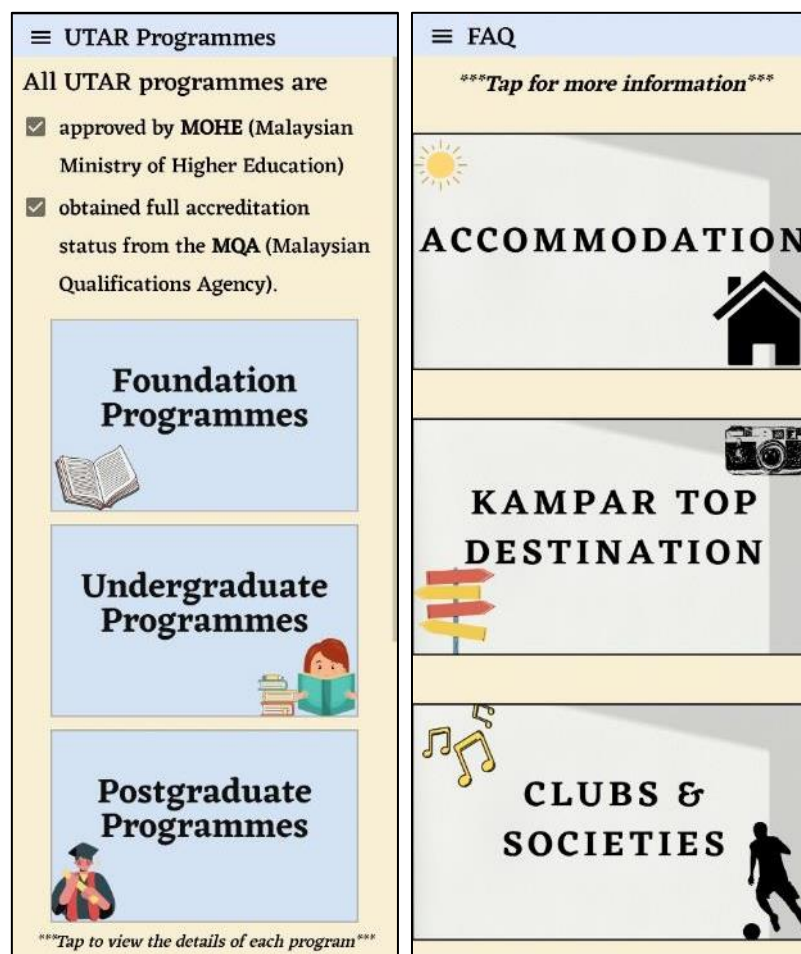


Figure 5-5-5: User Interface for Programme Module

Figure 5-5-6: User Interface for FAQ Module

Both modules should display the additional information in browser when user has tapped the hyperlink. However, if user does not have internet connectivity, the system should display an error message.

CHAPTER 5 SYSTEM IMPLEMENTATION AND TESTING

Test Action	Expected Result	Meet Expectation (√/×)
User taps on the <i>Foundation</i> button.	System directs the user to the <i>Foundation</i> interface	√
User taps on the <i>Undergraduate</i> button.	System directs the user to the <i>Undergraduate</i> interface	√
User taps on the <i>Postgraduate</i> button.	System directs the user to the <i>Postgraduate</i> interface	√
User taps on the <i>hyperlink</i> .	<u>If user's has Internet connectivity:</u> System displays the additional information in browser. Else, system display an error message.	√

Table 5-5-4: Test Result for Programmes Module & FAQ Module

Map Module & Video Module

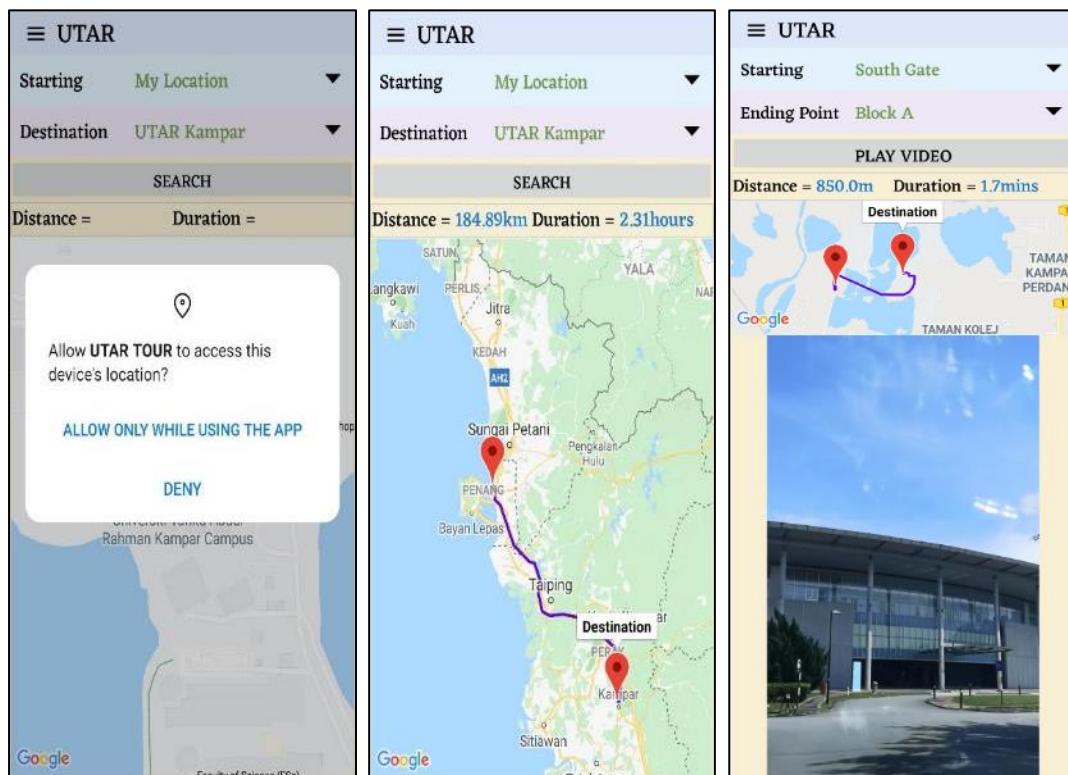


Figure 5-5-7: System Prompt for Location Access

Figure 5-5-8: User Interface for Map Module

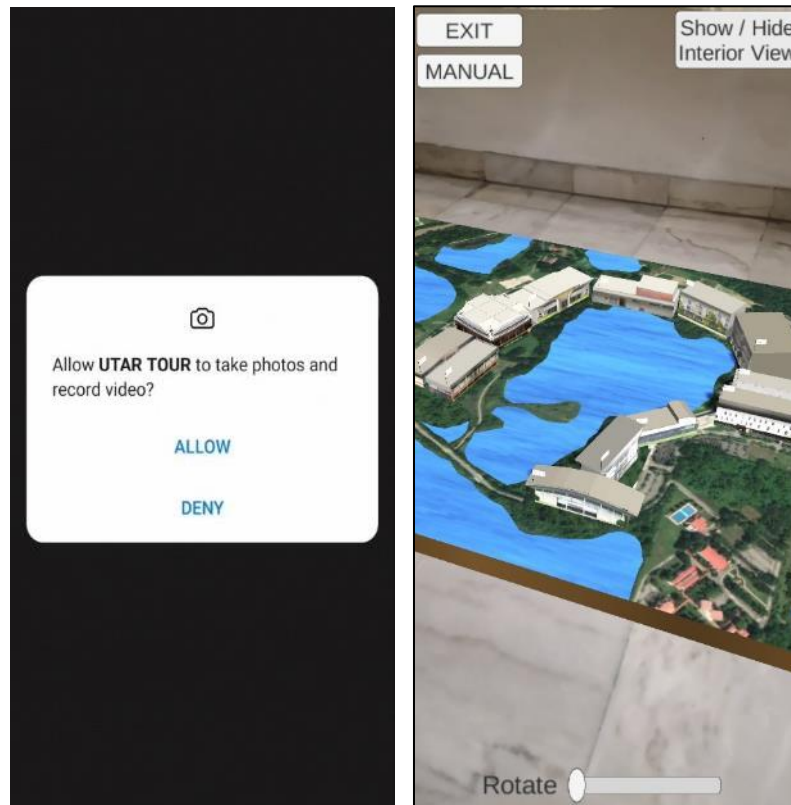
Figure 5-5-9: User Interface for Video Tour Module

CHAPTER 5 SYSTEM IMPLEMENTATION AND TESTING

When users first attempt to use either two of these modules after application installation, the system should get the access location permission from the user. If user allow, the marker on map, distance and duration will be displayed. Else the route will not be loaded.

Test Action	Expected Result	Meet Expectation (√/×)
User reaches this module without Internet connection.	System displays toast message to advice user to connect to WIFI/data.	√
User taps the <i>Search</i> button for the first time after application installation.	System gets access location permission from the user.	√
User taps the <i>Search</i> button without selecting starting point.	System prompts the user to select the starting point.	√
User taps the <i>Search</i> button without selecting destination.	System prompts the user to select the destination.	√
User taps the <i>Search</i> button after selecting starting point and destination	System displays the route and distance from the starting point to destination, and the estimated time needed on the map. **Only for Video Module Video from the starting point to the destination will be displayed.	√

Table 5-5-5: Test Result for Map Module & Video Modules

AR Tour Module*Figure 5-5-10: System Prompt for Camera Access Permission**Figure 5-5-11: User Interface for AR Tour Module*

When users first attempt to use this after application installation, the system should prompt for camera access permission. If users deny the camera access permission, the system will prompt for the permission again until users have agree. Then, a manual on how to use the guideline should be shown to the user before the system proceeds to the main page of AR Tour Module. If the system is able to detect a suitable surface to place the plane, the AR model will be simulated.

Test Action	Expected Result	Meet Expectation (√/×)
Users deny the Camera Access Permission.	System prompt for the permission again.	√
User taps the <i>Exit</i> button	System will exceed the AR module and back to the application home page.	√
User taps the <i>Manual</i> button	System will display the manual to use the AR feature.	√

User taps the <i>Show/Hide Interior View</i> Button	System will hide the buttons if they are shown on screen. Else, the buttons will be shown.	√
User taps the buttons in orange colour.	System will change the scene and displayed the interior view according to the selected button.	√
User taps the <i>exterior</i> button.	System will direct user to another scene that will display the exterior view of the building through AR.	√

Table 5-5-6: Test Result for AR Tour Module

5.6 User Acceptance Testing

User acceptance testing, which is also known as end-user testing, is carried out to survey whether that application is able to fulfil the user's requirement. The UAT process was carried out in Arnold Cycling Cafe, which is located in Butterworth, Penang. The testers were the customers of the cafe and were randomly invited to test the application. A free drink has been prepared for every volunteer as a token of appreciation. The feedback from the volunteers were summarized in Table 5-6-1.

Participants	Summary Feedbacks
Name: Lee Min Er Occupation: Student	<ul style="list-style-type: none"> • Her understanding towards UTAR Kampar campus has improved after using the application. • Satisfied that the application shows both exterior views and interior view of each building.
Name: Tan Elyn Occupation: White Collar	<ul style="list-style-type: none"> • Looking forward to more features, for example the restaurant nearby the campus. • The waiting time to load the AR module is slightly longer than she expected.
Name: Elinne Chan Occupation: Student	<ul style="list-style-type: none"> • Like the video tour that able to save her time to look for the buildings. • Commented that the UI design is simple yet direct.
Name: Law Yee Jia Occupation: Student	<ul style="list-style-type: none"> • The application is user friendly. • Amazed with the 3D layout of the campus.

CHAPTER 5 SYSTEM IMPLEMENTATION AND TESTING

Name: Anzo Loo Occupation: White Collar	<ul style="list-style-type: none">• Able to use the application without any guidance.• Surprised that AR technology can be adopted in campus virtual tour.
--	---

Table 5-6-1: Summary Feedbacks of User Acceptance Testing

The feedback from the UAT tester is mostly positive. This shows that the application has reached the user's expectation. Most of the users are amazed by the 3D layout of the campus and commented that the 3D modelling looks very real. There are also suggestions received during the UAT process. The suggestions are precious and useful and can be added into the future work.

CHAPTER 6 CONCLUSION

6.1 Project Review, Discussion and Conclusions

The project has completed and is able to reach all the project objectives. The project has made use of markerless AR technology to provide a convenient platform for users to visit the campus without the need to physically present to the campus. Moreover, users are able to get useful information about UTAR through the virtual campus tour. Furthermore, the project has provided a 3D view of the campus to the users. The overall layout and the significant buildings of the campus is presented to users via colour 3D model. Furthermore, the project has successfully delivered the basic details about all the significant buildings to the users through texts and 360-degree panoramic images. In addition, the project has revealed the environment of UTAR through images and videos. It is believed that users will have a better understanding towards UTAR Kampar campus after using the application.

Although the project is able to offer a convenient and carefree tour to the UTAR Kampar campus, however, this project contains some weaknesses too. Firstly, the AR module of the project is limited to the device that is supported by Vuforia. Therefore, it limits the number of users to enjoy the AR feature. Moreover, the application size of the project is up to 865MB. This is due to there are nearly 20 videos under the Video Tour module. The videos nearly occupy half of the application size. Users need to have enough storage in their devices to install the application. Improvements for future work can be made based on these weaknesses.

6.2 Novelties and Contribution of Work

The novelty of this project is that the current market does not consist of an Android application that offers a virtual tour to UTAR Kampar campus via AR. The benefits of applying AR in the campus tour not only bring benefits to the users, but also to the university as well. Users will no longer be restricted by distance and time and able to visit the UTAR Kampar campus through a few taps. In addition, instead of exploring the campus under the hot sun, they can take their time sightseeing the university in their most comfortable way through a mobile device. For the university, this will be a great chance to promote the campus in an interactive way. Therefore, this can be considered as a win-win situation for both parties.

6.3 Future Work

The future work of this project includes decreasing the file size of the application. The suggested way is to store the data by using cloud storage. However, it is important to find out the ways to retrieve the data of videos quickly to reduce the buffering time.

Moreover, the future work can be focused on to provide AR navigation in UTAR Kampar campus. By that, even if users are physically present in the campus, they no longer need to rely on the facilitator and are able to explore the campus individually.

Furthermore, the application can provide more information about UTAR Kampar town, including the price range of restaurants and accommodation. By that, users are able to estimate the expenses needed when they visit or enrol in the university.

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APPENDIX



LIST OF DEVICES SUPPORTED BY VUFORIA

Device Name
Samsung Galaxy A3 (2017), A40, A5 (2017), A50, A6 (2018), A7 (2018), A70
Samsung Galaxy A8 (2018), A8+ (2018)
Samsung Galaxy J5 (2017), J7 (2017)
Samsung Galaxy Note 8, Note 9, Note 10/Note 10 5G, Note 10+/Note 10+ 5G
Samsung Galaxy S7, S7 Edge Exynos, S7 Edge Snapdragon
Samsung Galaxy S8, S8+
Samsung Galaxy S9, S9+ Exynos, S9+ Snapdragon
Samsung Galaxy S10e, S10, S10+, S10 5G
Samsung Galaxy S20/S20 5G, S20+/S20+ 5G Exynos, S20+/S20+ 5G Snapdragon
Samsung Galaxy S21, S21+, S21 Ultra
Samsung Galaxy S20 Ultra/S20 Ultra 5G Exynos, S20 Ultra/S20 Ultra 5G Snapdragon
Samsung Galaxy Tab S3 9.7, S4 10.5, S6, S5e, Active Pro
Google Pixel 2, Pixel 2 XL, Pixel 3, Pixel 3 XL
Huawei Honor 8X, 10
Huawei Mate 20 lite, 20 Pro
Huawei P20 lite, P20, P20 Pro, P30, P30 Pro
Xiaomi Redmi Note 7, Note 7 Pro
Xiaomi Mi A3
OnePlus
Motorola Moto G6

For details supported model, kindly refer to the link below:

<https://library.vuforia.com/platform-support/vuforia-engine-recommended-devices.html>

POSTER

	FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
<h2>UTAR CAMPUS TOUR WITHIN MINUTES VIA AUGMENTED REALITY (AR)</h2>	
INTRODUCTION :	
<ul style="list-style-type: none">• Provide a virtual tour to UTAR Kampar Campus via AR.• Allows virtual tour to conduct at anytime and at anywhere.	
METHODS :	
<ul style="list-style-type: none">• Developed using Prototyping Model.• Use of Blender to build AR Model.• Use of Unity Game Engine to stimulate AR Model.• Use of Android Studio as IDE.	
FUNCTIONS :	
<ul style="list-style-type: none">• Provide a 3D overview of UTAR Kampar Campus in AR.• Use of images and texts to provide brief description about UTAR• Use of 360 degree panoramic images to provide inner scene of buildings.• Use of videos to provide navigation view between buildings.	
	
DONE BY : TEH WAN HUI	SUPERVISED BY : TS SAW SEOW HUI

PLAGIARISM CHECK RESULT

Universiti Tunku Abdul Rahman			
Form Title: Supervisor's Comments on Originality Report Generated by Turnitin for Submission of Final Year Project Report (for Undergraduate Programmes)			
Form Number: FM-IAD-005	Rev No.: 0	Effective Date: 01/10/2013	Page No.: 1 of 1



FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Teh Wan Hui
ID Number(s)	17ACB01762
Programme / Course	Bachelor of Computer Science
Title of Final Year Project	UTAR Campus Tour Within Minutes via Augmented Reality (AR)

Similarity	Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)
Overall similarity index: <u> 3 </u> % Similarity by source Internet Sources: <u> 1 </u> % Publications: <u> 1 </u> % Student Papers: <u> 1 </u> %	
Number of individual sources listed of more than 3% similarity: <u> 0 </u>	
Parameters of originality required and limits approved by UTAR are as follows: (i) Overall similarity index is 20% and below, and (ii) Matching of individual sources listed must be less than 3% each, and (iii) Matching texts in continuous block must not exceed 8 words <i>Note: Parameters (i) – (ii) shall exclude quotes, bibliography and text matches which are less than 8 words.</i>	

Note Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

Signature of Supervisor

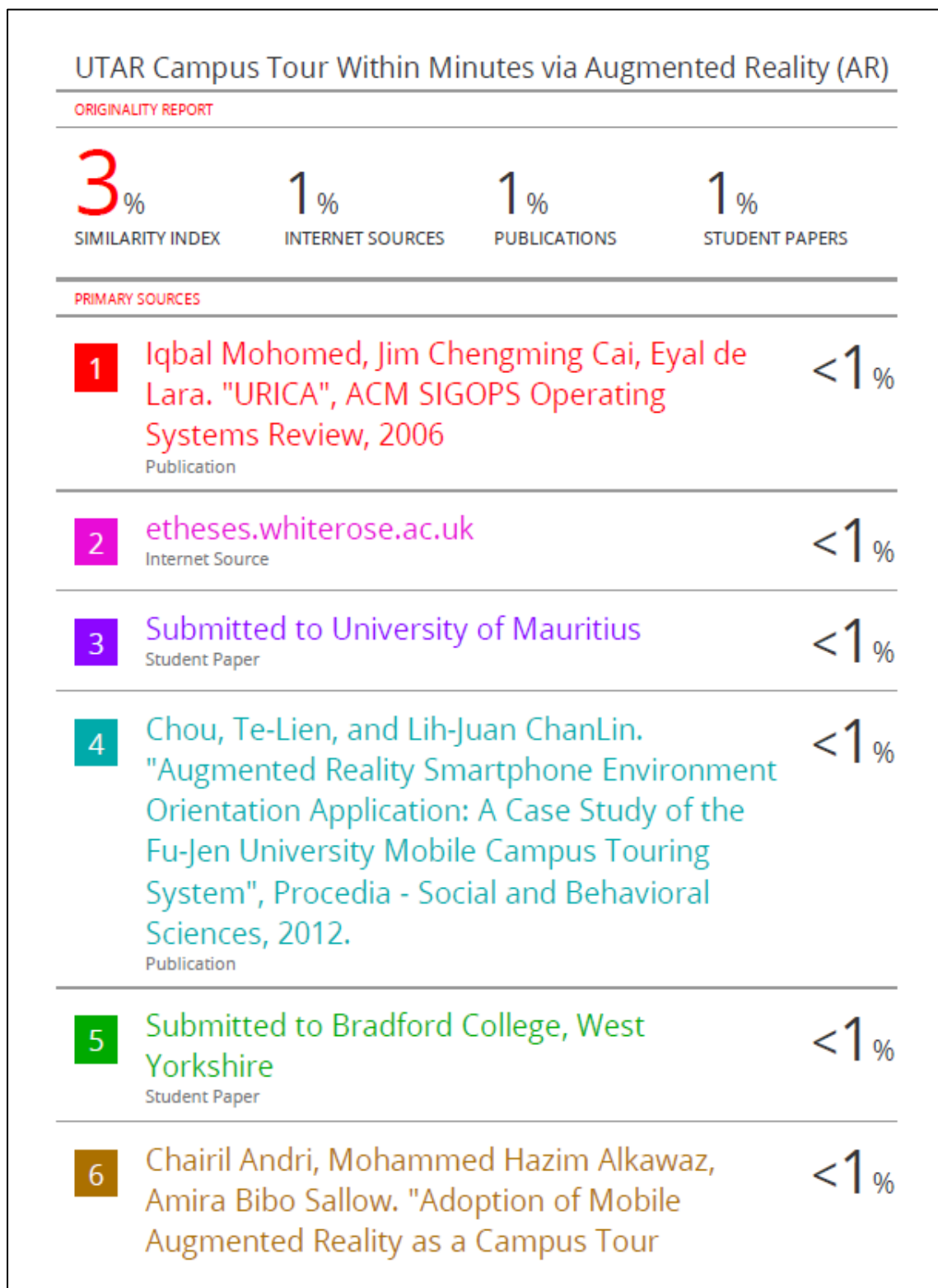
Name: Ts. SAW SEOW HUI

Date: 15/4/2021

Signature of Co-Supervisor

Name: _____

Date: _____



<p>Application", International Journal of Engineering & Technology, 2018</p> <p>Publication</p>		
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BIWEEKLY REPORT

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Trimester 3, Year 3	Study week no.: 2
Student Name & ID: Teh Wan Hui 17ACB01762	
Supervisor: Ts Saw Seow Hui	
Project Title: UTAR Campus Tour Within Minutes via Augmented Reality (AR)	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Successfully built the AR function that is able to display the UTAR map.

Provide the UI function to scale the map.

Integrate AR function with android application.

2. WORK TO BE DONE

Collect data in UTAR Kampar to build the 3D buildings.

3. PROBLEMS ENCOUNTERED

No problem encountered.

4. SELF EVALUATION OF THE PROGRESS

So far so good.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(*Project I / Project II*)

Trimester, Year: Trimester 3, Year 3	Study week no.: 4
Student Name & ID: Teh Wan Hui 17ACB01762	
Supervisor: Ts Saw Seow Hui	
Project Title: UTAR Campus Tour Within Minutes via Augmented Reality (AR)	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Successfully collect the data needed in UTAR Kampar.

Successfully implement the function to rotate the terrain in AR Module.

2. WORK TO BE DONE

Build the 3D models on Blender.

Enhance the existing terrain in AR Module.

3. PROBLEMS ENCOUNTERED

Unfamiliar with Blender to build the 3D models.

4. SELF EVALUATION OF THE PROGRESS

Have to self-learn and look for more online resources to build the 3D model through Blender.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(*Project I / Project II*)

Trimester, Year: Trimester 3, Year 3	Study week no.: 6
Student Name & ID: Teh Wan Hui 17ACB01762	
Supervisor: Ts Saw Seow Hui	
Project Title: UTAR Campus Tour Within Minutes via Augmented Reality (AR)	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Done building the five 3D model of UTAR buildings.

Successfully enhanced and improved the presentation of the terrain.

2. WORK TO BE DONE

Continue to build the rest of the 3D model of UTAR.

Include the interior scene of each building in the AR module.

3. PROBLEMS ENCOUNTERED

3D modelling is much more time consuming than expected. Have to speed up everything.

4. SELF EVALUATION OF THE PROGRESS

A bit out of time. Need to speed up to catch up the dateline.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(*Project I / Project II*)

Trimester, Year: Trimester 3, Year 3	Study week no.: 8
Student Name & ID: Teh Wan Hui 17ACB01762	
Supervisor: Ts Saw Seow Hui	
Project Title: UTAR Campus Tour Within Minutes via Augmented Reality (AR)	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Done building all the UTAR blocks via Blender, including the guard house.

Done adding the interior view to each building.

2. WORK TO BE DONE

Add the description panel to each building.

Add new function and module to the application.

Write a user guideline to guide the user on how to simulate the AR model.

3. PROBLEMS ENCOUNTERED

The interior view of each building can be added into the scene but cannot be rotated.

4. SELF EVALUATION OF THE PROGRESS

Will look out for more resources on how to make the interior view rotatable.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(*Project I / Project II*)

Trimester, Year: Trimester 3, Year 3	Study week no.: 10
Student Name & ID: Teh Wan Hui 17ACB01762	
Supervisor: Ts Saw Seow Hui	
Project Title: UTAR Campus Tour Within Minutes via Augmented Reality (AR)	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Done adding description for each building.

Done making the interior scene rotatable.

Done writing a user manual for the AR module.

Done designing and setting up the user interface for the new modules, which are Map module and Video Tour Module.

Done adding the Google map to the application and showing in the system.

2. WORK TO BE DONE

Enhance the UI for the AR module.

Integrate the AR module from Unity to Android Studio.

Edit the videos for video tour.

3. PROBLEMS ENCOUNTERED

Unable to retrieve user's current location for the Map module.

4. SELF EVALUATION OF THE PROGRESS

Will look out for more resources to solve the problem encountered.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(*Project I / Project II*)

Trimester, Year: Trimester 3, Year 3	Study week no.: 12
Student Name & ID: Teh Wan Hui 17ACB01762	
Supervisor: Ts Saw Seow Hui	
Project Title: UTAR Campus Tour Within Minutes via Augmented Reality (AR)	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

Done enhancing the user interface of the AR module and integrate it with Android Studio.

Able to get and retrieve the user's current location and show it on map.

Done calculating distance and show the route between two points and display it on map.

Done editing the videos for the video tour.

2. WORK TO BE DONE

Test and debug the application.

3. PROBLEMS ENCOUNTERED

No problem encountered.

4. SELF EVALUATION OF THE PROGRESS

So far so good.



Supervisor's signature





Student's signature

FYP CHECKLIST**UNIVERSITI TUNKU ABDUL RAHMAN****FACULTY OF INFORMATION & COMMUNICATION
TECHNOLOGY (KAMPAR CAMPUS)****CHECKLIST FOR FYP2 THESIS SUBMISSION**

Student Id	17ACB01762
Student Name	TEH WAN HUI
Supervisor Name	Ts SAW SEOW HUI

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✓	Signed form of the Declaration of Originality
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✓	Abstract
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✓	List of Tables (if applicable)
N/A	List of Symbols (if applicable)
✓	List of Abbreviations (if applicable)
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*Include this form (checklist) in the thesis (Bind together as the last page)

<p>I, the author, have checked and confirmed all the items listed in the table are included in my report.</p> <p></p> <p>_____ (Signature of Student) Date: 15th April 2021</p>	<p>Supervisor verification. Report with incorrect format can get 5 mark (1 grade) reduction.</p> <p></p> <p>_____ (Signature of Supervisor) Date: 15/4/2021</p>
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