AR CAMPUS CONNECT: ENHANCING SOCIAL CONNECTIVITY THROUGH AUGMENTED REALITY IN UNIVERSITY SETTINGS

BY

TAY MIN MIN

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)

JUN 2024

UNIVERSITI TUNKU ABDUL RAHMAN

REPORT STATUS DECLARATION FORM

Title: AR Campus Connect: Enhancing Social Connectivity through Augmented Reality in University Settings

Academic Session: Jun 2024

I TAY MIN MIN

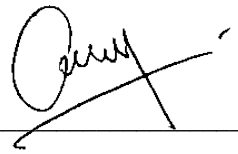
(CAPITAL LETTER)

declare that I allow this Final Year Project Report to be kept in
Universiti Tunku Abdul Rahman Library subject to the regulations as follows:

1. The dissertation is a property of the Library.
2. The Library is allowed to make copies of this dissertation for academic purposes.

Verified by,

(Author's signature)



(Supervisor's signature)

Address:
No.32, Jalan Genuang,
Taman Eastern,
85000 Segamat, Johor.

Dr. Cheng Wai Khuen
Supervisor's name

Date: 10.9.2024

Date: 13.9.2024

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

UNIVERSITI TUNKU ABDUL RAHMAN

Date: 10.9.2024

SUBMISSION OF FINAL YEAR PROJECT

It is hereby certified that ***Tay Min Min*** (ID No: ***21ACB03903***) has completed this final year project entitled "AR Campus Connect: Enhancing Social Connectivity through Augmented Reality in University Settings" under the supervision of Ts Dr Cheng Wai Khuen (Supervisor) from the Department of Computer Science, Faculty of Information and Communication Technology.

I understand that University will upload softcopy of my final year project in pdf format into UTAR Institutional Repository, which may be made accessible to UTAR community and public.

Yours truly,

Tay Min Min
(*Student Name*)

DECLARATION OF ORIGINALITY

I declare that this report entitled "**AR CAMPUS CONNECT: ENHANCING SOCIAL CONNECTIVITY THROUGH AUGMENTED REALITY IN UNIVERSITY SETTINGS**" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature : 

Name : Tay Min Min

Date : 10.9.2024

ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude to my supervisor, Dr. Cheng Wai Khuen, who gave me this opportunity to create the AR Campus Connect application. I am very interested in AR technology, and my supervisor gave me a lot of advice when I was about to start developing this project, which inspired me to gain a deeper understanding of the AR field. Big thanks to my supervisor for his cultivation and encouragement.

There is one particular important person in my life that I would like to thank, Tan Ri Neng, for his constant support and encouragement and for remaining by my side when I was at a low point in my life. Lastly, I would like to thank my parents and family for their support and love and for all the help they have given me throughout my studies, I love you all.

ABSTRACT

This project introduces an innovative AR application called AR Campus Connect, designed to revolutionize the campus experience for Universiti Tunku Abdul Rahman (UTAR) students. The project aims to address the prevalent challenges faced by universities students, including unfamiliarity with campus structures, lack of awareness about campus events, and limited avenues for social interaction. The project adopted the incremental development model of Agile development methodology, which involved iterative cycles of specification, development and validation. Moreover, the implementation of AR technology relies on the integration of the ARCore API. Within this project, the utilization of the geospatial creator tool within ARCore facilitates the seamless placement of anchors at arbitrary coordinates. This functionality extends beyond ground-level placement, as anchors can also be positioned on buildings, enhancing the versatility of the application. By activating their phone's camera, users can effortlessly visualize anchor points on nearby buildings and access instant event-related information. Notably, the Geospatial Creator tool employs a combination of Visual Positioning Service (VPS) and Global Positioning System (GPS) data to achieve high-accuracy Geospatial poses. In instances where VPS or GPS data is unavailable, such as when the device is out of VPS range or experiencing poor GPS signal, the system seamlessly switches to utilize data from the alternate source, ensuring continued accuracy in location tracking. Furthermore, the project integrates the Google Maps SDK to provide users with instant access to their current location and UTAR building markers. The system also incorporates real-time location updates, with the user's location being refreshed every five seconds. This frequent updating ensures that users receive accurate and up-to-date information about their whereabouts, facilitating smooth navigation and exploration of the campus. AR Campus Connect also introduces two key features: Moment and Event. The Moment feature allows users to capture and share significant on-campus experiences with peers, enriching their campus life through interactive AR content. Meanwhile, the Event feature provides updates and notifications about campus happenings, ensuring students stay informed and engaged with their university community. Firebase's Cloud Firestore serves as the database solution for this project, providing a cloud-based platform for real-time data storage and retrieval. In conclusion, AR Campus Connect represents a groundbreaking solution to the challenges faced by UTAR students in navigating and engaging with their campus environment by harnessing the power of AR technology and Agile development methodologies.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS

β	beta
Ω	Ohm (resistance)

LIST OF ABBREVIATIONS

AR	Augmented Reality
VR	Virtual Reality
POI	Point of Interest
BIW	Bried Information Widget
API	Application Programming Interface
USB	Universal Serial Bus
RAM	Random Access Memory
SSD	Solid State Drive

Chapter 1

Introduction

In this chapter, I present the background and motivation of my research, my contribution to the field, and the outline of my thesis. This chapter will also include the statements of the existing problems to provide a clear understanding of my research.

1.1 Project Background

Augmented Reality (AR) is a revolutionary technology that seamlessly blends the virtual world with the real world, enhancing people's perception and interaction with the environment. Unlike Virtual Reality (VR), which immerses the user in a fully synthetic environment, AR enriches the real world by superimposing virtual information, such as graphics, sound, video, or GPS data, onto the real world. This integration of virtual and real content has redefined the way people interact with the digital and physical world, taking place in real time and accurately registered in three dimensions, providing users with a dynamic and interactive experience. AR's ability to superimpose digital information onto the physical world allows users to visualize data, manipulate virtual objects, and immerse themselves in interactive experiences like never before.

Based on Figure 1.1.1 [1], it can be seen that the number of students enrolled in public higher education institutions in Malaysia has increased significantly during the period of 2016-2019. There was a massive epidemic in 2020, resulting in a significant decline in enrollment in public higher education institutions in Malaysia. Disregarding the factor of the epidemic, one can see that the number of enrollments is increasing steadily from year to year. Freshmen generally take a few weeks to familiarize themselves with the campus environment. Typically, universities would provide freshmen with electronic or hard-copy campus maps to help them quickly acquaint themselves with various buildings on campus. However, this approach may be less effective as some nooks and crannies may not be labeled on the map, rendering the student unable to locate the place.

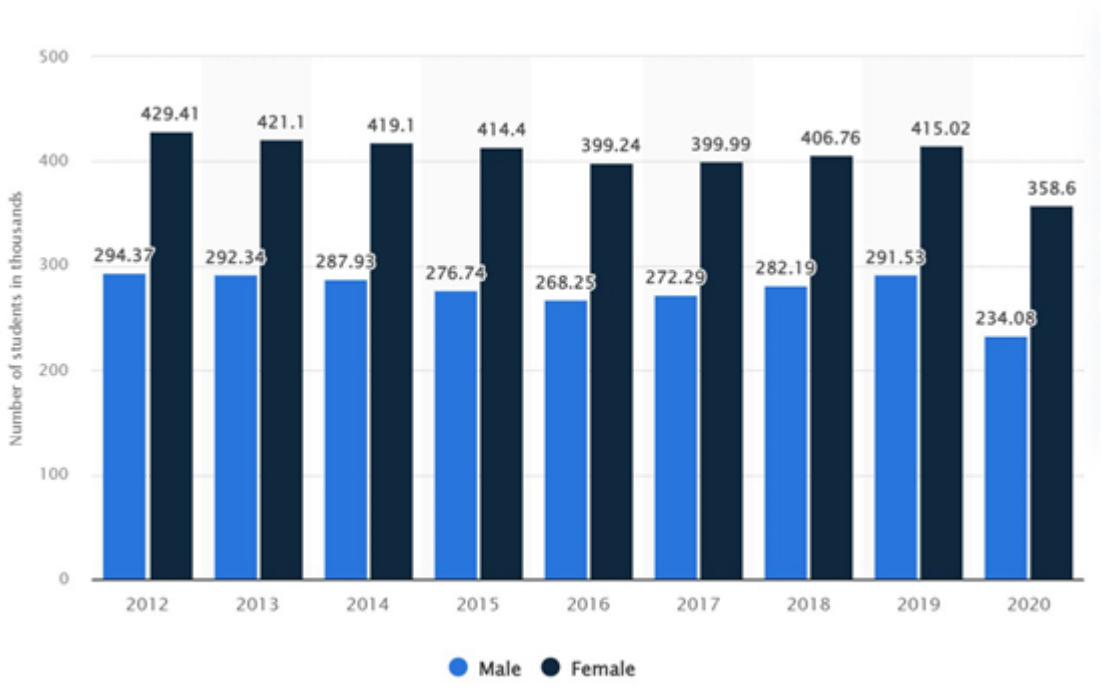


Figure 1.1.1: Number of students enrolled in public higher education institutions in Malaysia from 2012 to 2020, by gender.

Apart from that, Figure 1.1.2 shows that many university students post their final year project questionnaires on social media, seeking help from their fellow students to complete the questionnaires in order to achieve the minimum required amount of responses. Social media has become a major platform for university students to interact with each other, where they not only share their opinions but also issues with their coursework. This has also led to a phenomenon where their posts do not effectively reach the students in the same school but are spread all over the world due to the fact that the audience of social media is very large. Therefore, posting through social media may not be the best method for university students who simply want to reach their fellow students.

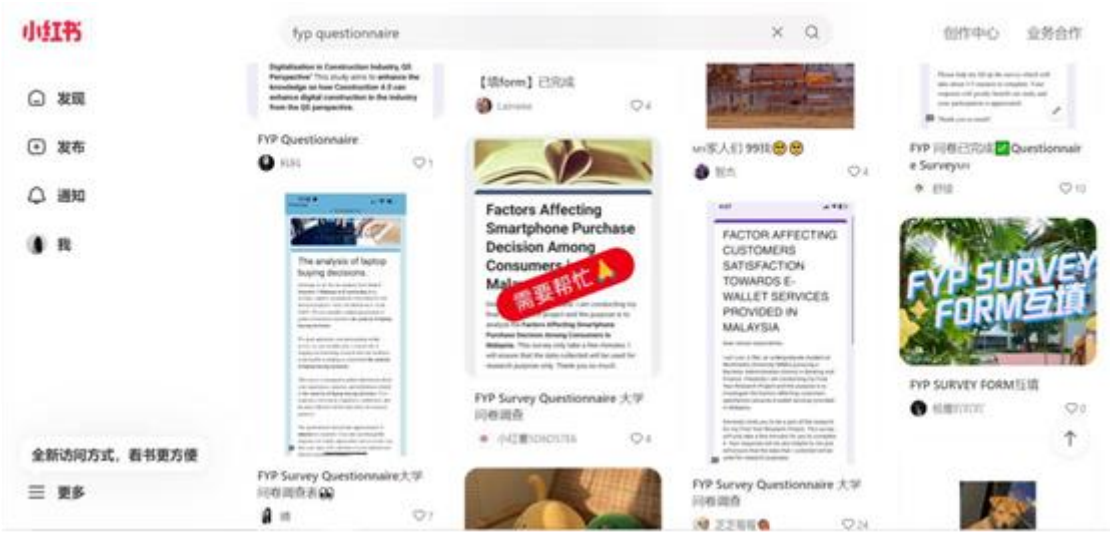


Figure 1.1.2: Screenshot of university students online asking people to complete questionnaires in the XiaoHongShu application.

1.2 Problem Statement

Based on the research, several problems have been identified that today's university students would encounter throughout their university careers:

1. **Students are unable to familiarize themselves quickly and effectively with the distribution and structure of the campus area.**

   Freshmen are often unfamiliar with the campus structure when they first enrol, which results in them having to spend a lot of time looking for and identifying routes to their classes. Some of the students may encounter the same issue as they are only familiar with the routes to their classrooms and therefore tend to get overwhelmed when a new semester starts and the classrooms change to a different building.

2. **Students are not aware of university events in a timely manner.**

   Although most of the universities will keep students updated on campus events via email, it is inevitable that some students do not have the habit of checking their emails and therefore miss out on many opportunities to attend campus events.

3. **Students are unable to reach the majority of students at the same university.**

   When a university society organizes a new event, the student committee will be responsible for promoting the event to increase its exposure. However, due to the lack of opportunities to interact with students from the same school, some of the events were little known and therefore not well attended. The same situation happens to final year university students, who generally need to collect a large number of questionnaires for their final year project. The lack of access to fellow students added to the difficulties of their final year project.

1.3 Motivation

In order to solve the problem mentioned in the problem statement, I decided to develop a mobile application to assist university students in better adapting to university life. Campus applications on the market today have relatively few functions, and some may only have the function of signing in for classes without other functions that can help students familiarize themselves with the campus and make friends, so university students often encounter difficulties in their extracurricular life. They may not be able to fit in well with other students, or they may not be able to make many friends because they don't have many opportunities to meet new people. The cause of this is the lack of functionality in campus applications that allow students to communicate and interact with each other, resulting in a lack of communication medium for students. They may also miss many opportunities to participate in campus events because they are not notified in time, thus graduating with regrets. This can be avoided if the campus application is able to notify the students about the upcoming campus events in a timely manner. The goal of this project is to prevent such things from happening, so that all university students can have a great university experience and spend their university life happily and fulfilling.

1.4 Research Objectives

The primary objective of this project is to develop an innovative application leveraging AR technology to quickly familiarise UTAR students with the campus environment. Using their mobile devices, students can view AR-based markers that provide detailed information about buildings, facilities, and campus landmarks. This immersive experience reduces the learning curve for new students, enabling them to adapt to their surroundings swiftly while enhancing their confidence and independence in navigating the campus.

By seamlessly integrating AR technology into the campus lives of students, the application aims to revolutionize how they access and engage with campus information and events. Through the cameras of their mobile phones, students will be empowered with instant access to comprehensive and up-to-date campus information, thereby fostering a more informed and connected campus community. By simply pointing their phones towards nearby buildings, students can seamlessly view pertinent details about the buildings and events, thereby eliminating the need for cumbersome navigation between multiple platforms or physical notice boards. This not only enhances efficiency but also enriches the overall campus experience by providing students with a dynamic and interactive means of accessing essential information.

In addition, the application facilitates seamless interaction between students to enhance the social aspect of campus life. When a new event is created, other users will see an AR icon on the screen in real time, displaying information and the location of the event. This breaks the limitations of traditional social applications that only display text notifications, enabling an instant, convenient, and immersive way to socialize. If students want to learn more about an event, they can simply touch the AR marker on the screen to get detailed information about the event. This innovative approach not only increases the visibility of events but also promotes spontaneity and serendipity, fostering a culture of exploration and discovery within the campus community.

1.5 Project Scope and Direction

1.5.1 Project Scope

The scope of this project is to strengthen the social connections among UTAR students through augmented reality technology, offering convenience to students while also helping them to better adapt to campus life. The project will develop a mobile application with several features that will not only assist UTAR students in exploring the campus but also allow them to share information through the application, which in turn will enhance the cohesion among university students.

Furthermore, campus events are undoubtedly beneficial for university students. The project also includes the function of campus event promotion, which allows UTAR students to browse nearby campus events in a timely and convenient manner. This can also boost the participation of UTAR students in campus events. Remarkably, this project is mainly focused on building an Android version for Android users.

1.5.2 Project Direction

1. **To provide students with an immersive and seamless campus exploration experience through augmented reality.**

   An anthropomorphic virtual character would be created to guide users in exploring the campus. It could display the information of buildings in front of users, including name, faculty, etc., to give the user a clear understanding of each building. Besides, a campus map will also be displayed in the application to facilitate users in moving around the campus.

2. **To enhance campus social interaction and engagement among students by enabling students to share campus-related announcements through the AR platform.**

   Students are able to post their final year project questionnaires, society event posters, or activity booth invitations on the AR noticeboard in the application to attract other students' attention and interest. In addition, there would be a notification panel showing the ongoing events and upcoming events on top of each of the event halls. Students are able to get instant updates of school events without the hassle of checking email or social media.

3. **To compare various platforms and tools and determine the best fit for developing AR Campus Connect.**

   There are many AR development platforms and tools available in the market, each with its own advantages and disadvantages. This objective aims to analyze the features of each development platform and tool and select the most suitable one for AR Campus Connect application development to ensure the development of a user-friendly, feature-rich application with a clean user interface.

1.6 Contributions

In line with the project's overarching goal, the application will be positioned as a comprehensive and user-friendly mobile AR application tailored specifically for UTAR students. The application will serve as a multi-functional platform that facilitates meaningful connections between UTAR students, enabling them to establish new friendships, expand their social networks, and acclimatize to the campus environment. To achieve this, a number of important features would be integrated into the application, including a campus tour that would allow users to explore their surroundings and familiarize themselves with the various facilities; a notice board that will allow students to post information about societies and relevant campus information; a campus events feature that will ensure that students are kept up-to-date with the active life of the university community, and so on. This project could enhance UTAR students' overall university experience and promote a sense of connection and affiliation within the campus community.

1.7 Report Organization

The details of this project are covered in the following chapters. Chapter 2 reviews some of the relevant past research and points out the differences between AR notice boards and traditional notice boards, as well as emphasizes the features and importance of AR notice boards. Chapter 3 describes the methodology of developing the AR Campus Connect application and the system framework. Chapter 4 presents the system design and its components. Chapter 5 covers the implementation of the system, while Chapter 6 focuses on the evaluation and discussion of its performance. The final chapter provides a conclusion and recommendations, summarizing the key findings and contributions of the project while offering insights and suggestions for future work.

Chapter 2

Literature Review

2.1 Previous Works on Campus Connect Application

2.1.1 Mobile Campus Touring System for Beijing Normal University, China

Mobile Campus Touring System [2] is an AR-based campus touring system for cultural activity in Beijing Normal University, which consists of two subsystems: AR Displaying system and auxiliary collaboration system. The AR Displaying system, which serves as the main function of the application, combines the user's location with real-time images, allowing users to capture their real-world surroundings through their mobile phone's camera and present location-based virtual learning information on the user's phone screen. Users can click on the information of interest to begin detailed learning. The auxiliary collaboration system, on the other hand, allows users to post comments, follow activities of interest, and rate activities, etc. These features enhance collaboration among students and enable them to communicate with other students with similar interests on certain cultural activities.

Figure 2.1.1.1: Captured images on the smartphone screen about auxiliary collaboration system. [2]

When the application is launched, the system will automatically access GPS information and then load the point of interest (POI) information corresponding to the user's location. For instance, when the user points the mobile phone camera at the library building in the university, a virtual object representing the library building will appear on the user's phone screen. The user can click on this virtual object to get detailed activity information about the library.

Figure 2.1.1.2: AR and GPS based activity information module for Mobile Campus Touring System. [2]

2.1.1.1 Strengths

Mobile Campus Touring System is able to provide information and activity of various POI on campus, enabling students to stay abreast of various campus activities. This is particularly beneficial to new students as they can quickly access information about various buildings in the campus through simple operations, which will effectively help them familiarize and adapt to the campus quickly. In addition, the auxiliary collaboration system allows students to interact on cultural activities, which not only enhances bonding among students but also helps them to expand their network.

2.1.1.2 Weaknesses

However, the Mobile Campus Touring System does not provide navigation function, hence it is considered not comprehensive enough as a campus tour system. For those who are not familiar with the campus, such as alumni, parents, or new students, the navigation function can be a great convenience as they generally need to find a specific building, such as a dormitory or a particular lecture hall once they arrive on campus. Besides, the system does not have the feature to filter activity. All upcoming campus activities are displayed in the activity information list. Students are unable to filter for activities at a specific time or in a specific venue, which can actually cause some problems for students looking for information on a specific event.

2.1.2 Campus Event App for Bowling Green State University, USA

Campus Event App for Bowling Green State University [3] is an application mainly used to search for events in the vicinity. The application allows users to locate nearby events in real time, and also allows them to choose the best route to the selected event using the map displayed within the application. There are two ways for users to find events in the application, one is through AR and the other is through Event List. If the user chooses AR, one can point the phone's camera in any direction, and the nearby events in that direction will appear as virtual icons on the user's phone screen, overlaid with the reality. Whereas if the user selects Event List, then a list of upcoming events will be displayed.

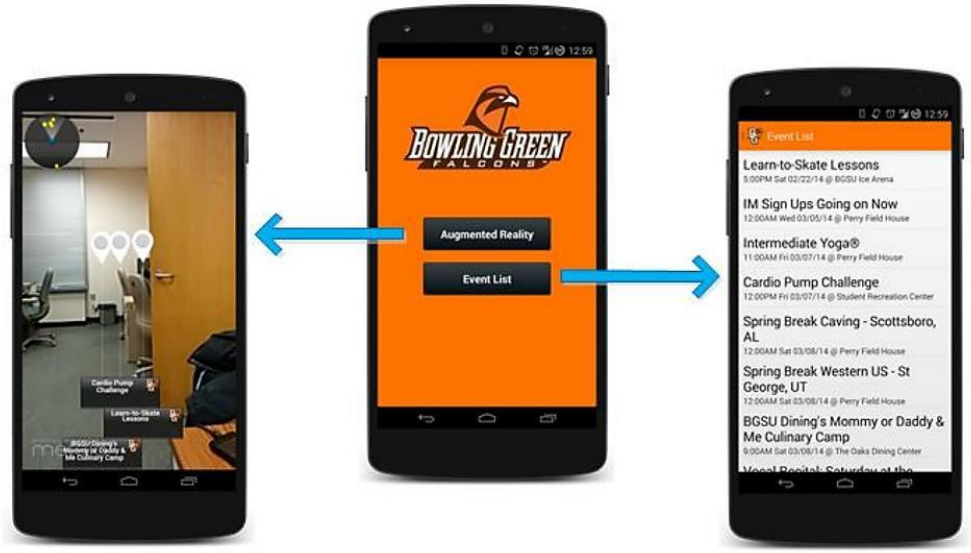


Figure 2.1.2.1: Two main functions of Campus Event App. [3]

Regardless of which option the user selects, the system will bring up the event detail screen whenever the user clicks on an event displayed on the screen, such as the virtual icon representing the event in the AR interface or any event in the event list. The event detail screen will display detailed information about the event, such as the event date and time, event location, and event description. The bottom of the event detail screen also includes a Map button and an Event Link button. The user can click on the Map button to view the exact location of the event and get directions from the current location to the event location. When the Event Link button is pressed, the user will be taken to the event website (if available).

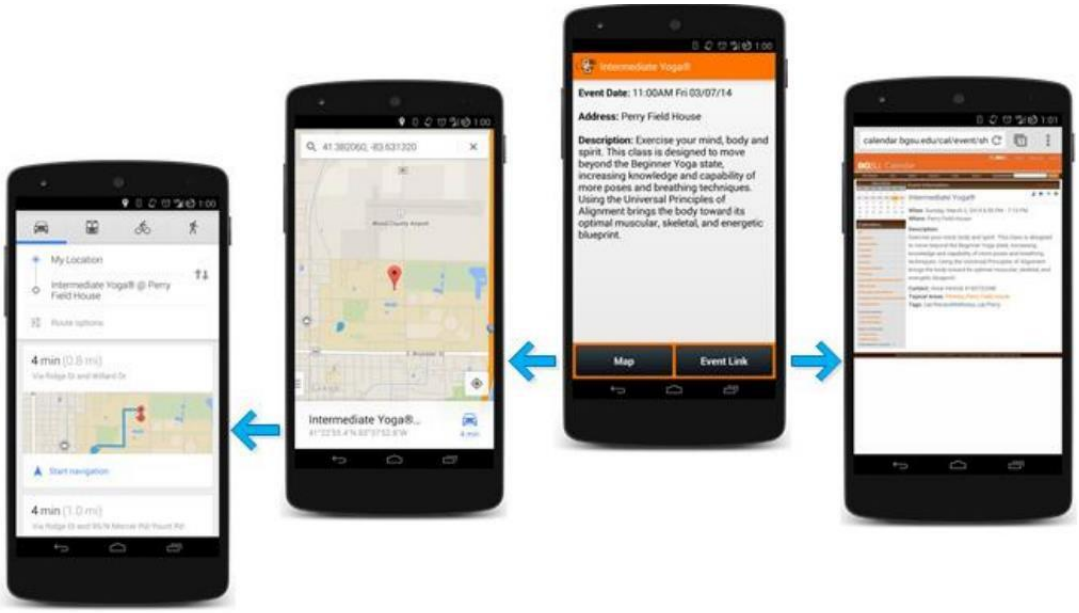


Figure 2.1.2.2: Event detail screen, map, and event link. [3]

2.1.2.1 Strengths

The Campus Event App has the obvious advantage of allowing users to find information about nearby campus events and get directions to the event at any time. Whereas previous applications did not allow users to view event information and routes at the same time and users had to switch between multiple apps, the Campus Event app saves a lot of hassle by allowing users to view event information, locations, and routes within the application.

2.1.2.2 Weaknesses

While the Campus Event App allows users to view the event's location, it does not have the feature to find the distance of every event from the user's current location. As a result, the user will need to open the event map one by one to compare the distance of each event to the current location.

2.1.3 iMAP-CampUS for Macquarie University, Australia

iMAP-CampUS [4] is designed to provide users with information about various buildings as they move around the Macquarie University. The iMAP-CampUS application includes about 25 various buildings around campus, such as Macquarie Library, Macquarie Theater, and Macquarie Hospital. As the user walks around the campus, POI icons of different sizes will appear on the user's phone screen, with larger POI icons indicating that the user is closer to the building. Furthermore, all POIs on the screen are represented by circular icons to reduce the user's cognitive load.

Figure 2.1.3.1: POI size on the user's phone screen. [4]

Notably, the iMAP-CampUS application contains a wide range of features that allow the user to view detailed information about each POI, get navigation directions to the POI, make phone calls, surf the website, send e-mails, and play videos or audios. Users can simply click on the POI icon on the screen and a brief information widget (BIW) will pop up, which displays detailed information about the POI and several function buttons, such as "Play Audio", "Take Me There", etc. Users can click on the buttons to achieve the corresponding functions. Moreover, users can also switch to Map View instead of Reality View to view campus-wide POIs, which is considered very useful.

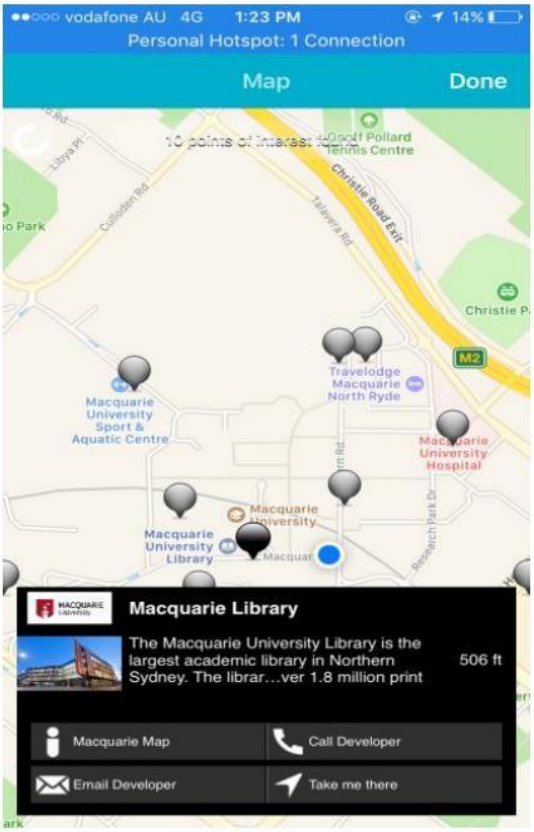


Figure 2.1.3.2: Map View of iMAP-CampUS. [4]

2.1.3.1 Strengths

The ability of iMAP-CampUS to provide users with the information about various POI on campus can help students to quickly familiarize themselves with the campus environment. iMAP-CampUS is also a user-friendly application which allows users to easily reach out to the staff of a specific department by calling or emailing them through the application. This is quite convenient for students as it eliminates the need to search online for the contact details of a specific department when they encounter issues and need assistance.

2.1.3.2 Weaknesses

Although the fact that all POIs in the Reality View are represented by circular icons eases the cognitive burden on the user, it has to be admitted that the icons do not represent different buildings and can easily cause confusion for the user. Many neighbouring buildings may appear in the user's phone screen at the same time, thus if the application does not use different icons to represent different POIs, the user may easily click on the wrong icon due to the confusion of POIs, which may bring an unpleasant experience to the user.

2.1.4 MyARCampus for Patras University, Greece

MyARCampus [5] is an application designed to facilitate student life at the Patras University using AR technology. It provides detailed information about campus buildings and course schedules for classrooms, and students can also use the application to access detailed bus timetable information for bus stops on campus. Through MyARCampus, students are able to access the latest information about university buildings, classrooms, and bus stops by scanning them with their mobile phone cameras at any time. However, it is worth noting that the app requires students to be connected to the internet in order to use it.

There are three types of POIs established in MyARCampus: 1) buildings and complexes, 2) classrooms, auditoriums, and libraries, and 3) bus stops. Scanning different types of POIs will display different information. For example, when the user scans buildings and complexes, a link to the department's official website will be displayed. The user could just click on the link and the screen will automatically redirect to the relevant website.

Figure 2.1.4.1: Illustration of scenario when a building is recognized. [5]

When the user scans a classroom, auditorium, or library, the relevant weekly schedule will be popped up, so that students can quickly check the usage arrangement of the room for the week.

Figure 2.1.4.2: Illustration of scenario when a classroom is recognized. [5]

Additionally, when a bus stop is detected by the camera, users will be able to view the available lines for that bus stop, as well as the timetable and route for each line. This is particularly convenient for students who do not have their own transport, as buses might be their main mode of transport, hence the ability to view bus routes and timetables quickly and easily could bring a great deal of convenience to their campus life.

Figure 2.1.4.3: Illustration of scenario when a bus stop is recognized. [5]

2.1.4.1 Strengths

MyARCampus covers not only POIs of buildings on campus but also POIs of bus stops, which is a rarity in any campus application on the market. Additionally, MyARCampus allows users to view classroom and bus schedules at any time (online), greatly facilitating course attendance, navigation, and on-campus transport. Students can also organize and manage their schedules better through the application.

2.1.4.2 Weaknesses

MyARCampus has one major drawback, which is it does not support online database to update the information. This implies that if MyARCampus were to be extended to other POIs, the information would need to be provided in the form of printed, static announcements. This is relatively inflexible and the information may not be updated in a timely manner.

2.1.5 Bangor CampusConnect for Bangor University, United Kingdom

Bangor CampusConnect [6] is the official Bangor University application that allows new students to connect with other students who will be studying at Bangor University and access information about the university, including announcements, maps, accommodation, and more. New students can download the application before their program started, and it will display important university news and Welcome Week information to assist new students in getting a head start on student life and the process of commencement.

The Bangor CampusConnect application has the Groups feature that allows users to create a variety of groups to congregate other students with the same hobbies or interests. University societies can create society communication groups within the application to facilitate communication with society members and organization of society events. In addition, new students can use this feature to form exploration groups to gather other students to explore the campus and its surroundings. By using the Groups feature in the Bangor CampusConnect app, students are able to build their own social network and connect with existing students.

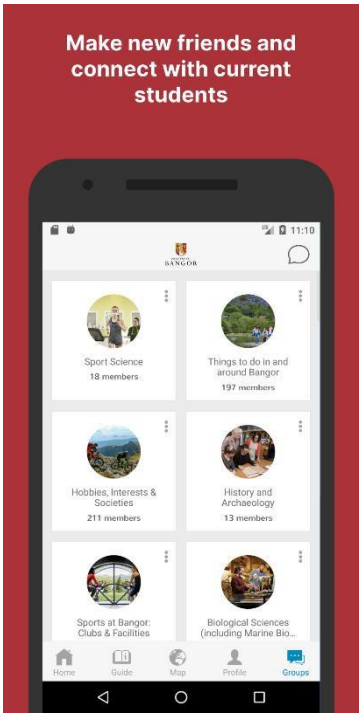


Figure 2.1.5.1: Groups feature in the Bangor CampusConnect application. [6]

Apart from this, the Bangor CampusConnect application also includes the Map feature which allows users to explore POIs and facilities in the vicinity of the university. Once the user has launched the feature, Google Maps will be displayed on the screen with Bangor University and neighboring POIs marked on the map, allowing new students to get a full overview of the campus environment without having to arrive on campus. This is a valuable feature for new students as it provides them with an overview of the campus in advance, saving them a great deal of time when they enter the university in the future.

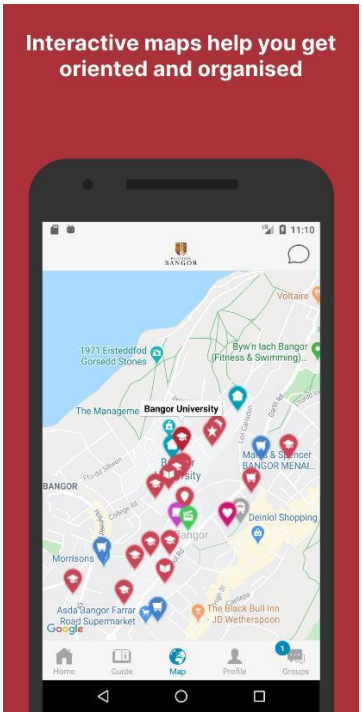


Figure 2.1.5.2: Map feature in the Bangor CampusConnect application. [6]

2.1.5.1 Strengths

Bangor CampusConnect is an application that offers great convenience to new students, with the advantage of allowing them to quickly integrate into the campus even before their program started. The application allows new students to interact with existing students and connect with other new students, which could effectively mitigate their nervousness at the time of enrollment.

2.1.5.2 Weaknesses

The Bangor CampusConnect application's shortcoming is that it does not provide students with detailed information about the buildings within the campus. If new students are provided with information about the buildings and facilities on campus in advance, they could have a much smoother time finding their classrooms at the beginning of the program instead of having to spend a lot of time looking around. Through Google Maps in the application, users could only know the POIs around the university, but not the buildings and facilities in the campus, hence they have to wait until the time of admission to explore the campus.

2.2 Summary of Previous Studies

Table 2.2.1 shows the comparison between existing systems and the proposed system. The existing systems used in comparison include Mobile Campus Touring System, Campus Event App, iMAP-CampUS, MyARCampus, and Bangor CampusConnect. It can be seen from the table that all the existing systems used in comparison have their own strengths, but none of them are able to integrate the campus tour and campus connect features well.

Some systems focus only on the campus tour feature, such as iMAP-CampUS and MYARCampus. Each of them could provide users with detailed information about POIs, but they do not allow users to interact with other people or view university announcements. It is undeniable that the campus tour feature they provide is fairly practical for students, but the lack of comprehensive functionality also leads to a lack of opportunities for students to communicate and interact with other students. In addition, Mobile Campus Touring Sysem and Campus Event App provide campus event features that allow students to access campus events at any time, which facilitates attendance of campus events as well as enhances students' enthusiasm for learning. It is worth noting that Mobile Campus Touring Sysem has more sophisticated features than Campus Event App, which allows students to interact within the application, such as leaving comments under the event details. By doing so, students have the opportunity to get to know each other through campus events, expanding their network and enriching their university life. However, neither of these applications also supports students viewing university announcements through the applications. While Bangsor CampusConnect is an excellent campus connect application that allows students to stay in touch with their peers at any location, it is not equipped with campus navigation feature nor AR technology, and therefore is not able to assist students in exploring and discovering the campus.

Application / Feature	Mobile Campus Touring System	Campus Event App	iMAP-CampUS	MyAR Campus	Bangor Campus Connect	Proposed System
AR Technology	Yes	Yes	Yes	Yes	No	Yes
Tracking	Marker-less	Marker-less	Marker-less	Marker-based	N/A	Marker-less
POI Info	Yes	No	Yes	Yes	No	Yes
Navigation	No	Yes	Yes	No	No	Yes
Campus Event	Yes	Yes	No	No	No	Yes
Comment	Yes	No	No	No	No	Yes
Able to establish post	Yes	No	No	No	No	Yes
Able to view university announcement	No	No	No	No	Yes	Yes
Able to work without present in campus vicinity	Yes	Yes	Yes	No	Yes	Yes

Table 2.2.1: Comparison based on features in campus connect applications.

2.3 Comparison between AR Notice Board and Traditional Notice Board

The evolution of AR technology has opened up various opportunities and transformed lifestyles, offering a novel experience to humanity. Among these advancements, the emergence of AR notice boards stands out prominently. Comparing AR notice boards to traditional counterparts, be they physical or digital, reveals several distinct advantages across multiple dimensions. These include enhanced accessibility, heightened interactivity, increased versatility, reduced environmental impact, and increased cost-effectiveness.

Firstly, in terms of accessibility, traditional notice boards, whether physical or digital, are constrained by their static nature. Physical notice boards necessitate a physical presence, limiting access primarily to individuals within close proximity. Similarly, while digital notice boards may extend accessibility to remote users through online platforms, they still require active engagement with the digital interface, such as accessing a website or application. In contrast, AR Notice Boards leverage augmented reality technology to provide users with immediate access to information overlaid onto their physical surroundings, transcending geographical barriers and offering a seamless user experience. By integrating information directly into the user's environment via smartphones or AR-enabled devices, AR Notice Boards provide unrivaled accessibility, ensuring that users can access relevant information effortlessly, regardless of their location.

Furthermore, interactivity constitutes a significant point of departure between AR Notice Boards and traditional counterparts. Physical notice boards typically offer limited interactivity, allowing users to view posted notices but offering little opportunity for engagement or interaction. Digital notice boards, while more interactive than their physical counterparts, often provide standard features such as scrolling through content or clicking on links. In contrast, AR Notice Boards introduce a dynamic layer of interactivity, enabling users to engage with digital content overlaid onto physical objects or locations in real-time. Users can interact with AR markers to access additional information, participate in interactive experiences, or even contribute their own content, fostering a more engaging and immersive user experience.

Moreover, the versatility of AR Notice Boards far surpasses that of traditional notice boards. Physical notice boards are typically limited by the available physical space and are static in nature, requiring manual updating and maintenance. Digital notice boards offer greater flexibility in terms of content management and updating but are still confined to digital displays or screens. AR Notice Boards, on the other hand, leverage the flexibility of digital content while seamlessly integrating it into the physical environment. This fusion of digital and physical worlds enables AR Notice Boards to adapt dynamically to changing information and contexts, providing a versatile platform for disseminating a wide range of content, from event announcements and campus updates to interactive advertisements and multimedia presentations.

In addition, considering environmental impact, traditional notice boards, particularly physical ones, incur significant resource consumption and environmental footprint. Physical notice boards require paper, printing materials, and regular maintenance, contributing to paper waste and environmental degradation. While digital notice boards reduce paper usage, they still rely on electronic displays, consuming electricity and contributing to electronic waste. In contrast, AR Notice Boards offer a more environmentally sustainable alternative by reducing reliance on physical materials and leveraging existing digital infrastructure. By utilizing smartphones or AR-enabled devices that users already possess, AR Notice Boards minimize resource consumption and environmental impact while delivering information in a more sustainable and eco-friendly manner.

Not only that, but the cost aspect constitutes a significant consideration when comparing AR Notice Boards with traditional counterparts. Traditional notice boards, whether physical or digital, entail various costs associated with materials, maintenance, and infrastructure. Physical notice boards require ongoing expenditures for paper, printing, and maintenance of physical displays, while digital notice boards involve upfront investments in hardware, software, and ongoing maintenance and support. Conversely, AR Notice Boards offer potential long-term cost savings by reducing the need for physical materials, minimizing maintenance requirements, and leveraging existing digital infrastructure. Besides, as AR technology continues to advance and become more accessible, the cost of implementing AR Notice Boards is expected to decrease, making them increasingly cost-effective compared to traditional alternatives in the long run.

In summary, while traditional notice boards are the traditional means of disseminating information, AR notice boards represent a paradigm shift in the way information is accessed, interacted with, and experienced. Through its unrivaled accessibility, dynamic interactivity, multi-functionality, and cost-effectiveness, AR notice boards provide a transformative platform for human communication and participation with the environment, heralding the arrival of a new era of immersive interactive environments.

2.4 Proposed Solutions

In response to the shortcomings observed in existing systems, this project aims to introduce a mobile AR application that seamlessly integrates campus navigation and campus connect functionalities, thereby enhancing UTAR students' university experience. By incorporating an AR notice board feature, students will not only be able to navigate the campus but also engage in interactive experiences, facilitating connections with peers across different courses. This proposed system will offer interactive features enabling students to exchange information and interact with peers seamlessly. Moreover, the inclusion of a campus navigation feature will expedite the process of familiarizing new and existing students with campus structures. Additionally, a unique aspect of this system will be the ability for students to establish posts, providing a platform for university societies to promote their activities and enabling students to distribute surveys and questionnaires. Ultimately, this comprehensive system aims to empower students in various facets of their university life, offering a more convenient and efficient university experience, while leveraging the benefits of AR technology.

Chapter 3

System Methodology

3.1 Methodology

There are various models in Agile development methodology, this project adopted the incremental development model of Agile development methodology as it has a great advantage that the development activities can be carried out concurrently and continuously produce numerous versions of the system. This allows developers to make improvement on the initial version and repeat the process in a continuous loop, eventually generating the final version of the system. The incremental development model could be split into several phases such as outline description, specification, development, and validation.

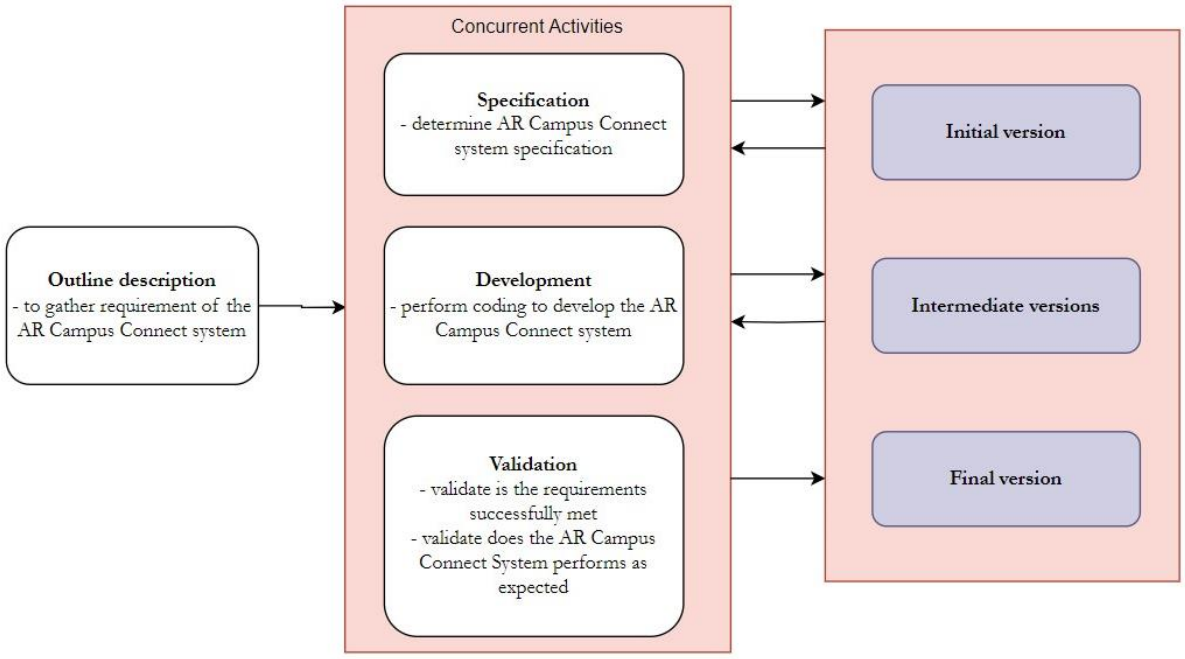


Figure 3.1.1: Project workflow in incremental development model.

- **Outline Description**

  As the initial phase of the project development, the system requirements are gathered during this phase. All functional and non-functional requirements are documented and subsequent incremental features of the system are added based on the importance of the requirement. The AR Campus Connect system has some basic requirements, for instance:

  1. Students should be able to view buildings information.
  2. Students should be able to view the university map.
  3. Students should be able to view campus events.
  4. Students should be able to create new campus events.
  5. Students should be able to establish posts.
  6. Students should be able to comment on posts.
  7. Students should be able to like posts.
  8. Students should be able to dislike posts.
  9. Students should be able to receive notifications.

- **Specification**

  In this phase, the AR Campus Connect system specifications are determined. It is also necessary to identify issues such as what tools and technologies will be required for the project, who will be the users of the AR Campus Connect system and where and when the system will be used, etc. at this phase. At the moment, our target users are UTAR students and the application should be used on campus.

- **Development**

  The coding is performed in the development phase, by using Unity. The main programming language adopted in this project is C# as it is the dominant scripting language for the Unity.

- **Validation**

  During the validation phase, the performance of the AR Campus Connect system and the extent to which the system meets the requirements will be validated.

3.2 System Design Diagram

3.2.1 Use Case Diagram

Figure 3.2.1.1 illustrates the use case diagram for the AR Campus Connect System, showcasing the interactions between various actors and system functionalities. The main actors in the system include the User and Admin, with both Student and Organization categorized as User. Each actor engages with distinct components of the application based on their respective roles and responsibilities.

Users have access to several core functions within the AR Campus Connect application. They can view information about campus buildings by interacting with AR markers, which enhances their understanding of the campus layout. Additionally, users can utilize the navigation feature to help them move around the campus. The application also allows users to visit the building website with just a click. Users are kept informed of campus events by viewing the latest updates through AR markers. They also have the ability to create new events, sharing them with the broader campus community. Moreover, users are enabled to manage posts within the application, which includes the ability to establish new posts, like or dislike posts, and comment on existing posts. These features help facilitate social interaction and engagement within the campus environment. Notably, for actions such as liking or disliking posts and commenting on them, notifications are automatically generated and sent to the relevant users to ensure that users remain engaged and up-to-date. Authentication is also required each time users execute actions within the post management system.

Furthermore, The Admin role possesses more extensive control over the system’s content and users. Admins are responsible for updating building information to ensure that students have access to the latest details about campus facilities. Additionally, admins could manage the system's users, including responsibilities such as role assignments and access control.

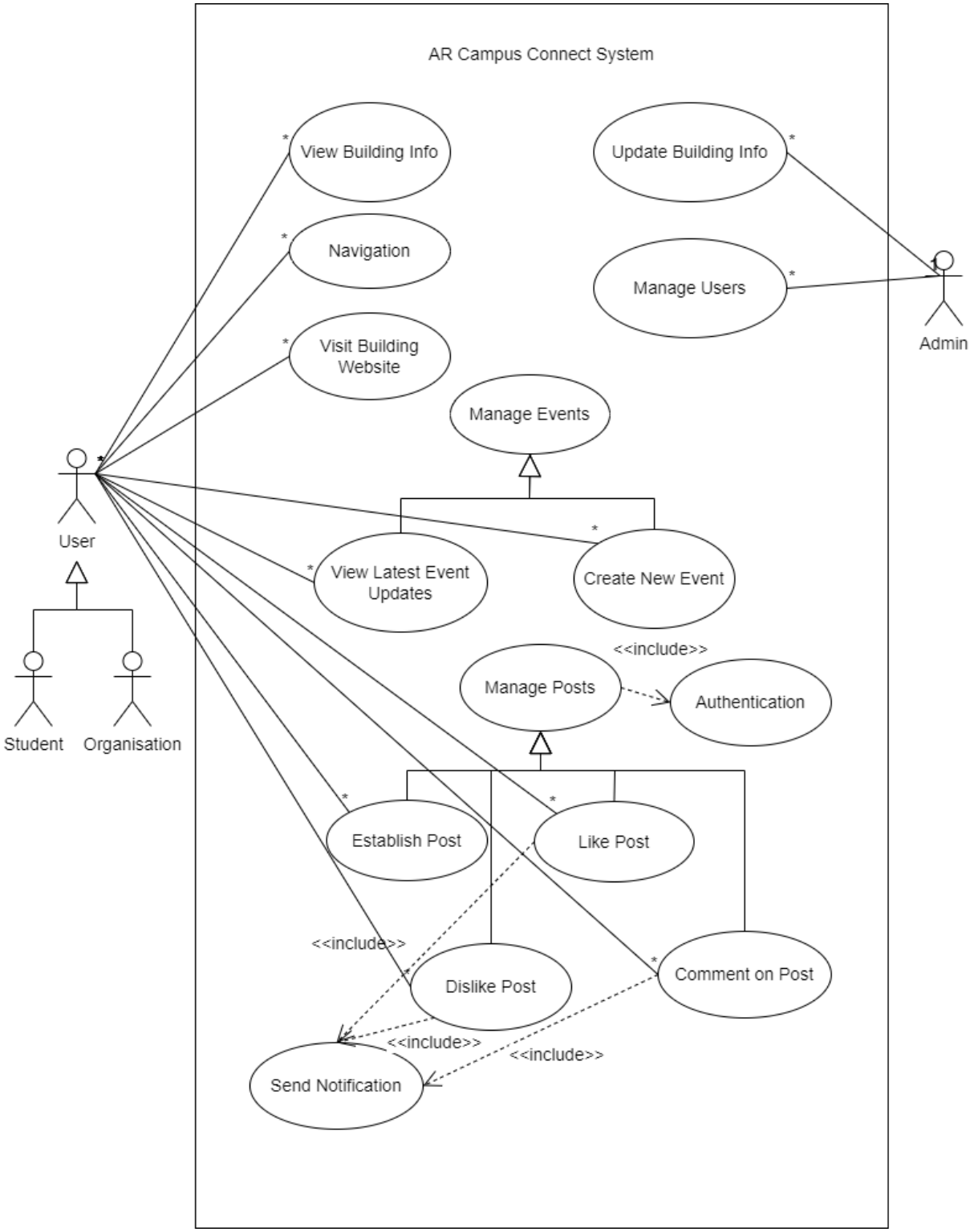


Figure 3.2.1.1: Use Case Diagram.

3.2.2 Activity Diagram

Figure 3.2.2.1 illustrates the flow of interactions between users and the AR Campus Connect System for various functionalities related to building information, events, and posts. The diagram is divided into two swim lanes: one representing user and the other representing the AR Campus Connect System.

The process begins with the localisation system, which plays a crucial role in identifying the user's position within the campus. This step forms the foundation for the AR Campus Connect System to function effectively. If localisation is successful, the user can interact with the various anchors; if not, the system will terminate and not proceed with displaying relevant information. Once the localisation is successful, the system displays different types of anchors including building info anchor, event anchor, and post anchor.

After the user clicks the building anchor, the system will display the building information, and if the user chooses to view additional details, they can click a button to either display the website or navigate to the location via Google Maps.

For events, when the user clicks an event anchor, the system displays event details and allows the user to create new events. The process of uploading an event is facilitated by the system after the user submits the necessary information, which is then stored in the Firebase. This ensures that new events are updated and accessible to other users through event anchors.

The figure also outlines how the system handles user interaction with posts. When the user clicks on a post anchor, the system displays the post details. If the user chooses to interact with the post by liking, disliking, or commenting, the system first verifies the user's authentication status. If the user is logged in, they can proceed to interact with the post. However, if the user is not logged in, the system redirects them to the login process. If the user does not have an account, they are prompted to register before proceeding. Successful login or registration allows the user to update post details by interacting with the post.

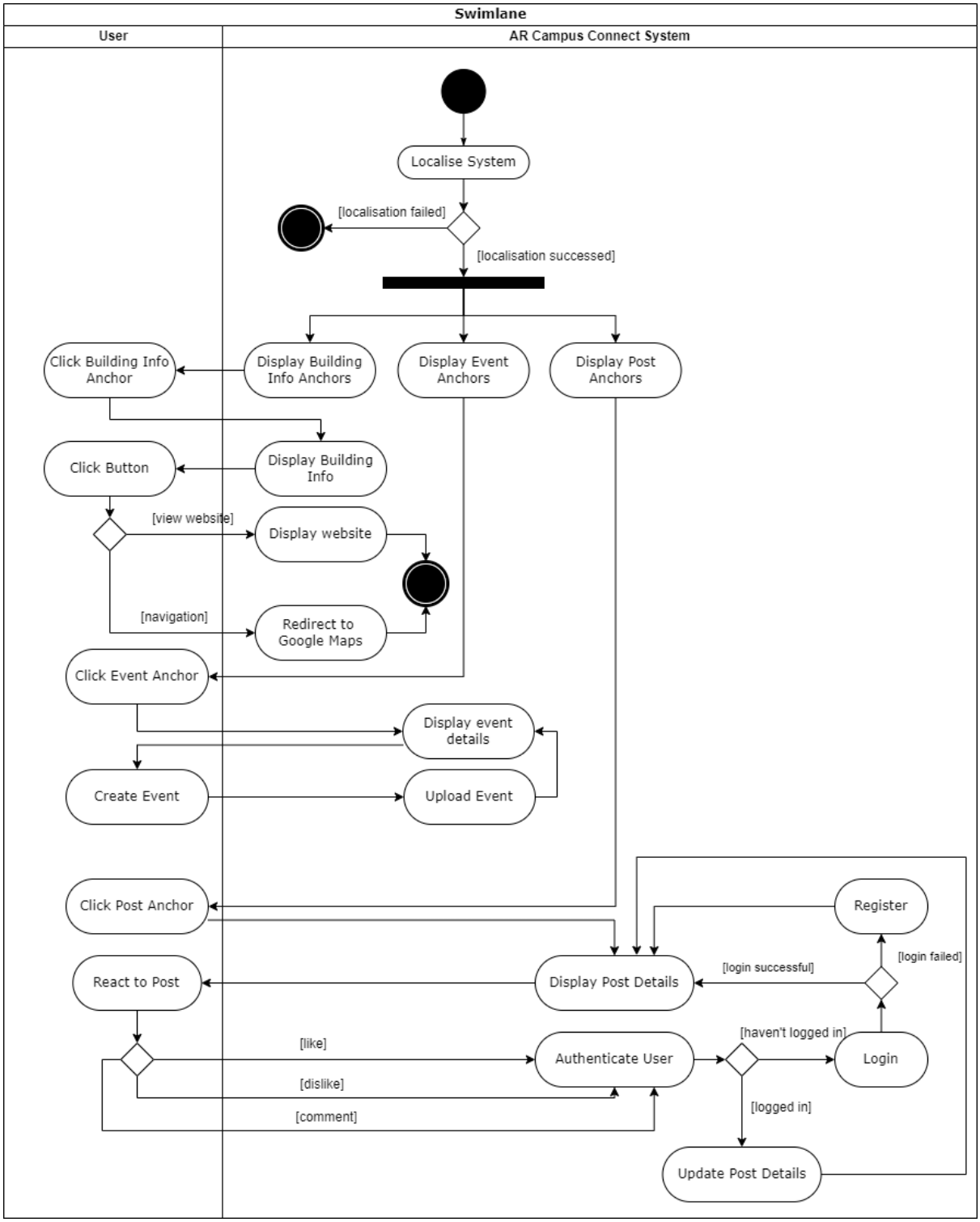


Figure 3.2.2.1: Activity Diagram.

Chapter 4

System Design

4.1 System Flowchart

Figure 4.1.1 depicts the process flow for user interaction within the AR Campus Connect System, starting with the localisation of the user's device to ensure proper functionality. If the localisation is unsuccessful, the process ends there. However, if localisation is successful, the system proceeds by displaying various anchors including building info anchor, event anchor, and post anchor.

The first set of actions is based on whether the user wants to interact with post anchors. If the user selects a post anchor, the system displays the relevant post details, allowing the user to engage with the post. For example, users can express their reactions by liking, disliking, or commenting on an existing post. Additionally, they have the option to create a new post. To carry out these actions, authentication is required to verify their authorisation. If the user is logged in and authenticated through Firebase, the post details are updated accordingly. If the user does not have an account, they will be redirected to register page before proceeding.

In the case of event anchors, the user can either create a new event or view details of an existing one. Similar to the post anchor flow, the system authenticates the user before allowing the creation of new events. Upon successful authentication, event details are updated in Firebase, ensuring real-time synchronization of data.

Additionally, the system supports interaction with building information anchors. When the user clicks on a building information anchor, the system displays information related to that building. From this point, the user can either be redirected to the building’s website or to Google Maps for navigation, depending on the chosen action. This provides an interactive and user-friendly method for users to access essential campus information.

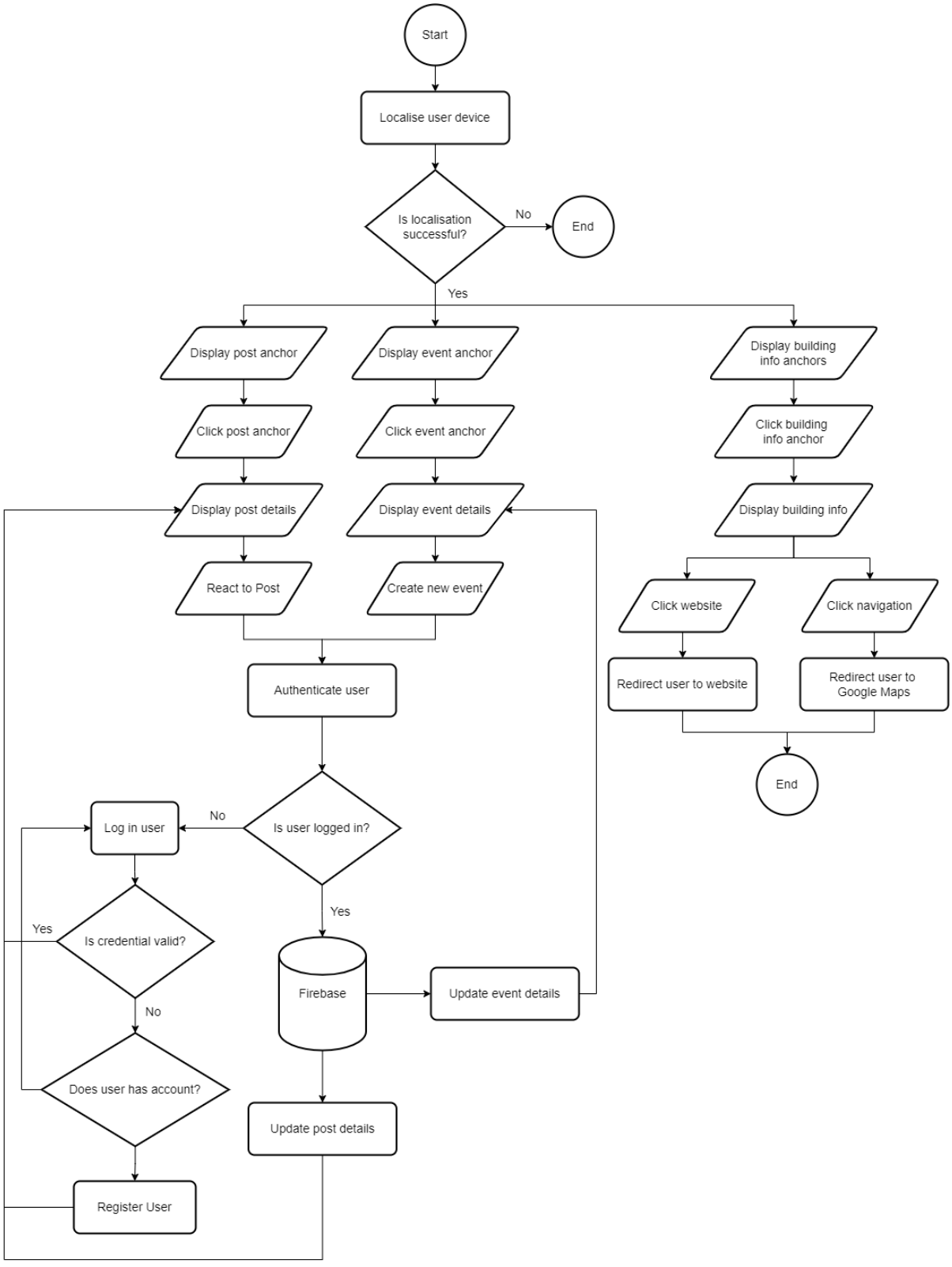


Figure 4.1.1: System Flowchart.

4.2 System Components Specifications

4.2.1 Unity

The system components for the AR Campus Connect application are organized within the Unity hierarchy under the main root object labeled “AR Campus Connect”, which functions as the container for all key elements. It’s worth mentioning that one of the primary components is the XR Origin, responsible for managing the position and orientation of the user's AR view. Nested within this is the Camera Offset, containing the Main Camera that renders the augmented reality environment, ensuring a seamless AR experience for the user. Additionally, the AR Session object handles the lifecycle of the AR session, while ARCore Extensions provides advanced ARCore functionalities to enrich the AR experience.

The Canvas object is integral to the user interface, hosting multiple panels that facilitate interaction. These include ARView, which manages user interaction with the AR environment, and AvailabilityCheck, responsible for checking the availability of VPS services. The PrivacyPrompt panel displays necessary privacy notifications, while Dashboard, SignUp, and LogIn provide navigation and user account management functionalities, forming the core of the application's interface for user engagement.

EventSystem is used to handle all input events, which allows for seamless interaction between the user and the AR objects or UI elements. The GeospatialController manages geospatial functionalities, leveraging ARCore’s geospatial API to ensure accurate positioning and placement of AR elements relative to real-world coordinates. This is complemented by the AR Geospatial Creator Origin, which contains the Cesium3DTileset. The tile set plays a crucial role in rendering extensive geographical data within the Unity editor, which significantly aids developers by streamlining the programming process.

To enable users to view AR elements in a real-world environment, it is essential to incorporate geospatial creator anchors. I have added multiple anchors to the system, each positioned at various buildings on campus. For instance, I created an anchor named “Block N” to represent the location at Block N. I then included elements such as “Block N Post” and “BuildingEvent,” each of which presents different canvases and information to the user. Users can interact with these elements by clicking on them.

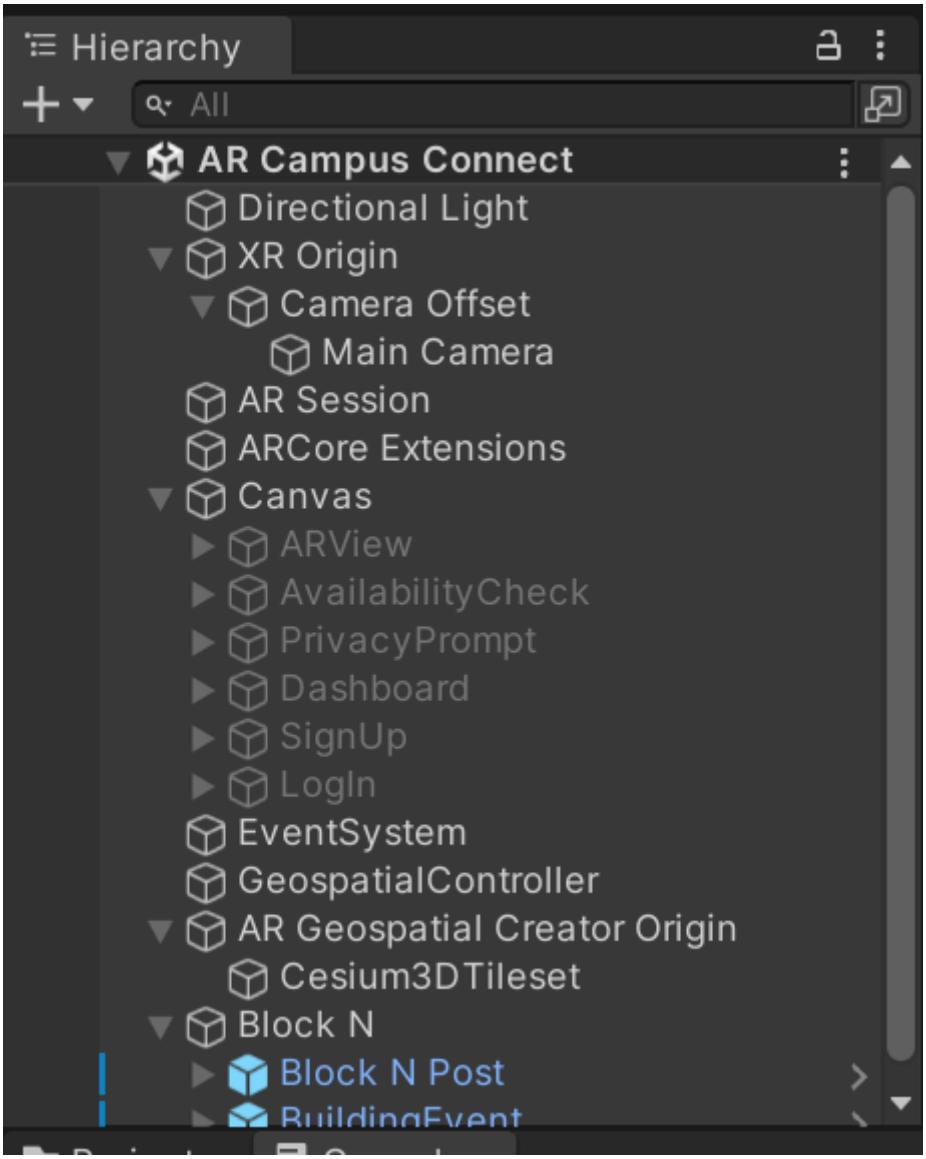


Figure 4.2.1.1: Unity hierarchy.

4.2.2 Firebase

Firebase serves as the primary database for the AR Campus Connect System, providing a versatile and scalable backend solution. It provides an efficient platform for managing various aspects of data handling, such as user authentication, real-time data operations, and storage, making it highly suitable for this AR-driven application. A critical feature employed within the system is Firebase Authentication, which ensures user credentials are properly validated before granting access to specific functionalities. This includes actions like liking or disliking posts, commenting on existing posts, and other interactive features. By implementing Firebase Authentication, the system guarantees that only verified users can modify data, such as creating new campus events or engaging with posts through comments and reactions.

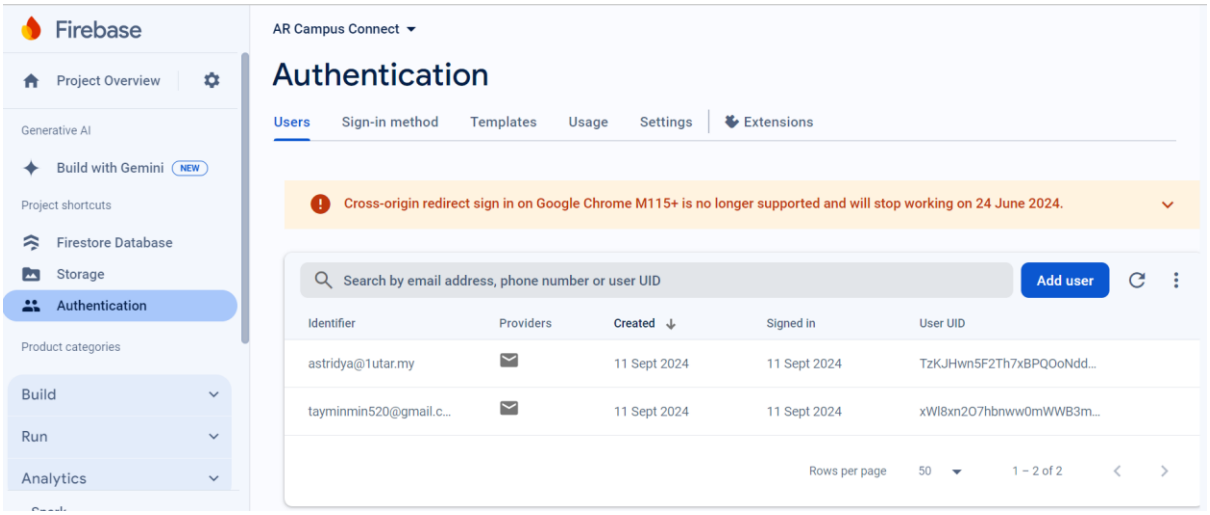


Figure 4.2.2.1: Firebase Authentication.

Beyond user authentication, the system utilizes Firebase Cloud Firestore to store user-specific information, including personal details and like or dislike counts. Firestore's real-time synchronization feature allows for instantaneous updates throughout the application, ensuring users have access to the most up-to-date information. This is particularly useful in a dynamic environment like a campus, where events, posts, and interactions are frequently updated.

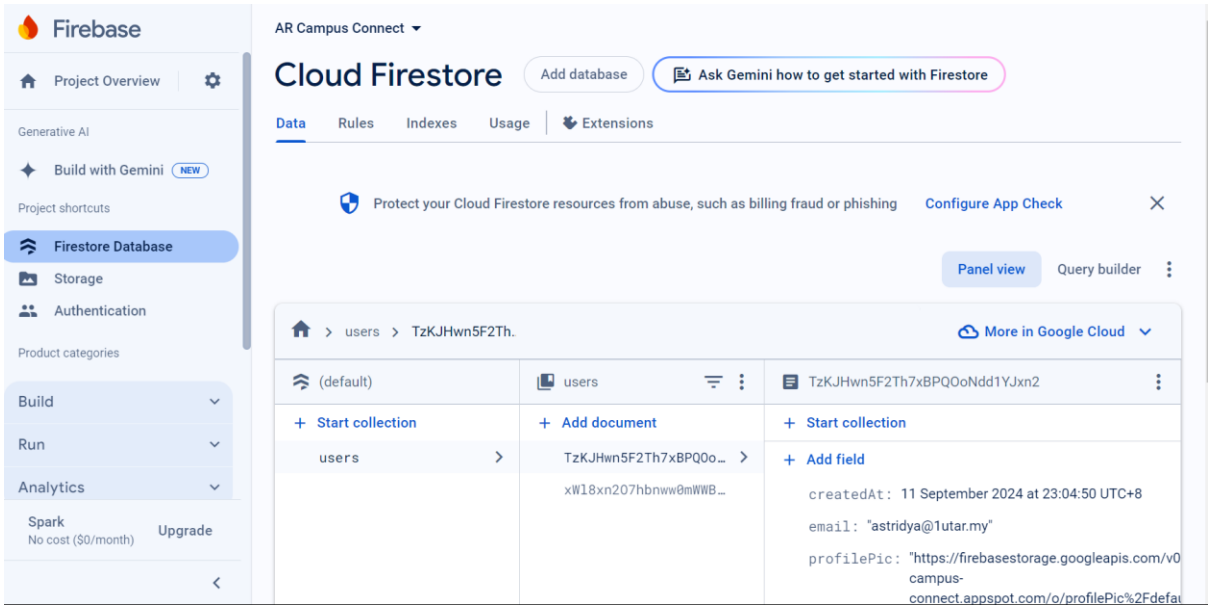


Figure 4.2.2.2: Firebase Cloud Firestore.

Furthermore, Firebase Storage is employed to manage multimedia content, including campus buildings images and user profile pictures. The flexibility of Firebase Storage also facilitates the storage and retrieval of profile pictures, enhancing the user experience by providing personalized visuals tied to user accounts. This seamless integration of Firebase's various services contributes to the smooth operation of the AR Campus Connect System, ensuring data security, real-time functionality, and efficient storage management.

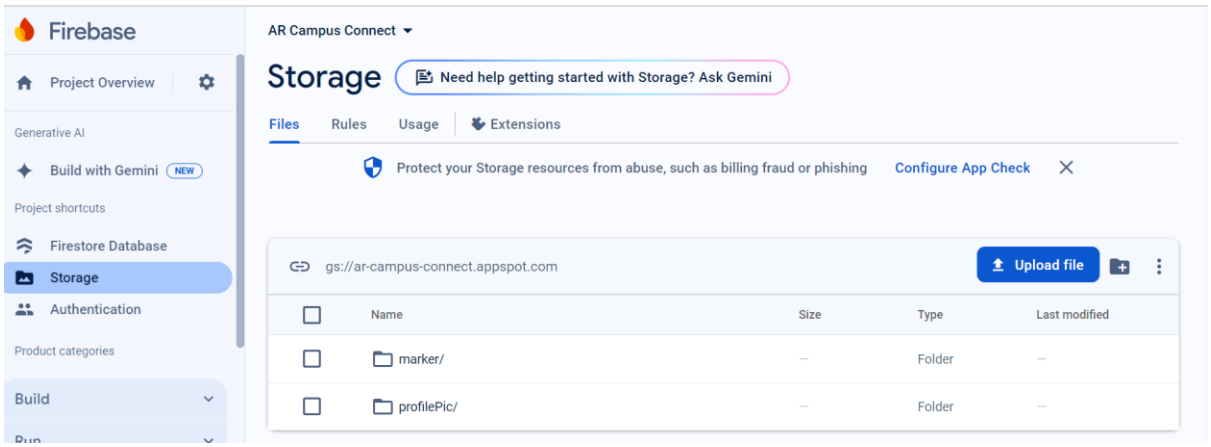


Figure 4.2.2.3: Firebase Storage.

Chapter 5

System Implementation

5.1 Hardware Setup

The hardware involved in this project includes a laptop and an Android mobile device. The laptop is used for development and programming of the application whereas the mobile device is used for testing and deploying this mobile AR application in the campus area. In order to deploy the AR Campus Connect application, it is required to ensure that the device is ARCore supported and a USB cable is prepared for connecting the device to the development laptop.

Description	**Specifications**
Model	Asus Zenbook UX425EA
Processor	11th Gen Intel(R) Core(TM) i7-1165G7 @ 2.80GHz
Operating System	Windows 10
Graphic	Intel ® Iris ® Xe Graphics
Memory	8GB RAM
Storage	512GB SSD

Table 5.1.1: Specifications of laptop.

Description	**Specifications**
Model	Oppo F11 Pro
Processor	Mediatek MT6771 Helio P70
Operating System	Android
Graphic	Mali-G72 MP3
Memory	8GB RAM
Storage	128GB

Table 5.1.2: Specifications of mobile device.

5.2 Software Setup

The project is developed with several technologies, such as ARCore, Google Maps, Unity, C# and Firebase.

- **ARCore**

  ARCore is an augmented reality development framework on the Google platform. This project adopted its application programming interface (API) and utilized it to build an augmented reality experience in the system. Through this technology, the AR Campus Connect application enabled the placement of markers in the real world and allowed users to interact with them. It can be said that the technology is the core of the project.

- **Google Maps**

  Google Maps is a web mapping platform provided by Google that provides detailed information about geographic regions and sites around the world. The AR Campus Connect application allows users to navigate around campus using the Google Maps SDK to quickly locate campus buildings on a map and easily navigate to them.

1. **Unity**

   Unity, a robust game engine created by Unity Technologies, was my tool of choice for developing the AR Campus Connect application. To effectively implement AR features, it was necessary to use Unity version 2021.3 or later, along with Android Build Support.

- **C#**

  Unity's native support for the C# programming language made it the ideal choice for developing the AR Campus Connect application. This compatibility allowed for seamless scripting and customization, enabling the creation of complex AR interactions and features with greater ease and efficiency. Additionally, the extensive resources and documentation available for C# in Unity further streamlined the development process, making it easier to troubleshoot, optimize, and enhance the application's functionality.

2. Firebase

Firebase is a cloud-based NoSQL database known for its real-time data synchronization and storage capabilities. With its robust features and free tier, it became the ideal solution for managing and storing data in the AR Campus Connect application.

5.3 Setting and Configuration

1. Install AR Foundation package.
    - Navigate to Window > Package Manager.
    - Next to Packages, select Unity Registry.
    - Type “AR Foundation” in the search bar and click install.

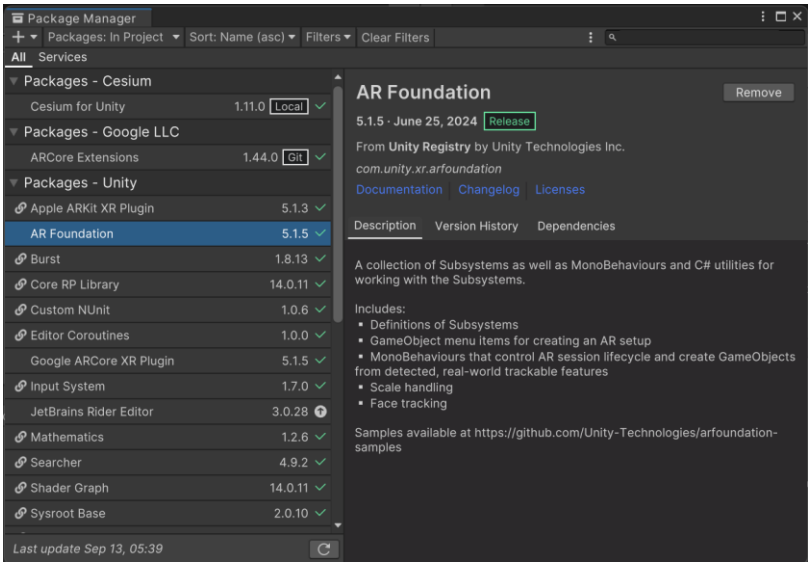


Figure 5.3.1: AR Foundation package.

2. Install Google ARCore XR Plugin.
    - Navigate to Window > Package Manager.
    - Next to Packages, select Unity Registry.
    - Type “Google ARCore XR Plugin” in the search bar and click install.

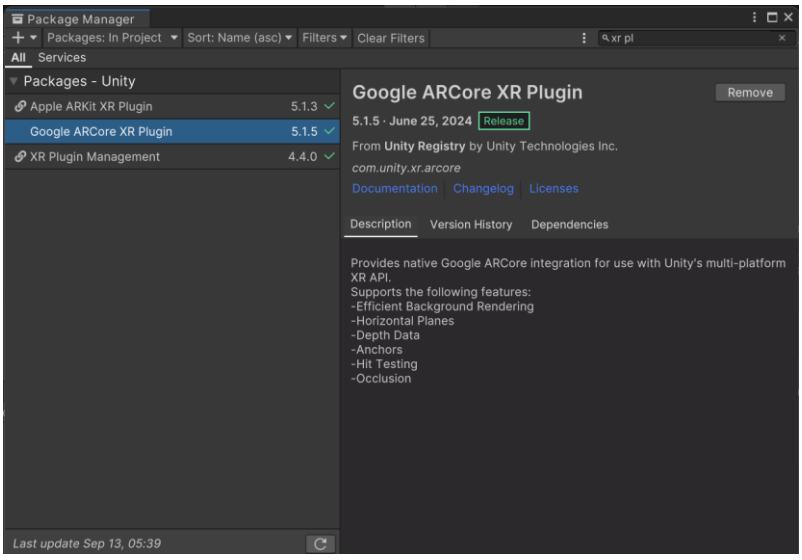


Figure 5.3.2: Google ARCore XR Plugin.

3. Enable Google ARCore.

   Navigate to Edit > Project Settings. In XR Plug-in Management, open the Android tab and enable Google ARCore.

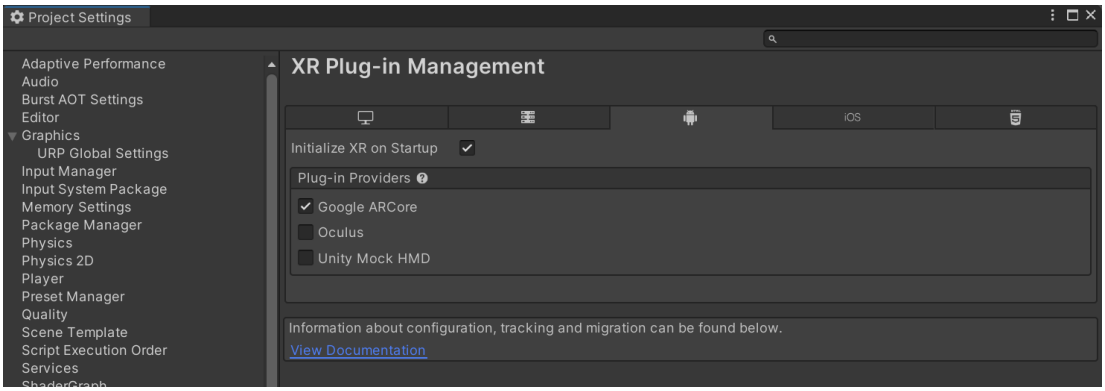


Figure 5.3.3: XR Plug-In Management.

4. Configure Player Settings.
   - In Other Settings > Rendering, uncheck Auto Graphics API.

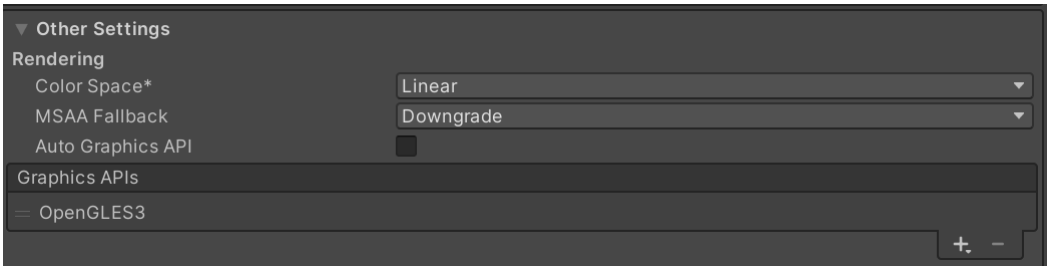


Figure 5.3.4: Other Settings > Rendering.

   - In Other Settings > Identification > Package Name, create a unique application ID.
   - In Other Settings > Identification > Minimum API Level, specify Android 7.0 ‘Nougat’ (API Level 24) or higher.

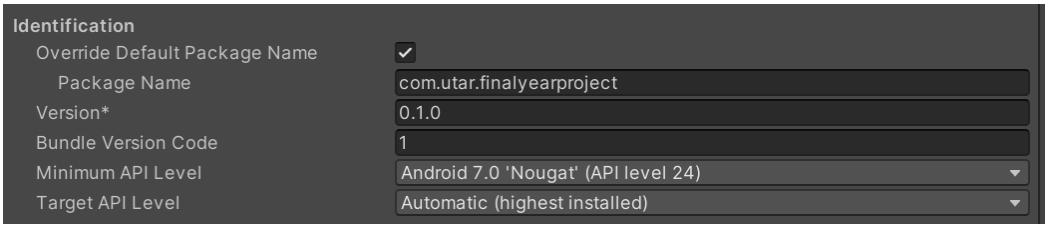


Figure 5.3.5: Other Settings > Identification.

- In Other Settings > Configuration > Scripting Backend, Select IL2CPP instead of Mono.
- In Other Settings > Configuration > Target Architecture, enable ARM64 (64-bit ARM).

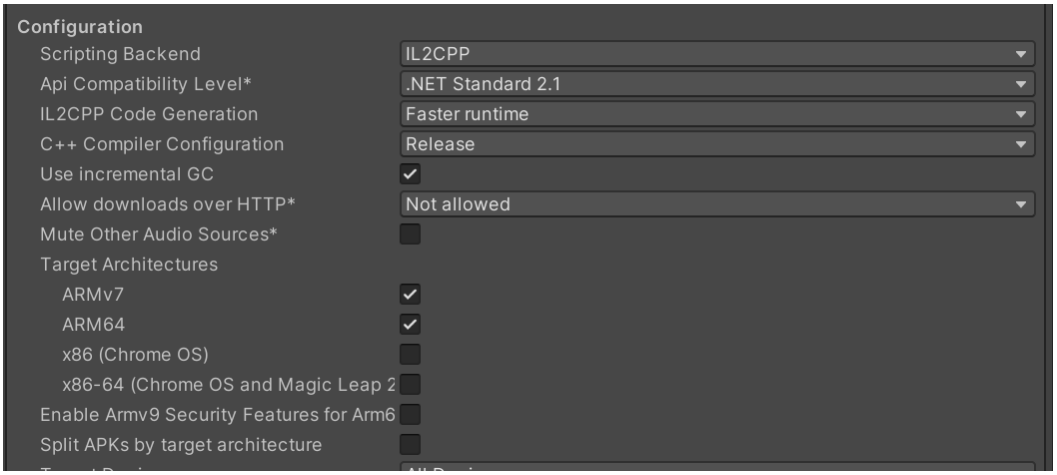


Figure 5.3.6: Other Settings > Configuration.

5. Select Android platform.
   - Navigate to File > Build Settings.
   - Select Android.
   - Click “Switch Platform”.

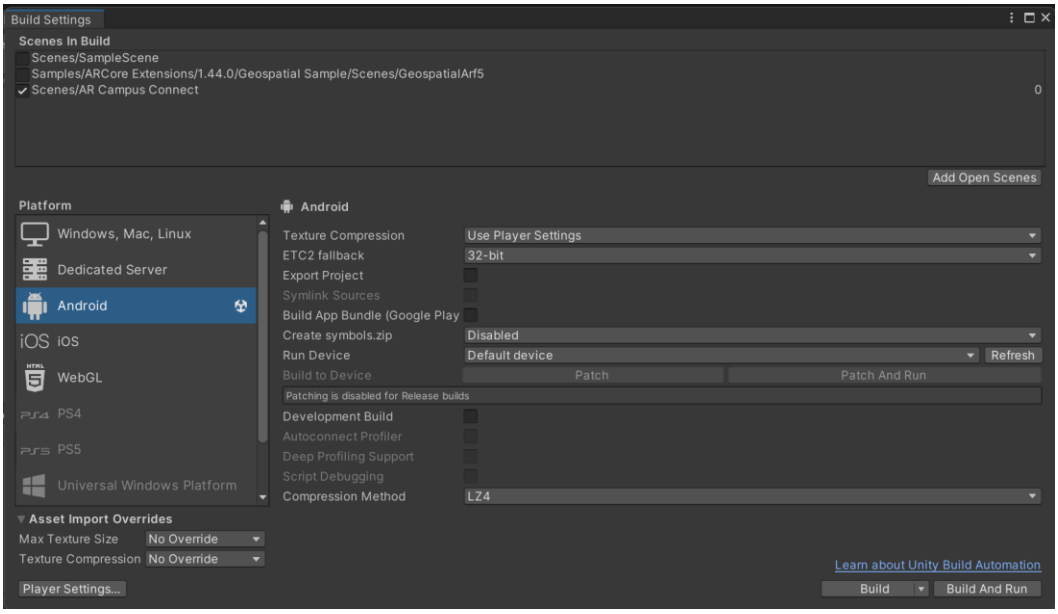


Figure 5.3.7: Build Settings.

6. Import ARCore Extensions package.
    - Navigate to Window > Package Manager.
    - Click the "+" button and choose the "Add package from git URL..." option.
    - Paste the URL into the text field: https://github.com/google-ar/arcore-unity-extensions.git#arf5
    - Click "Add".

Figure 5.3.8: Add package from git URL…

7. Setup scene.
    - In Hierarchy pane, add AR Session, XR Origin (Mobile AR) and ARCore Extensions.
    - In Project > Assets pane, right-click and select Create > XR > ARCore Extensions Config.
    - In Project > Assets pane, right-click and select Create > XR > Camera Config Filter.
    - In Hierarchy pane, select the ARCore Extensions package.
    - In Inspector pane, for each of the following fields, click the target button, and connect each field with its corresponding game object, as follows:
        i. Session: Use scene's AR Session.
        ii. XR Origin: Use scene's XR Origin.
        iii. Camera Manager: Use scene's AR Camera.
        iv. ARCore Extensions Config: Use ARCoreExtensionsConfig asset.
        v. Camera Config Filter: Use ARCoreExtensionsCameraConfigFilter asset.

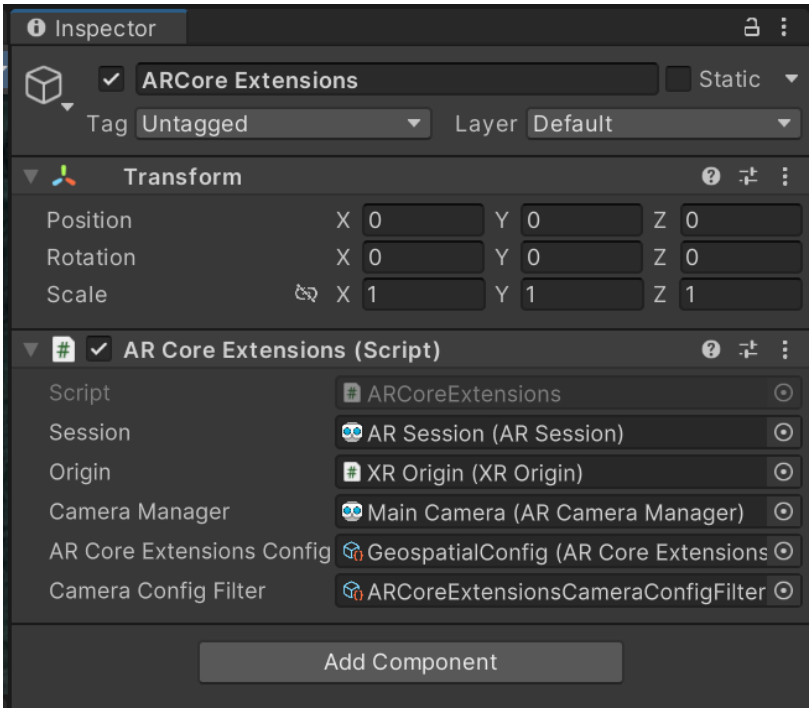


Figure 5.3.9: Inspector pane of ARCore Extensions.

8. Setup API.
    - Set up API access to use the ARCore Geospatial API
    - Set up API access to use the Google Map Tiles API.

9. Enable Geospatial.
    - Navigate to Edit > Project Settings > XR Plug-in Management > ARCore Extensions, enable Geospatial.
    - Enter API credentials.

10. Add required dependencies.
    - Download the most recent version of the precompiled .tgz of Cesium for Unity from their GitHub Releases page.
    - Navigate to Window > Package Manager.
    - Click the "+" button and choose "Add package from tarball".
    - Select the downloaded Cesium for Unity .tgz file.
    - Install additional dependencies as prompted, such as Text Mesh Pro.

11. Enable Geospatial Creator.
    - Navigate to Edit > Project Settings > XR Plug-in Management > ARCore Extensions, enable Geospatial Creator.
    - After enabling the Geospatial Creator toggle, a non-modal wizard will be displayed to confirm that the project is compatible with the Geospatial Creator.
    - Click "Finish".
    - After finishing the wizard, Unity will trigger a compilation of scripts. Wait for the recompilation to complete.

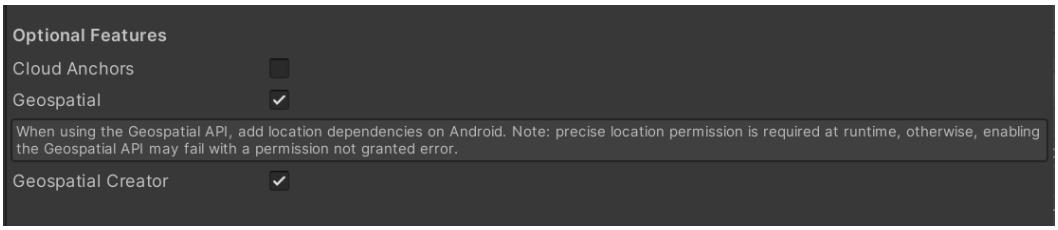


Figure 5.3.10: ARCore Extensions Settings.

12. Add Geospatial Creator Origin.
    - In Hierarchy pane, add Geospatial Creator Origin, then select it.
    - In Hierarchy pane, select the Geospatial Creator Origin.
    - In Inspector pane, add a georeference by clicking the "Add Cesium Georeference Component" button.
    - Insert the API key.
    - Set up the latitude, longitude and height fields.

13. Add and place Geospatial Anchor.
    - In Hierarchy pane, add Geospatial Creator Anchor, then select it.
    - In Inspector pane, specify latitude, longitude and height.

5.4 System Operation

5.4.1 Sign Up

AR Campus Connect features a sign-up function that streamlines the account creation process for new users. As part of this process, users are asked to provide a username, email address, password, and confirm their password. The email address acts as a unique identifier within the application, with each email being permitted for registration only once.

The password and confirm password fields are included to enhance security by ensuring that users set a strong and consistent password for their accounts. This dual-entry process helps prevent errors and ensures that the password is entered correctly, contributing to the overall security of user accounts. Once the required information is submitted and validated, users can successfully create an account, gaining access to the full range of features offered by AR Campus Connect.

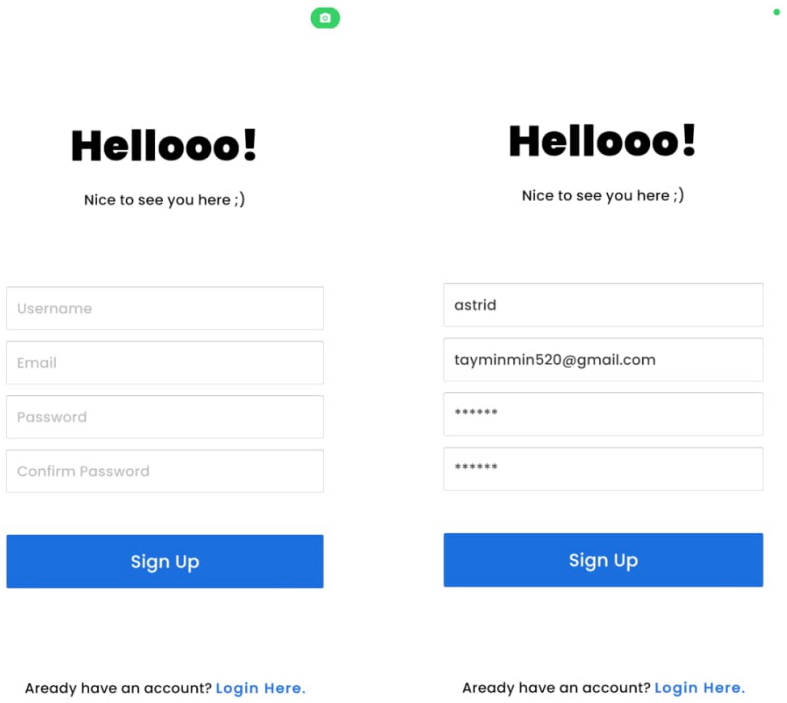


Figure 5.4.1.1: Sign up page.

5.4.2 Log In

The login page of AR Campus Connect requires users to enter their email address and password to access their accounts. This straightforward login process ensures secure entry to the application by verifying the user's credentials. For added convenience, the page also features a "forgot password" function. This function allows users who have forgotten their password to securely reset it. By following a simple recovery process through email, users can regain access to their accounts without compromising security.

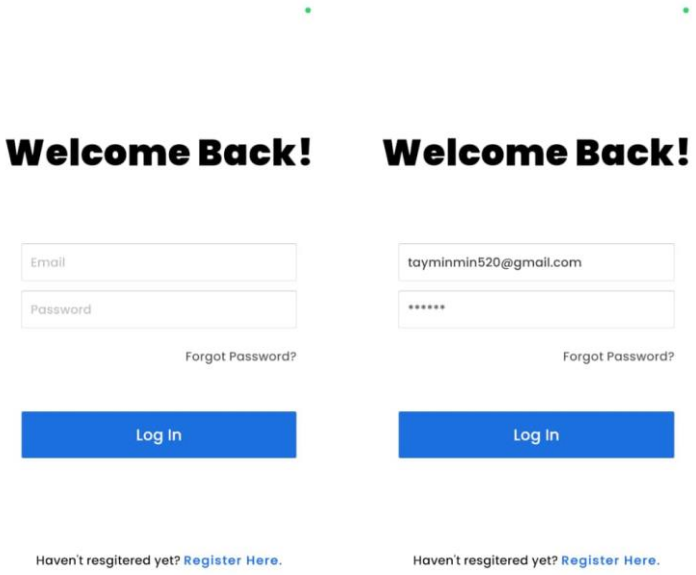


Figure 5.4.2.1: Log in page.

5.4.3 Moment

The Moment feature in AR Campus Connect provides users with a dynamic platform for social interaction and engagement. Through this feature, users can create posts, which allows them to share updates or thoughts with the community. Additionally, users have the ability to interact with existing posts by liking, disliking, or commenting, thereby expressing their opinions and engaging in discussions. The Moment page serves as a central hub where users can view and interact with posts made by others. This page is designed to foster a sense of community and encourage active participation, as users can explore a variety of posts, stay informed about what their peers are sharing, and contribute to the conversation through their interactions.

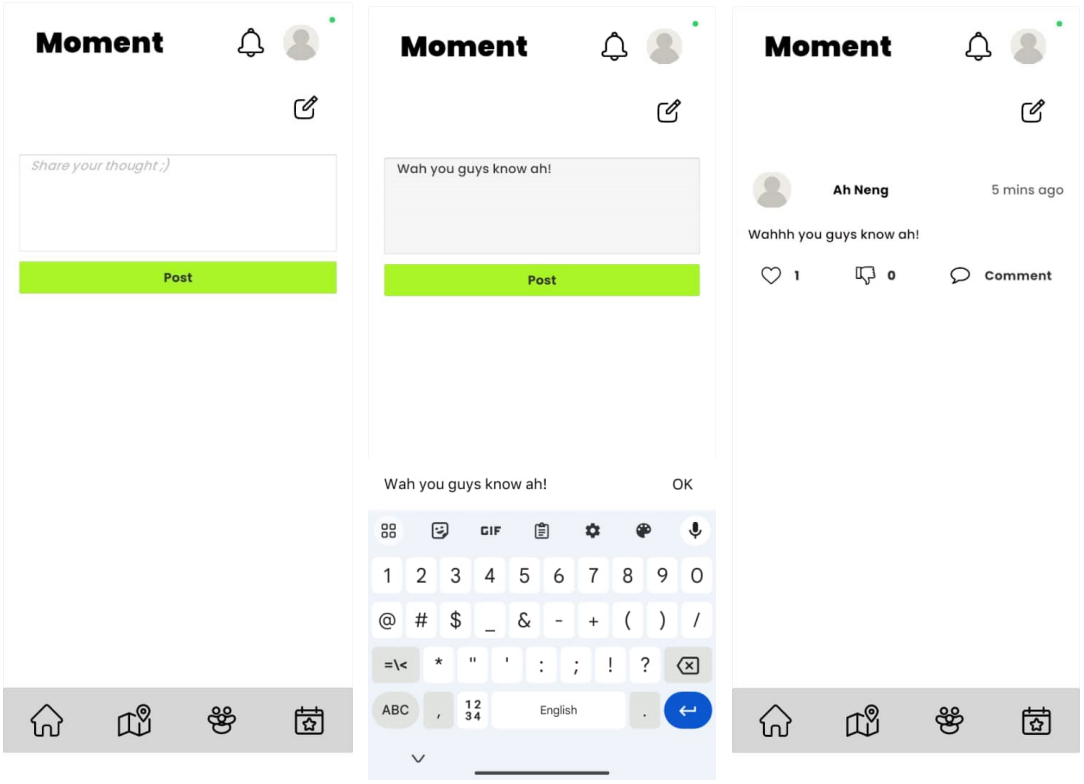


Figure 5.4.3.1: Moment.

5.4.4 Event

The Event page in AR Campus Connect offers a comprehensive platform for users to stay updated on campus activities and contribute to the campus community by creating new events. Users can browse through a list of all upcoming events, providing them with valuable information about various campus activities, gatherings, and opportunities.

In addition to viewing events, users have the capability to create new events, which requires entering specific information to ensure the event is properly described and organized. To create a new event, students are required to input several key details: the event title, which provides a clear and concise name for the event; the event date, which specifies the scheduled time for the event; the event location, which indicates where the event will take place; and the event details, which offer a more thorough description and any additional information relevant to the event. This structured approach to event creation ensures that all pertinent information is captured and presented clearly, facilitating effective communication and organization of campus events.

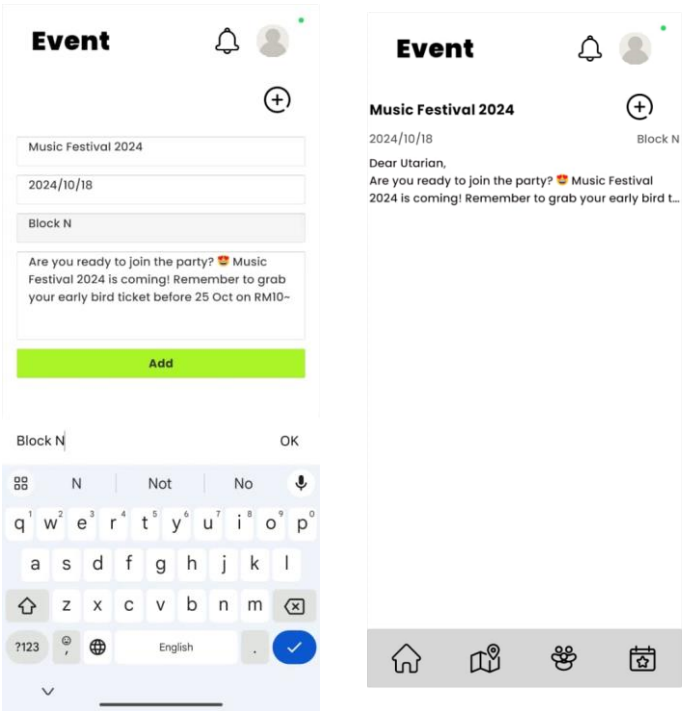


Figure 5.4.4.1: Event.

5.4.5 Map View

The map view in AR Campus Connect is designed to provide users with an intuitive and interactive navigation experience across the UTAR campus. Prominent markers are strategically placed to represent key UTAR buildings, offering users clear and immediate visual cues for orientation and navigation.

Users can engage with these markers effortlessly by clicking on them, which triggers the display of detailed information about each building. The interactive nature of the map view not only simplifies navigation but also enriches the user's understanding of the campus layout and the purpose of each building.

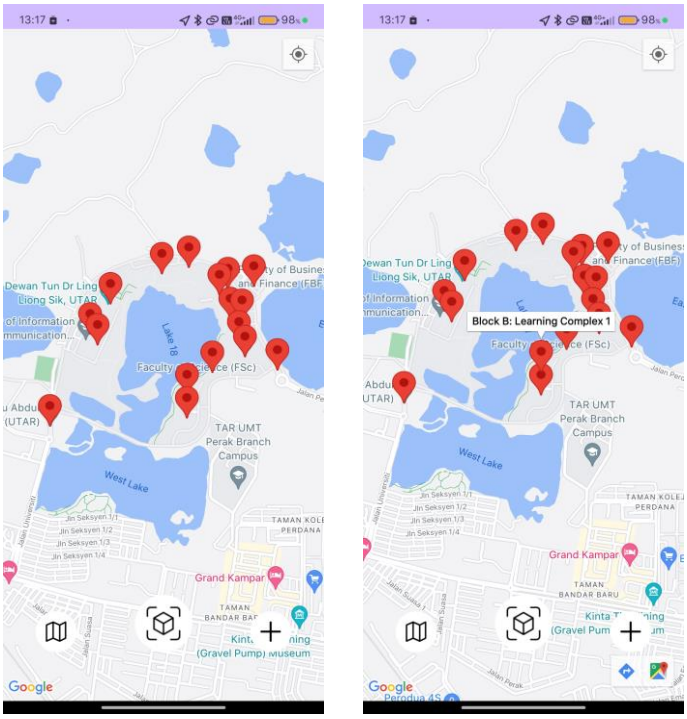


Figure 5.4.5.1: Map view.

5.4.6 AR View

When using the application in AR View throughout the UTAR campus, users will come across AR notice boards strategically placed on nearby buildings. These virtual notice boards are seamlessly integrated with the physical UTAR structures, offering students real-time updates on upcoming events and recent moments shared within the community.

As users navigate the campus and encounter these AR notice boards, they can interact with them by clicking on the corresponding anchors. This action activates a page redirection function that provides detailed information relevant to the notice board's content. This integration of augmented reality with physical locations ensures that users receive timely and pertinent information directly within their campus environment, enhancing their engagement and awareness of campus activities.

Figure 5.4.6.1: AR view.

5.4.7 User Profile

The user profile provides a comprehensive view of individual user information, serving as a personalized hub for managing account details. This profile displays essential elements including the user's username, profile picture, description and account creation time. To further enhance user interaction, the profile page also features a count of likes and dislikes accumulated by the user, reflecting their activity and engagement within the application.

Moreover, users are empowered to manage and update their account information directly through the profile page. By inputting the relevant details into the designated fields and clicking the update button, users can modify their profile information, ensuring that their data remains current and accurate. This functionality provides users with control over their profiles, enabling them to make adjustments as needed and maintain an up-to-date representation of their information within the application.

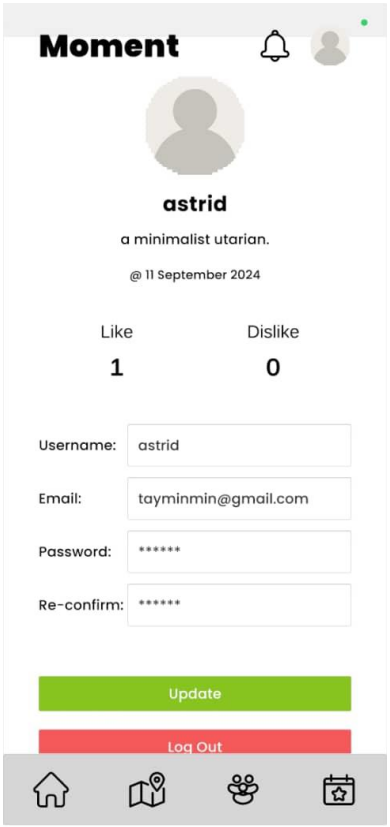


Figure 5.4.7.1: User profile.

5.5 Implementation Issues and Challenges

The primary implementation challenges encountered in this project revolve around the development of the AR session. As a newcomer to AR technology, navigating the complexities of implementing AR features posed a significant learning curve. Overcoming technical hurdles such as integrating AR functionalities seamlessly with the existing application framework required extensive research, experimentation, and troubleshooting. This took up a lot of my time and effort, and in fact slowed down my development progress due to frequent bugs in AR session.

Despite these challenges, one novel aspect of this project lies in the implementation of an interactable AR notice board. This innovative feature enhances user engagement by allowing users to interact with virtual notice boards overlaid onto physical structures within the campus environment. By leveraging AR technology, users can access real-time information, announcements, and updates directly within the context of their surroundings. This novel approach not only enhances the usability and effectiveness of traditional notice boards but also showcases the transformative potential of AR in augmenting everyday experiences.

5.6 Concluding Remark

In summary, the development of the AR Campus Connect application was an intricate process involving both hardware and software elements. The setup and configuration of the system demanded meticulous attention to detail to meet the precise requirements of augmented reality technology. Despite facing various issues and challenges during development, these were effectively addressed through ongoing iterative improvements and testing, leading to the creation of a functional and robust system.

Chapter 6

System Evaluation and Discussion

6.1 System Testing and Performance Metrics

Response Time

Response time is a critical metric for evaluating the performance of the AR Campus Connect application. It measures the duration between a user's action, such as reacting to a post, submitting a new event or interacting with an AR element, and the application's response. During testing, the application's response time was closely monitored to identify and address any delays that could affect user satisfaction.

Error Rate

The error rate quantifies the frequency of errors encountered during the use of the AR Campus Connect application, including issues such as failed interactions, system crashes, or incorrect data display. A low error rate is crucial for ensuring the reliability and stability of the application. Comprehensive testing was conducted to detect and rectify bugs or glitches that could impact functionality.

Resource Utilisation

Resource utilisation measures how efficiently the AR Campus Connect application uses system resources such as CPU, memory, and battery power, especially on mobile devices. Since AR applications typically require substantial processing power and memory to render AR elements and manage real-time data, it's essential to ensure the application doesn't overuse these resources, leading to lag, overheating, or excessive battery drain. By tracking resource utilization during testing, potential inefficiencies can be identified and optimized to improve the application's overall performance, ensuring a smooth user experience even on lower-end devices.

6.2 Testing Setup and Result

Table 6.2.1 shows the testing setup and result obtained. In summary, the testing of the AR Campus Connect application yielded valuable insights into the performance metrics for various user actions. The response time for most actions was within acceptable limits, with interactions like liking or disliking a post achieving quick responses of 0.8 to 0.9 seconds. More complex actions such as creating a new post or event took slightly longer, averaging between 2.5 to 2.7 seconds. Overall, the system performed reliably, with the majority of actions completing successfully and minimal errors reported.

The error rate for all tested actions was predominantly low, with only one failure occurring out of fifty attempts. This indicates a high level of system stability. The resource utilization metrics showed that while CPU and memory usage were generally efficient, certain actions, such as creating new posts and events, resulted in higher CPU utilization and memory consumption. Battery consumption was also notably higher during these more intensive actions.

These results provide a comprehensive overview of the AR Campus Connect application's performance across various user interactions. While the system demonstrates robust functionality and reliability, areas for optimization have been identified, particularly in managing resource usage during more demanding operations.

User Actions	**Performance Metrics**	**Testing Setup**	**Result**
Users clicks the AR anchors	Response Time	Record the duration between user action and system response	1.8 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 35% Memory Usage: 150 MB Battery Consumption: 5% per hour

Users like a post	Response Time	Record the duration between user action and system response	0.9 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 20% Memory Usage: 80 MB Battery Consumption: 2% per hour
Users dislike a post	Response Time	Record the duration between user action and system response	0.8 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 18% Memory Usage: 70 MB Battery Consumption: 1.8% per hour
Users comment on a post	Response Time	Record the duration between user action and system response	1.2 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 30% Memory Usage: 120 MB Battery Consumption: 4% per hour
Users create new post	Response Time	Record the duration between user action and system response	2.5 seconds

	Error Rate	Repeat the action 5 times	4 succeed, 1 failed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 40% Memory Usage: 180 MB Battery Consumption: 7% per hour
Users create new event	Response Time	Record the duration between user action and system response	2.7 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 45% Memory Usage: 200 MB Battery Consumption: 8% per hour
Users update personal details	Response Time	Record the duration between user action and system response	1.4 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 25% Memory Usage: 100 MB Battery Consumption: 3% per hour
Users sign in	Response Time	Record the duration between user action and system response	2 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery	CPU utilization: 30%

		consumption while user perform the action	Memory Usage: 140 MB Battery Consumption: 6% per hour
Users sign up	Response Time	Record the duration between user action and system response	2.3 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 35% Memory Usage: 160 MB Battery Consumption: 6.5% per hour
Users log out	Response Time	Record the duration between user action and system response	1.2 seconds
	Error Rate	Repeat the action 5 times	5 succeed
	Resource Utilisation	Monitor the CPU, memory and battery consumption while user perform the action	CPU utilization: 15% Memory Usage: 60 MB Battery Consumption: 2% per hour

Table 6.2.1: Testing setup and result.

6.3 Project Challenges

One of the primary challenges I faced was the significant lag in Unity. At times, the build and run process would take between 1 to 3 hours, which severely impacted both development and debugging efficiency. This lag not only extended the time required to see changes in the application but also disrupted the iterative testing and refinement process. The slow build times made it difficult to quickly address issues and implement new features, ultimately slowing down overall progress. To mitigate this challenge, I explored various optimization strategies, such as optimizing scripts, but the lag remained a persistent issue that required careful management and patience.

The second major challenge was managing the AR session within the application. The complexity of AR technology meant that even when the application was not in AR view, interactions with other non-AR elements were sometimes inadvertently affected. This issue arose from the intricate interplay between AR and non-AR components, where the AR session's background processes could influence the behavior of user interface elements or other features outside the AR view. Addressing this challenge required thorough debugging and fine-tuning to ensure that AR interactions did not interfere with the application's general functionality.

6.4 Objectives Evaluation

The objective evaluation of the AR Campus Connect application focuses on three critical aspects: performance, stability, and usability. These metrics were carefully assessed to ensure that the application meets high standards and delivers a satisfactory user experience.

Performance

The performance of the AR Campus Connect application was evaluated based on the system's ability to complete localisation within a specified timeframe. The application demonstrated impressive efficiency, achieving full localization within 2.5 seconds. This rapid localisation is essential for minimising delays and enhancing the user experience, as it allows students to rapidly identify and interact with key campus features. Efficient performance ensures that users can seamlessly navigate and explore their surroundings, supporting the objective of swift campus familiarisation.

Stability

Stability was assessed by monitoring the application over 50 sessions, during which it experienced only 1 crash. This results in a crash rate of 2%, indicating a high level of reliability. The low crash rate reflects the AR Campus Connect application's robustness and stability, minimizing disruptions for users. Besides, stable performance is crucial for providing consistent access to campus information and maintaining an uninterrupted user experience, which aligns with the goal of offering reliable, instant information access.

Usability

Usability was assessed based on the accuracy of AR object placement and user interaction. The AR Campus Connect application generally placed AR objects accurately within the real-world environment, facilitating effective interaction with campus features. However, some objects occasionally experienced slight deviations from their intended positions, causing minor visual shifts. Despite these occasional deviations, the overall usability of the application remains strong, allowing students to effectively engage with AR elements.

6.5 Concluding Remark

In conclusion, Chapter 6 has provided a comprehensive analysis of the AR Campus Connect application's system testing, performance metrics, project challenges, and objective evaluation.

The performance metrics indicate that the application achieves efficient localization and interaction with minimal delays, contributing to a smooth user experience. The stability assessment confirms a high level of reliability, with a low crash rate ensuring consistent and dependable performance. Usability findings highlight the application’s effectiveness in placing AR objects accurately and maintaining user engagement, despite occasional minor deviations. While the application has shown strong results in meeting its objectives, the project also faced challenges, such as lag in Unity and managing the AR Session.

Overall, AR Campus Connect represents a significant step forward in integrating augmented reality with campus life, providing UTAR students with valuable tools for navigation, information access, and social interaction.

Chapter 7

Conclusion and Recommendation

7.1 Conclusion

In conclusion, the development of the AR Campus Connect application represents a significant milestone in the realm of campus technology solutions. By harnessing the power of AR technology, this project endeavors to revolutionize the way UTAR students navigate and engage with their campus environment.

The identification of key challenges faced by today's university students reveals a multifaceted landscape where students grapple with various obstacles in navigating and engaging with their academic environment. Chief among these challenges is the issue of unfamiliarity with campus structures, which often leaves students feeling disoriented and overwhelmed, especially during their initial days on campus. Without a clear understanding of the locations of key buildings, facilities, and amenities, students may struggle to find their way around campus efficiently, leading to frustration and inefficiency in their daily routines. Moreover, the lack of awareness about campus events poses another significant challenge for students. Despite the abundance of extracurricular activities, workshops, seminars organized by university and student societies, many students remain uninformed or unaware of these opportunities due to inadequate communication channels or information dissemination methods. This results in missed opportunities for personal and professional development, as well as limited avenues for social interaction and community engagement.

In light of these challenges, there arises an urgent call for innovative solutions that not only recognize the complexities of these issues but also proactively address them to empower students in their academic journey. The dynamic and rapidly evolving landscape of higher education demands innovative approaches that go beyond traditional paradigms and embrace cutting-edge technologies and methodologies. These innovative approaches must not only target the symptoms of the challenges faced by students but also address the underlying root causes to effect meaningful and sustainable change. This requires a comprehensive and holistic approach that encompasses various facets of the university experience, including academic and social development, and AR Campus Connect application is the answer.

The AR Campus Connect application, equipped with innovative AR notice board and map view features, offers a transformative solution to address the challenges faced by university students. Through the AR notice board feature, students can effortlessly stay informed about campus events, announcements, and activities in real-time. By superimposing virtual information onto the physical campus environment, the AR notice board provides students with instant access to relevant information directly within their surroundings. This eliminates the need for students to rely on traditional methods of communication, such as emails or physical notice boards, which may be prone to oversight or delay. Additionally, the interactive nature of the AR notice board fosters engagement and participation, enabling students to interact with and contribute to the campus community in meaningful ways.

Furthermore, the map view feature of the AR Campus Connect application offers a practical solution to the challenge of unfamiliarity with campus structures. By providing students with a comprehensive and interactive campus map, complete with building labels and navigation tools, the application empowers students to navigate their campus environment with confidence and ease. Whether it's finding their way to a specific building for a class or locating facilities such as libraries or gates, the map view feature ensures that students have access to the information they need to navigate their campus efficiently. Moreover, the real-time updating capabilities of the map view feature enable students to stay informed about any changes or updates to campus structures, ensuring that they are always up-to-date with the latest information.

In addition, AR Campus Connect offers social interaction features that enable users to engage with one another. Users can create new posts or react to existing ones by liking, disliking, or commenting, thereby providing a platform for meaningful connections between UTAR students. The system also includes event-related features, allowing users to post and view upcoming events, which helps UTAR students stay informed about campus activities. These functionalities not only enhance user engagement but also foster a sense of community and connectivity within the campus.

7.2 Recommendation

While the AR Campus Connect system is largely functional, it could benefit from additional interactive features, such as messaging and following. Currently, the system only supports interactions through liking, disliking, or commenting, which limits users' ability to establish deeper connections. To enhance the social experience, future updates could include a messaging feature, enabling students to privately communicate and foster stronger relationships. Additionally, implementing a follow feature would allow users to stay updated with each other's latest activities and news.

REFERENCES

[1] Statista Research Department and N. 9, "Malaysia: Students in public higher education institutions by gender," Statista, https://www.statista.com/statistics/794845/students-in-public-higher-education-institutions-by-gender-malaysia/

[2] L. Pei, S. Cai, and P.-F. Shi, "Mobile Campus Touring System Based on AR and GPS: A Case Study of Campus Cultural Activity," in Proceedings of the 21st International Conference on Computers in Education, ICCE 2013, ResearchGate, Nov. 2013. Available: https://www.researchgate.net/publication/262730169_Mobile_Campus_Touring_System_based_on_AR_and_GPS_a_Case_Study_of_Campus_Cultural_Activity

[3] J. T. Chao, L. Pan, and K. R. Parker, "Campus Event App - New Exploration for Mobile Augmented Reality," Issues in Informing Science and Information Technology, vol. 11, pp. 001-011, 2014, doi: https://doi.org/10.28945/1976.

[4] H. Alqahtani and M. Kavakli, "iMAP-CampUS," Proceedings of the 9th International Conference on Computer and Automation Engineering - ICCAE '17, 2017, doi: https://doi.org/10.1145/3057039.3057062.

[5] V. Kokorogianni, E. Papaioannou, and C. Kaklamanis, "AUGMENTED REALITY-ASSISTED NAVIGATION IN A UNIVERSITY CAMPUS," IJAEDU-International E-Journal of Advances in Education, pp. 416–425, Aug. 2017, doi: https://doi.org/10.18768/ijaedu.336727.

[6] A. S. Author, "Bangor CampusConnect by CampusConnect," NowGaming. https://appadvice.com/game/app/bangor-campusconnect/1399892283 (accessed September 9, 2023).

APPENDIX

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** 4
Student Name & ID: Tay Min Min (21ACB03903)	
Supervisor: Dr. Cheng Wai Khuen	
Project Title: AR Campus Connect: Enhancing Social Connectivity through Augmented Reality in University Settings	

1. WORK DONE

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

Switched platform from Android Studio to Unity

2. WORK TO BE DONE

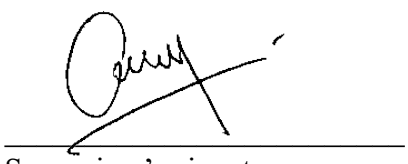
Setting up system environment for AR

3. PROBLEMS ENCOUNTERED

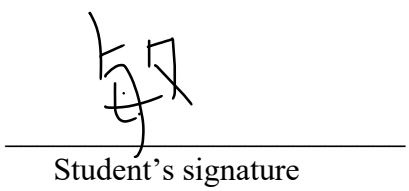
Unfamiliar with Unity, setting up took a lot of time

4. SELF EVALUATION OF THE PROGRESS

Good direction, since Android Studio is unable to produce desired result



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** 6
Student Name & ID: Tay Min Min (21ACB03903)	
Supervisor: Dr. Cheng Wai Khuen	
Project Title: AR Campus Connect: Enhancing Social Connectivity through Augmented Reality in University Settings	

1. WORK DONE

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

- Set up the environment for AR
- place anchors in campus area

2. WORK TO BE DONE

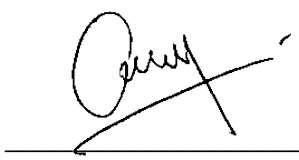
Modify the anchor to display canvas in real world

3. PROBLEMS ENCOUNTERED

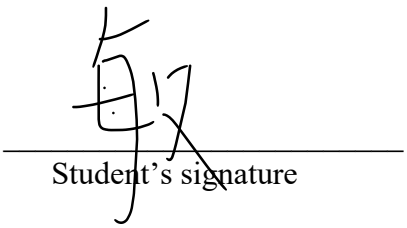
Struggle to design the canvas as the operation method is different with what I usually use

4. SELF EVALUATION OF THE PROGRESS

A bit slow. I was going to start designed the UI for pages this week.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** 8
Student Name & ID: Tay Min Min (21ACB03903)	
Supervisor: Dr. Cheng Wai Khuen	
Project Title: AR Campus Connect: Enhancing Social Connectivity through Augmented Reality in University Settings	

1. WORK DONE

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

Real world canvas set up & design completed

2. WORK TO BE DONE

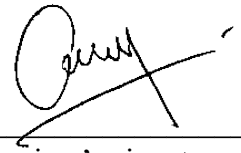
UI design for pages

3. PROBLEMS ENCOUNTERED

N/A

4. SELF EVALUATION OF THE PROGRESS

Progressing nicely!



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** 10
Student Name & ID: Tay Min Min (21ACB03903)	
Supervisor: Dr. Cheng Wai Khuen	
Project Title: AR Campus Connect: Enhancing Social Connectivity through Augmented Reality in University Settings	

1. WORK DONE

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

Completed UI design for pages

2. WORK TO BE DONE

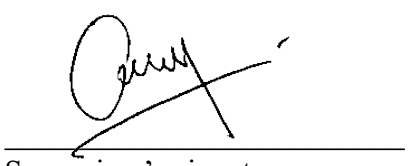
- fix interaction of AR elements to display pages
- code for page interactions

3. PROBLEMS ENCOUNTERED

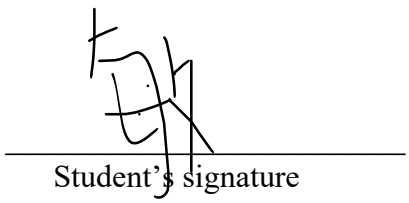
- clicking on AR elements does not redirect to other pages

4. SELF EVALUATION OF THE PROGRESS

Progress went well and although a few errors were encountered, they were able to be resolved in a short period of time.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** 12
Student Name & ID: Tay Min Min (21ACB03903)	
Supervisor: Dr. Cheng Wai Khuen	
Project Title: AR Campus Connect: Enhancing Social Connectivity through Augmented Reality in University Settings	

1. WORK DONE

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

- Fixed AR elements interaction

2. WORK TO BE DONE

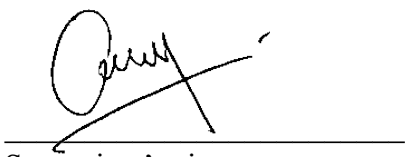
- solve page interactions bugs
- modify UI
- documentation
- test the final product in UTAR campus

3. PROBLEMS ENCOUNTERED

Unity became very laggy, sometimes I had to wait about 20 minutes – 3 hours just to run the application, and this greatly affected my programming & debug speed

4. SELF EVALUATION OF THE PROGRESS

Application works as expected, however, I spent too much time waiting for Unity to build the application.



Supervisor's signature

Student's signature

POSTER

AR Campus Connect

Enhance Social Connectivity through Augmented Reality in University Settings

AR Campus Connect is designed to revolutionize the campus experience for UTAR students. The project aims to address the prevalent challenges faced by UTAR students, including unfamiliarity with campus structures, lack of awareness about campus events, and limited avenues for social interaction.

Objectives

Facilitates seamless interaction between students

Provide students with real-time updates on upcoming and on-going events on AR notice boards

Empowers students to navigate their campus environment with confidence and ease

Methodology

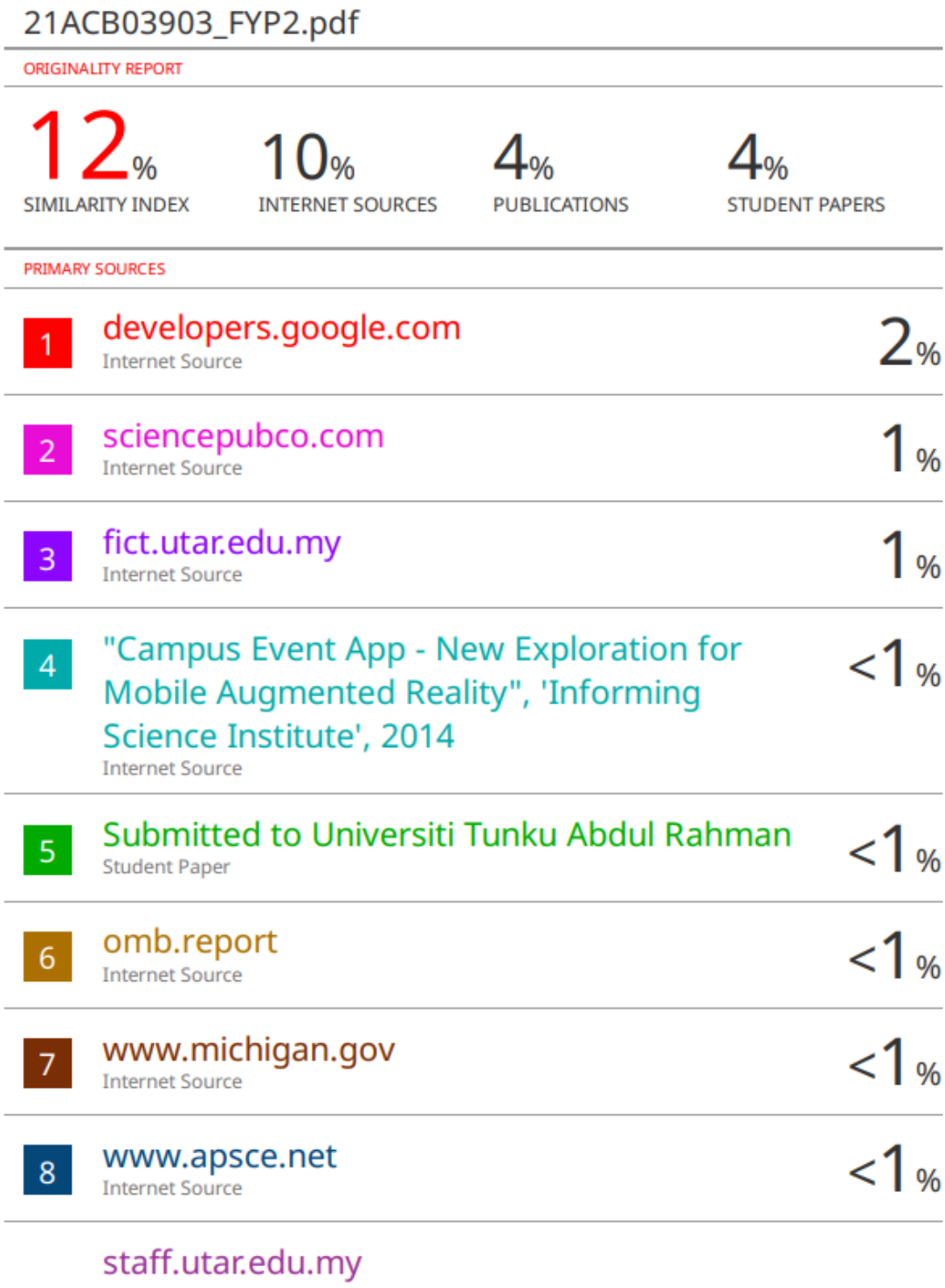
- Developed using incremental development model of Agile development methodology
- Unity & C#
- ARCore API for AR View
- Maps SDK for Map View

Conclusion

AR Campus Connect represents a groundbreaking solution that harness the power of AR technology to implement AR notice board, moment, event board and map features to solve the challenges faced by UTAR students.

Project Developer: Tay Min Min
Project Supervisor: Dr Cheng Wai Khuen

PLAGIARISM CHECK RESULT



21ACB03903_FYP2.pdf

ORIGINALITY REPORT

12%	10%	4%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	developers.google.com Internet Source	2%
2	sciencepubco.com Internet Source	1%
3	fict.utar.edu.my Internet Source	1%
4	"Campus Event App - New Exploration for Mobile Augmented Reality", 'Informing Science Institute', 2014 Internet Source	<1%
5	Submitted to Universiti Tunku Abdul Rahman Student Paper	<1%
6	omb.report Internet Source	<1%
7	www.michigan.gov Internet Source	<1%
8	www.apsce.net Internet Source	<1%

staff.utar.edu.my

9	Internet Source	<1 %
10	www.coursehero.com Internet Source	<1 %
11	Submitted to Temple University Student Paper	<1 %
12	www.ocerint.org Internet Source	<1 %
13	umpir.ump.edu.my Internet Source	<1 %
14	ir.canterbury.ac.nz Internet Source	<1 %
15	text-id.123dok.com Internet Source	<1 %
16	www.openworldlearning.org Internet Source	<1 %
17	Submitted to Buckinghamshire Chilterns University College Student Paper	<1 %
18	Submitted to The Manchester College Student Paper	<1 %
19	Submitted to Asia e University Student Paper	<1 %
20	scholarworks.lib.csusb.edu Internet Source	

		<1%
21	www.statista.com Internet Source	<1%
22	Submitted to American University of Beirut Student Paper	<1%
23	Hamed Alqahtani, Manolya Kavakli. "iMAP-CampUS", Proceedings of the 9th International Conference on Computer and Automation Engineering - ICCAE '17, 2017 Publication	<1%
24	Submitted to King's College Student Paper	<1%
25	Submitted to Lyceum of the Philippines University Laguna Student Paper	<1%
26	Submitted to Queensland University of Technology Student Paper	<1%
27	docgiver.com Internet Source	<1%
28	eprints.utem.edu.my Internet Source	<1%
29	Submitted to Chichester College Group Student Paper	<1%

30	Submitted to Kolej Mara Banting Student Paper	<1 %
31	Nattamon Srithammee, Benchaporn Jantarakongkul, Kanuengnij Kubola, Prajaks Jitngernmadan. "Increasing Awareness of Cellular Signals on Smartphones using Augmented Reality", 2022 13th International Conference on Information and Communication Technology Convergence (ICTC), 2022 Publication	<1 %
32	Submitted to University of Hong Kong Student Paper	<1 %
33	eprints.usm.my Internet Source	<1 %
34	1library.net Internet Source	<1 %
35	Submitted to Queen Mary and Westfield College Student Paper	<1 %
36	community.intel.com Internet Source	<1 %
37	docs.geonetwork-opensource.org Internet Source	<1 %
38	psasir.upm.edu.my Internet Source	<1 %

39	repository.ju.edu.et Internet Source	<1 %
40	Submitted to Student Paper	<1 %
41	Fun Shao, Wise Shu, Tracy Tian. "Electric, Electronic and Control Engineering - Proceedings of the 2015 International Conference on Electric, Electronic and Control Engineering (ICEECE 2015), Phuket Island, Thailand, 5-6 March 2015", CRC Press, 2019 Publication	<1 %
42	Oubah Isman Okieh, Serhat Seker, Seckin Gokce, Martin Dennenmoser. "An Enhanced Forecasting Method of Daily Solar Irradiance in Southwestern France: A Hybrid Nonlinear Autoregressive with Exogenous Inputs with Long Short-Term Memory Approach", Energies, 2024 Publication	<1 %
43	apps.dtic.mil Internet Source	<1 %
44	core.ac.uk Internet Source	<1 %
45	idus.us.es Internet Source	<1 %
46	researchportal.port.ac.uk	

	Internet Source	<1%
47	www.zcc.net Internet Source	<1%
48	Arvind Dagur, Dhirendra Kumar Shukla, Nazarov Fayzullo Makhmadiyarovich, Akhatov Akmal Rustamovich, Jabborov Jamol Sindorovich. "Artificial Intelligence and Information Technologies", CRC Press, 2024 Publication	<1%
49	John Brady, Alison Ebbage, Ruth Lunn. "Environmental Management in Organizations - The IEMA Handbook", Earthscan, 2013 Publication	<1%
50	Lecture Notes in Electrical Engineering, 2015. Publication	<1%
51	Muhammad Nadeem, Amal Chandra, Audrey Livirya, Svetlana Beryozkina. "AR-LabOr: Design and Assessment of an Augmented Reality Application for Lab Orientation", Education Sciences, 2020 Publication	<1%
52	William R. Sherman. "VR Developer Gems", CRC Press, 2019 Publication	<1%
	dspace.daffodilvarsity.edu.bd:8080	


53
Internet Source
<1 %
54
researcharchive.vuw.ac.nz
Internet Source
<1 %
55
www.animeviews.com
Internet Source
<1 %
56
www.theseus.fi
Internet Source
<1 %
Exclude quotes On
Exclude bibliography On
Exclude matches < 8 words

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.: 1of 1

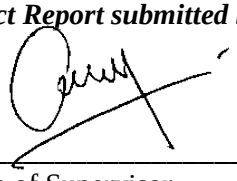
FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of	Tay Min Min
ID Number(s)	21ACB03903
Programme / Course	Bachelor of Computer Science (Honours)
Title of Final Year Project	AR Campus Connect: Enhancing Social Connectivity through Augmented Reality in University Settings

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)**
Overall similarity index: 12 % **Similarity by source** Internet Sources: 10 % Publications: 4 % Student Papers: 4 %	OK
Number of individual sources listed of more than 3% similarity: 0	
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** ***Note: Parameters (i) – (ii) shall exclude quotes, bibliography and text matches which are less than 8 words.***	

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: Dr. Cheng Wai Khuen

Date: 13.9.2024

Signature of Co-Supervisor

Name: _____

Date: _____

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF INFORMATION & COMMUNICATION TECHNOLOGY
(KAMPAR CAMPUS)

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student Id	21ACB03903
Student Name	Tay Min MIn
Supervisor Name	Dr. Cheng Wai Khuen

TICK (√)	DOCUMENT ITEMS Your report must include all the items below. Put a tick on the left column after you have checked your report with respect to the corresponding item.
√	Title Page
√	Signed Report Status Declaration Form
√	Signed FYP Thesis Submission Form
√	Signed form of the Declaration of Originality
√	Acknowledgement
√	Abstract
√	Table of Contents
√	List of Figures (if applicable)
√	List of Tables (if applicable)
√	List of Symbols (if applicable)
√	List of Abbreviations (if applicable)
√	Chapters / Content
√	Bibliography (or References)
√	All references in bibliography are cited in the thesis, especially in the chapter of literature review
√	Appendices (if applicable)
√	Weekly Log
√	Poster
√	Signed Turnitin Report (Plagiarism Check Result - Form Number: FM-IAD-005)
√	I agree 5 marks will be deducted due to incorrect format, declare wrongly the ticked of these items, and/or any dispute happening for these items in this report.

*Include this form (checklist) in the thesis (Bind together as the last page)

I, the author, have checked and confirmed all the items listed in the table are included in my report.

_____
(Signature of Student)
Date: 10.9.2024