

AUGMENTED REALITY  
NURSERY IN HAND APPLICATION

NEESHALLINI A/P MANIMARAN

BACHELOR OF COMPUTER SCIENCE  
(GRAPHIC AND MULTIMEDIA  
TECHNOLOGY)

UNIVERSITI MALAYSIA PAHANG

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**SENIOR LECTURER**  
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Date : 12 JUNE 2023

AUGMENTED REALITY NURSERY  
IN HAND APPLICATION

NEESHALLINI A/P MANIMARAN

Thesis submitted in fulfillment of the requirements  
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## **ABSTRACT**

Growing plants may be a hobby and interest for many people but it has become a hard process in recent years as everyone is starting to live a busy life and tend to forget about their plants resulting in the plants not surviving. As a solution to this problem, this Augmented Reality (AR) application can be used by them before purchasing a plant. This AR application is very handy as it can be used from anywhere if a smartphone and flashcards are present. From this application, knowledge on how to care for the plant can be obtained and could result in longer and healthier plant life. Through this application many of those who have lost interest in growing plants could regain their interest by choosing the right plan for them as growing them is also stated to be therapeutic and releases stress. The methodology adopted in this project is the ADDIE model, which makes the project development more organized. The AR application is developed using Unity Engine and Vuforia Engine while is designed using Photoshop. The simple interface allows users to focus more on the delivered content and achieve the goals of this project. After the project is completed, there will be playtesters to evaluate the project using the User Acceptance Test (UAT).



## **ABSTRAK**

Menanam tumbuhan mungkin menjadi hobi dan minat ramai orang tetapi ia telah menjadi satu proses yang sukar sejak beberapa tahun kebelakangan ini kerana setiap orang mula menjalani kehidupan yang sibuk dan cenderung melupakan tanaman mereka yang mengakibatkan tumbuhan tidak dapat bertahan. Sebagai penyelesaian kepada masalah ini, aplikasi Augmented Reality (AR) ini boleh digunakan oleh mereka sebelum membeli sesuatu tumbuhan dan mengenali maklumat tentang tumbuhan tersebut serta penjagaan yang diperlukannya. Aplikasi AR ini sangat berguna kerana ia boleh digunakan dari mana-mana sahaja jika telefon pintar dan kad imbas hadir. Daripada aplikasi ini, pengetahuan tentang cara menjaga tumbuhan boleh diperolehi dan boleh menghasilkan jangka hayat tumbuhan yang lebih lama dan sihat. Melalui aplikasi ini ramai di antara mereka yang hilang minat untuk menanam tumbuhan boleh mendapatkan semula minat mereka dengan memilih pelan yang sesuai untuk mereka kerana menanamnya juga dinyatakan sebagai terapi dan menghilangkan tekanan. Metodologi yang digunakan dalam projek ini ialah model ADDIE, yang menjadikan pembangunan projek lebih teratur. Aplikasi ini dibangunkan menggunakan 'Unity Engine' dan 'Vuforia Engine' manakala direka menggunakan Photoshop. Antara muka yang ringkas membolehkan pengguna menumpukan lebih pada kandungan yang dihantar dan mencapai matlamat projek ini. Projek ini akan diuji dan dinilai oleh beberapa penguji menggunakan kaedah menggunakan Ujian Penerimaan Pengguna (UAT) setelah siap.

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## **LIST OF ABBREVIATIONS**

AR	Augmented Reality
3D	3 – Dimensional
GUI	Graphical User Interface
OS	Operating System
SDK	Software Development Kit
UI	User Interface
UAT	User Acceptance Test
SDLC	Software Development Life Cycle
iOS	Internetwork Operating System
MB	Megabyte
A.I	Artificial Intelligence

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

Augmented Reality (AR) is a technology that superimposes a computer-generated image over the user's perspective of the real world according to the Oxford Dictionary. AR technology dates way back to the 1960s, 1968 to be exact when Ivan Sutherland developed the first head-mounted display system. However, the term 'Augmented Reality' was not in use until 1990 when it was invented by Boeing researcher Tim Caudell. Fast forward 54 years later, technology has tremendously evolved and now is a part of everyone's life, especially those of social media users. For example, the phenomenal AR games like Pokémon GO and filters on social media such as Instagram and TikTok.

There are two types of AR which are Marker – based AR and Marker - less AR. Marker-based AR uses image recognition to recognize things that have previously been pre-programmed into your AR device or application. They can assist your AR device in determining the location and orientation of the camera by being placed in the field of vision as points of reference. In most cases, this is accomplished by converting your camera to grayscale, detecting a marker, and then comparing that marker to every other marker stored in its information bank. Once a match is made, your device utilizes that data to determine the posture and position of the AR picture appropriately. Marker-less AR is more complex since there is no fixed place for your device to focus on. Your gadget must thus be able to distinguish objects as they come into view. The gadget will first identify the object using a recognition algorithm that looks for colors,

patterns, and similar elements. Then, utilizing time, accelerometer, GPS, and compass data, it will either position itself or utilize a camera to overlay a picture of anything you want over your actual surroundings.

AR is essential because it enhances user involvement and engagement while also delivering a more immersive experience. Studies have shown that AR increases the perceived value of products and businesses. Well-executed AR activity shows the innovation and responsiveness of forward-thinking businesses. As we know, AR is being used in the majority of the sectors today including education, healthcare, and defence sectors. Therefore, it enhances interaction and perceptions in such industries. Due to its utilization in the medical sector, patient lives have been made safer. It helps with accurate disorder diagnosis and early disorder identification. The next instance relates to the military, where soldiers may utilize combat simulation games to train without risking their lives during actual combat. Additionally, it will help them by forcing them to make fundamental decisions in actual combat (RF Wireless World, 2012).

Plants in general often give a perception of calmness and having some greeneries around your surrounding also helps with good air circulation. But some people avoid having plants around them by being worried that the plant may not survive due to the high commitment it takes to nurture it and it doesn't suit their lifestyle. AR technology helps solve these kinds of problems and doubts faced by people these days who are busy with their lifestyles.

In this project, AR technology is used to scan the target image which is flashcards to reveal the information and 3D image about the plants. In this way, the user can learn about which plant suits well with their lifestyle and will not have to worry about the plant not surviving after being bought with this application, it can help them clearly understand the needs of the plant such as watering frequency, exposure to sun and the extra nutrients it requires. Once the user gets to know about all of the plants' requirements through this application, they will be wiser in their decision to pick the plant with the requirement that matches their busy schedules.

## **1.2 Problem Statement**

The traditional way of learning about plants in detail was to go visit a nursery store and get information on how to take care of them. Then it slowly evolved to looking for information about plants on the internet. Anyhow, looking up information on the internet was tough as users need to know the name of the plant they are searching for in order to obtain a precise search answer. However, these two ways of learning about plants have their respective disadvantages. With this AR technology, they can have a look at how the plant would look in a 3D view and also obtain information about it all in one platform. Moreover, people, these days have become busier with their lifestyles that they think having plants around them is a big commitment.

## **1.3 Objective**

The objectives of this project are

- i. To study existing applications related to AR plant scanners.
- ii. To develop and design an AR application related to plants.
- iii. To evaluate the effectiveness and functionality of the developed AR application using the User Acceptance Test (UAT).

## **1.4 Scope**

- User Scope:
  - i. Universiti Malaysia Pahang (UMP) students
- Development Scope:
  - i. Software: Unity, Vuforia and Adobe Photoshop
  - ii. Hardware: Laptop, Android Smartphone

## **1.5 Thesis Organization**

This thesis consists of five chapters. Chapter 1 shall discuss the introduction of the project which includes the introduction, problem statements, and objectives.

Chapter 2 discusses the literature review of three existing game applications, descriptions, and comparison of game applications for landscape gardening.

Chapter 3 discusses the methodology that will be used to develop the project. For this project, the ADDIE methodology will be implemented. The stages that are used in this project are Analysis, Design, Develop, Implementation and Evaluation. All the phases as well as the tasks involved will be discussed here.

Chapter 4 explains the result and discussion based on the development and testing of this project. In this chapter, all the results and outputs of the project are briefly discussed. This includes the game development, testing, collecting data and result of the project.

Chapter 5 concludes and summarizes the result of the project. The limitation and further works were discussed thoroughly in this chapter.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

Chapter 2 explores the different applications of virtual reality in the field of landscaping. Three existing virtual reality applications in tourism were thoroughly examined in terms of their Graphical User Interface (GUI), Mobile Operating System (OS), the language provided, connection type, type of augmented reality used, size of the application, the main function of the application, the advantages, and disadvantages of the augmented reality application. This comparison of the existing application suggests the strength and effectiveness of the existing application, allowing this project to produce a better version of the application.

#### **2.2 Existing Systems**

In this section, three existing augmented reality applications in plant scanning will be reviewed. These three applications are Candide - For plant lovers, Picture This - Plant Identifier and Plant Scan - Identification.

##### **2.2.1 Candide - For plant lovers**

This application allows users to get to know about a wide range of plants. Users of this application can post inquiries, images and stories about their plants. They can also see other plants which can be found in the area where they are staying or inquire about a plant. The app's descriptions of the plants contain intriguing information,

categorization by science, symbolism, and more. Planting difficulty, planting seasons, soil needs, watering frequency, and other details are provided in the care instructions.

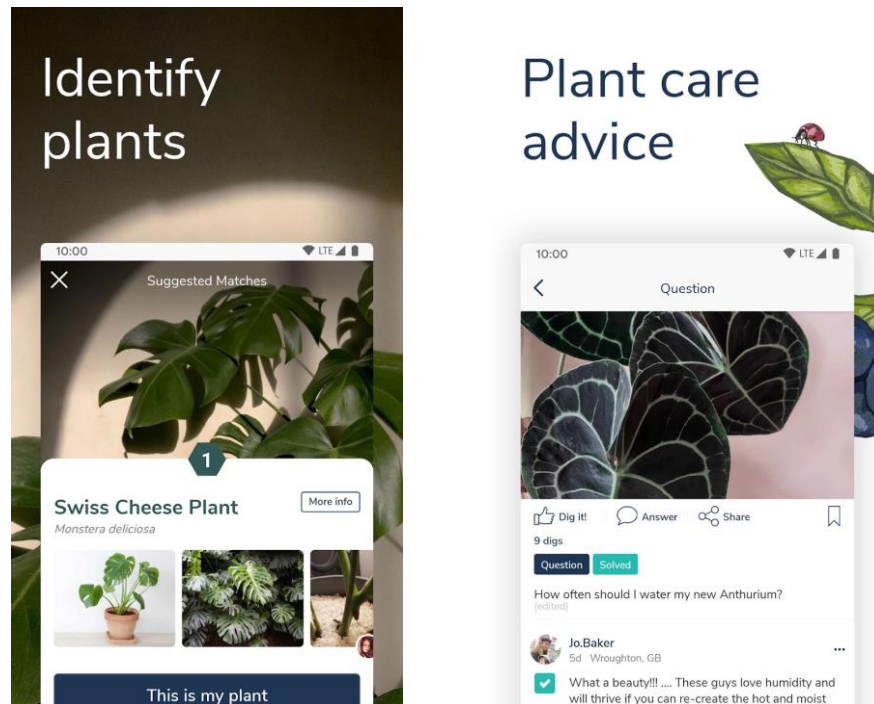


Figure 2.1: Example Candide - For plant lovers' interface

### 2.2.2 Picture This - Plant Identifier

Picture This - Plant Identifier is a computerized plant encyclopedia that recognizes flowers, trees, succulents, cacti, mushrooms, herbs, shrubs, and grasses. The app includes 10,000 distinct varieties of plant species. Find a plant or flower, position the camera, and take a shot after granting the app permission to use the device's camera. The software will quickly identify the object and suggest alternatives that the plant may be in a few seconds. The app's descriptions of the plants contain intriguing information, categorization by science, symbolism, and more. Planting difficulty, planting seasons, soil needs, watering frequency, and other details are provided in the care instructions. The free edition comes with a few initial free credits



for taking pictures of a few plants. For infinite credits, users can subscribe to a premium account that costs money.

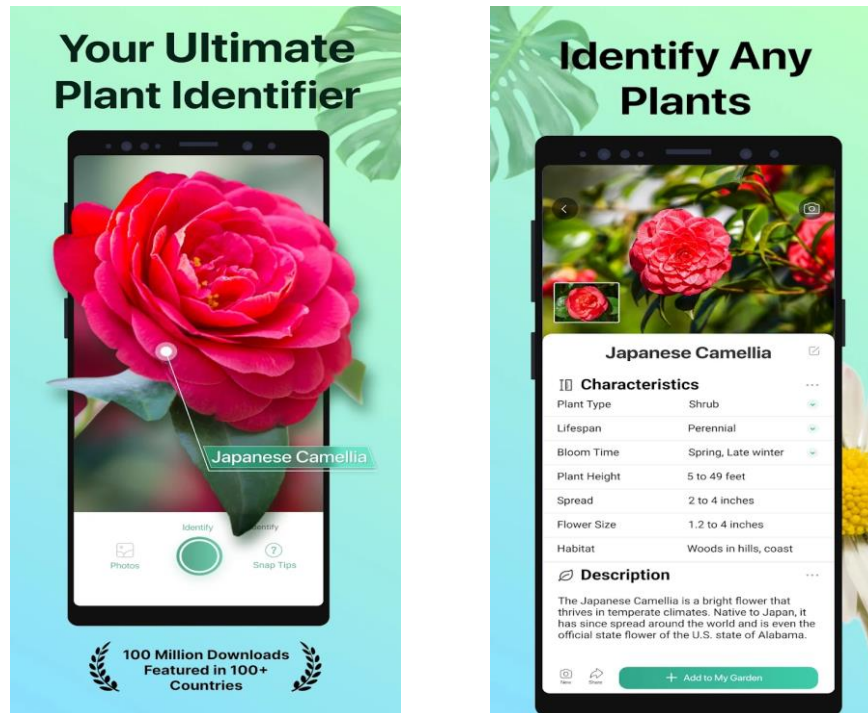


Figure 2.2: Example of Picture This - Plant Identifier's interface

### 2.2.3 Plant Scan - Identification

Plant Scan – Identification allows users to scan various types of families, genera and species including plants, bushes, trees, flowers, fruits, vegetables, nuts, mushrooms, cacti, and more. This application allows users to get to know about a wide range of plants. Users of this application can also add animated AR insects and birds in addition to real-time scanning just by touching the screen.

**Identify any Plant, Flower, Bush,  
Tree, Fruit, or Vegetable**  
Simply hold your Device up, No having to Take a Photo required!

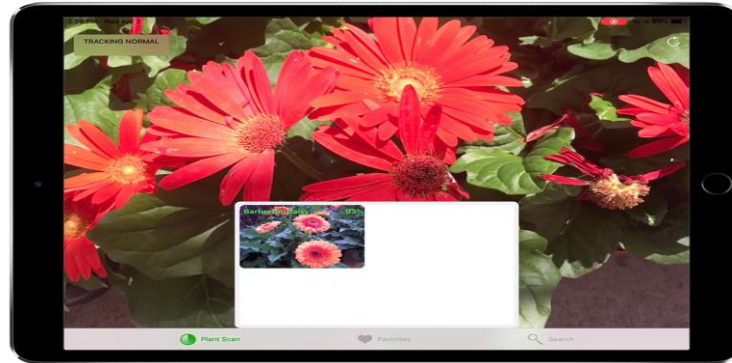


Figure 2.3: Example of Plant Scan - Identification interface

### **2.3 Analysis/ Comparison of Existing System**

Based on the review done earlier, Table 2.1 shows the comparisons of three existing virtual reality applications. Eight elements are used for comparison as GUI, OS, the language provided, connection type, type of augmented reality used, size of the application, the main function of the application, and the advantages and disadvantages of the application.

### 2.3.2 Analysis of comparison on existing system.

Table 2.1 Comparison between existing game applications

<b>Application name</b>	<b>Candide - For plant lovers</b>	<b>Picture This - Plant Identifier</b>	<b>Plant Scan - Identification</b>
<b>GUI</b>	The interface is attractive, with an attractive background and a well-organized layout.	The interface is beautiful with an attractive background and is well organized.	The interface is well organized and the background is colorful.
<b>OS</b>	Requires Android 5.0 and up	Requires Android 5.0 and up	Requires iOS 14.0 or later.
<b>Type of Connection</b>	Online	Online	Online
<b>Language Provided</b>	English	English	English
<b>Type of AR</b>	Marker-based	Marker-based	Marker-based
<b>Size of application</b>	33 MB	42 MB	201.3 MB
<b>Function</b>	1. Provides Identify button to scan the plant. 2. Provides a Share button to share doubts about the plant in the application.	1. Provide a Home button to navigate to the home page. 2. There are three more buttons which are Diagnose button, My Plants button and a More button.	1. Provides three buttons which are the scan button, favourites button and search button respectively.

<p><b>Advantage</b></p>	<p>1. The user can learn about many new plants as there are posts from other users.</p> <p>2. User can ask questions and receive replies from the members of the application.</p>	<p>1. Provides instructions on how to use the application and each button.</p> <p>2. Provides a wide range of identification for other nature things.</p>	<p>1. Provides information about a large range of plants.</p>
<p><b>Disadvantage</b></p>	<p>1. Users must log in to the application to identify a plant and also interact with the application.</p>	<p>1. Users must log in to the application</p>	<p>1. Accurate information cannot be received.</p>

### **2.3.3 Relevance of comparison with project title**

In this project, the proposed application is an online AR application that will help target users who are Universiti Malaysia Pahang (UMP) students and are interested in growing plants. This application will have a simple interface that will allow the user to experience AR marker-based plant scanning with ease. The user can scan flashcards which will contain images of plants and after scanning user can gain information about the plant and the language of the application will be English, which is an international language and most used among people. Moreover, the interface will also be colorful to attract users' attention and the user will be excited with this application.

## **2.4 Summary**

The summarized findings from this chapter are that the user UI must be simple, compact, well-organized, and well-color coordinated. Besides the UI, the language of the application and also functions are important because a user who does not understand the language of the application cannot use it and the function, instructions and navigation must be appropriate for the application so that it doesn't confuse the user and complicate the understanding of the application.

## **CHAPTER 3**

### **METHODOLOGY**

#### **3.1 Introduction**

A methodology is a set of methods, principles, and guidelines for overseeing a project. It can assist in obliging, developing a common language, and gaining a better grasp of project management. It assists in minimizing risk, limiting duplication of effort, and subsequently increasing the project's impact. A methodology has definitions, regulations as well as templates that need to be followed by the developer to produce a successful project. Through this, a common ground would be established for the developer to develop the project. Using methodology will help to establish a useful project framework that divides the project development process into multiple phases.

The techniques and procedures utilized for project management have an impact on the effectiveness of any project. The Software Development Life Cycle (SDLC) refers to the process of developing an information system, which involves appropriate analysis, design, implementation, and maintenance (The FAS Solutions, 2010). It assists developers and researchers in identifying techniques, development phases, and the structural flow between different phases of the project. Different SDLC approaches are advantageous for various sorts of projects. Developers commonly employ software development models such as the Agile model, Iterative model, Waterfall model, Rapid Application Development (RAD) model, Analyse, Design, Develop, Implement, and Evaluate (ADDIE) model, and others. These models divide the development process into phases, and they all begin with an analysis of the project's requirements, followed

by a design of how the system should appear, followed by development and implementation. Following the completion of the development phase, developers or researchers will conduct testing or evaluation, and ultimately, they will revise the product.

### 3.2 Project Management Framework ADDIE MODEL

For this project, the SDLC model that was chosen is the ADDIE model. The ADDIE model is a general technique that instructional designers and training developers have frequently used. The ADDIE model involves five phases which are the analysis, design, development, implementation, and evaluation phase. These phases serve as a continuous, dynamic basic framework for developing successful training and performance support systems. This model is suitable for this project because it focuses on a step-by-step approach to completing the project. Besides that, the ADDIE model is also meant to be a flexible and interactive model which also provides a clear picture of the continuous workflow from each phase. To achieve a well-developed project, all phases in the ADDIE model need to be completed. Thus, these developers can trackback their work from a phase if changes are required. Figure 3.1 below gives an illustration of the ADDIE model.

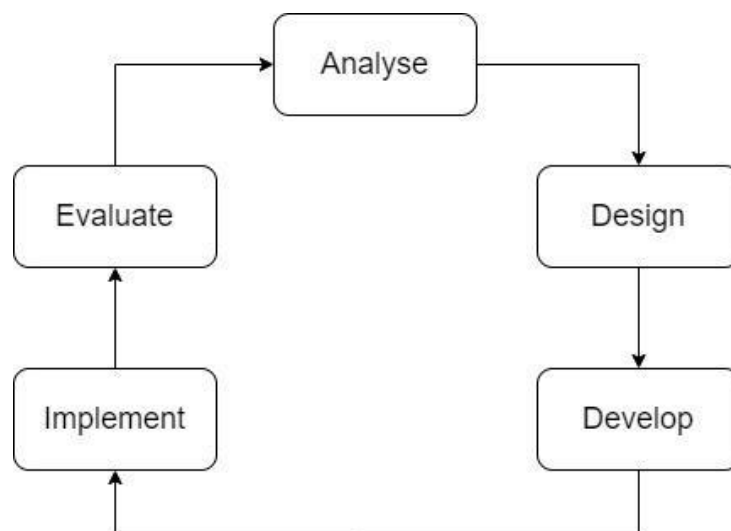


Figure 3.1 ADDIE Model

The ADDIE model begins with the Analysis phase, in which the developer examines the current situation to determine where everything stands and what needs to be done. During this phase, the developer should determine the project's objectives and the primary issue. Additionally, the developer must be able to identify all audience requirements and develop a design that meets all of them. The developer must also determine the project's scope during the analysis phase. In addition, the developer of this project must conduct research regarding the target audience, the product's desired outcomes, the project's deadline, the platform in which it will be delivered, and how the system will meet the requirements.

The following stage in the ADDIE model is the designing stage where each of the information is accumulated during the examination stage and fosters very educated choices on the learning project's development. The designing stage is an exceptionally essential stage that requires additional regard for subtleties and hence is very tedious. The Plan ease helps us with clear and brief data about the targets, material design, data or abilities required, and appropriate devices. Engineers are likewise prescribed to do a storyboard as it will help the designer see better and furthermore accelerate the cycle.

The third stage in the ADDIE model is the improvement stage where the designer begins fostering the genuine framework. In this stage all thoughts structure the planning stage that has been finished should be coordinated in the advancement, for example, happy outwardly, making designs, recording recordings, cautiously choosing textual styles and tones, etc. In this stage, testing is vital, in creating a framework that should be tried completely.

The following stage in the ADDIE model is the implementation stage where the designer does check and guarantees the undertaking is working. In this stage, it is guaranteed every one of the modules is joined to prepare a total task to be conveyed to the crowd.



In the final phase of the ADDIE model which is the evaluation phase where the project should be evaluated to see if there are any errors and if the project is functional. In this phase, surveys are done to receive audience feedback.

### 3.3 Project Requirement

The ADDIE model was chosen for this project as it is well organized and has a systematic approach to it. In addition to that, this model is done from phase to phase which then gives developers a clear workflow. Through this, developers can avoid unnecessary mistakes in the project. Figure 3.2 explains the details that are done in each phase of the ADDIE model.

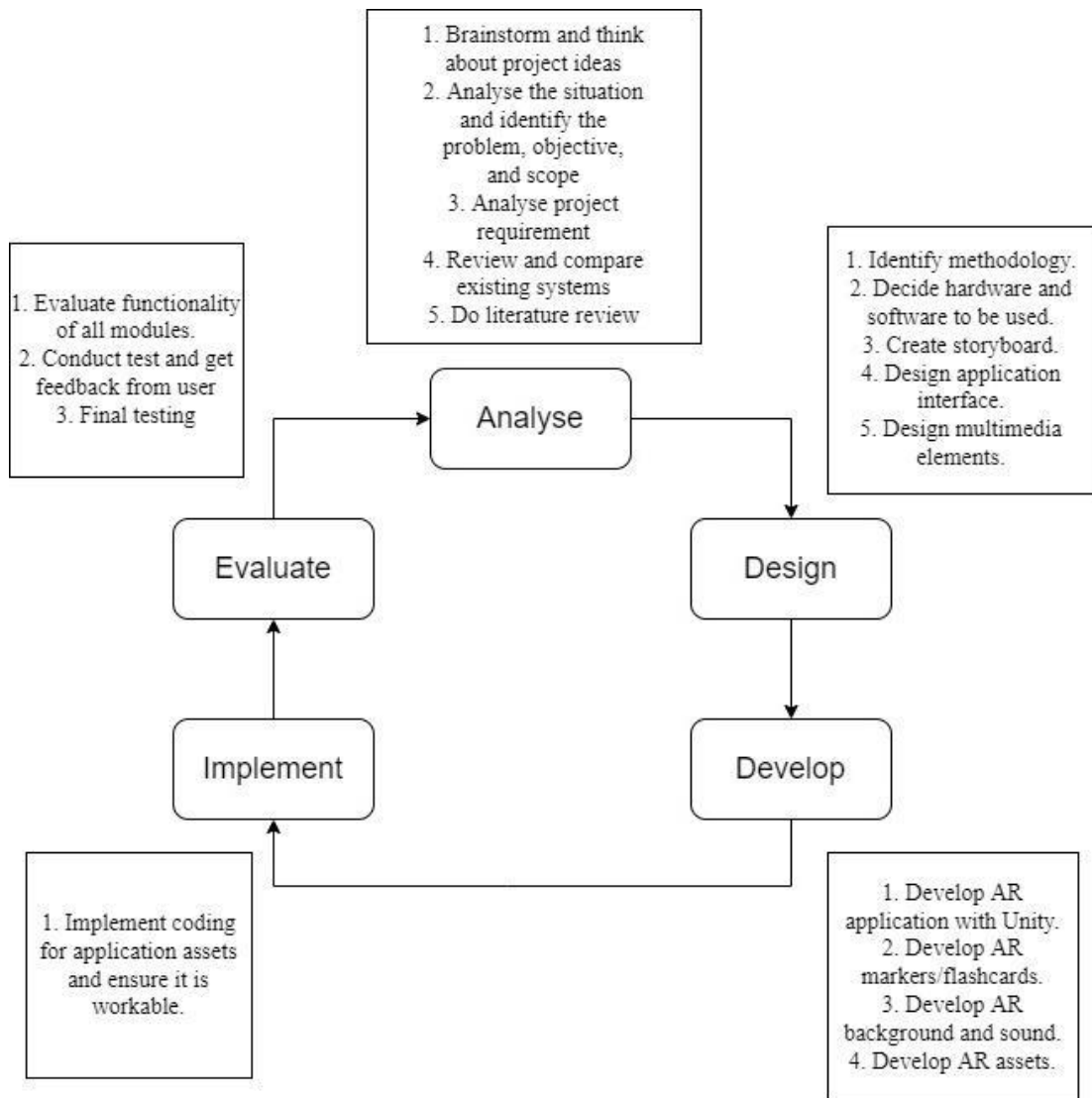


Figure 3.2 Proposed Task Framework for project ADDIE model

### **3.3.1 Analysis**

In this project, the analysis phase was done by generating ideas, determining the problem, and creating a remedy to help mitigate the problem's impact. First and foremost, a thorough study has been done regarding the background of the issue, mainly about the difficulties in growing a plant. The problem statement then was completed by making the conclusion and explaining the difficulties that can be highlighted. The objectives were then completed by outlining the project's goal and how it will assist the situation. The project's expectations and limits were outlined in scope. Furthermore, the literature review was done by studying different systems of plant scanner augmented reality applications. Three existing augmented reality systems in plant scanning were thoroughly examined in terms of their GUI, OS, the language provided, connection type, type of augmented reality used, size of the application, the main function of the application, and the advantages and disadvantages of the application. The functional and non-functional needs as well as the constraints and limitations are compiled into a list of project requirements, which are shown below.

### **3.3.2 Design**

The design phase is to create the structure of this project. The information in the Analysis phase is used to develop this project that meets the client's needs. The system's design is based on the requirements collected from the user of this system. System designing must be built based on the criteria and make sure it is user-friendly and easy to use. This system will allow users to learn about plants in the Augmented Reality environment. Users will learn about plants interactively by pointing the device at the printed poster, then a beautifully rendered 3D will pop up on the screen. Users can see the animation of the marker representation.

### **3.3.3 Development**

The production of the project starts in the Development phase. In this phase, the data collected from the previous stages will be utilized to create the application that can deliver the requirements. In the development phase, it is important to make sure the development activities are moving along the timeline of the project. This is to assure that the project can be done on time and that the requirements, as well as the objectives of the project, are fulfilled. During this phase, multiple software will be used such as Unity, Adobe Photoshop, and Vuforia engine to create different elements in the application. Examples of the elements are the AR feature itself and graphics.

### **3.3.4 Implementation**

The implementation phase is a process of presenting the system that has been developed to the client. The system will be tested in terms of concept and material. The system will be viewed by the testers for testing. This is to identify any error or any update that should be carried out to the system. Respond from the testers' users will be recorded.

### **3.3.5 Evaluation**

The evaluation phase is divided into two part which is Formative and Summative evaluations. All stages of phases in the ADDIE model present formative evaluation. Evaluation is presented in every decision that has been made up. Summative evaluation is made for the user after the application is successfully completed. Any improvement or change in the application is based on the feedback and measures of the effectiveness of this application. User Acceptance Test (UAT) is used to observe user reaction. If the project did not achieve the objective, the application needs to be redone.

### **Functional Requirements**

- The user should be able to use the AR application easily.
- The user should be able to interact with the system.
- The application should have appropriate buttons for users to navigate the application.
- The application should be able to scan the target image by using a camera application.
- The user should be able to view all media in the system.
- The language of the system should be available in English.

### **Non-Functional Requirements**

- The system should load within 5 seconds after starting up.
- The system should be able to access anytime by the user.
- The system should be easy to use and user-friendly.
- The application should be able to recognize the target image in less than 10 seconds upon scanning.

### **Limitations and Constraints**

- This application can only be used on smartphones.
- AR features in this application will only be activated with specific target markers (flashcards).

### 3.4 Propose Design

#### 3.4.1 Flowchart

A flowchart is used to represent the workflow of the process. Figure 3.1 shows the flowchart of the AR Nursery In Hand Application.

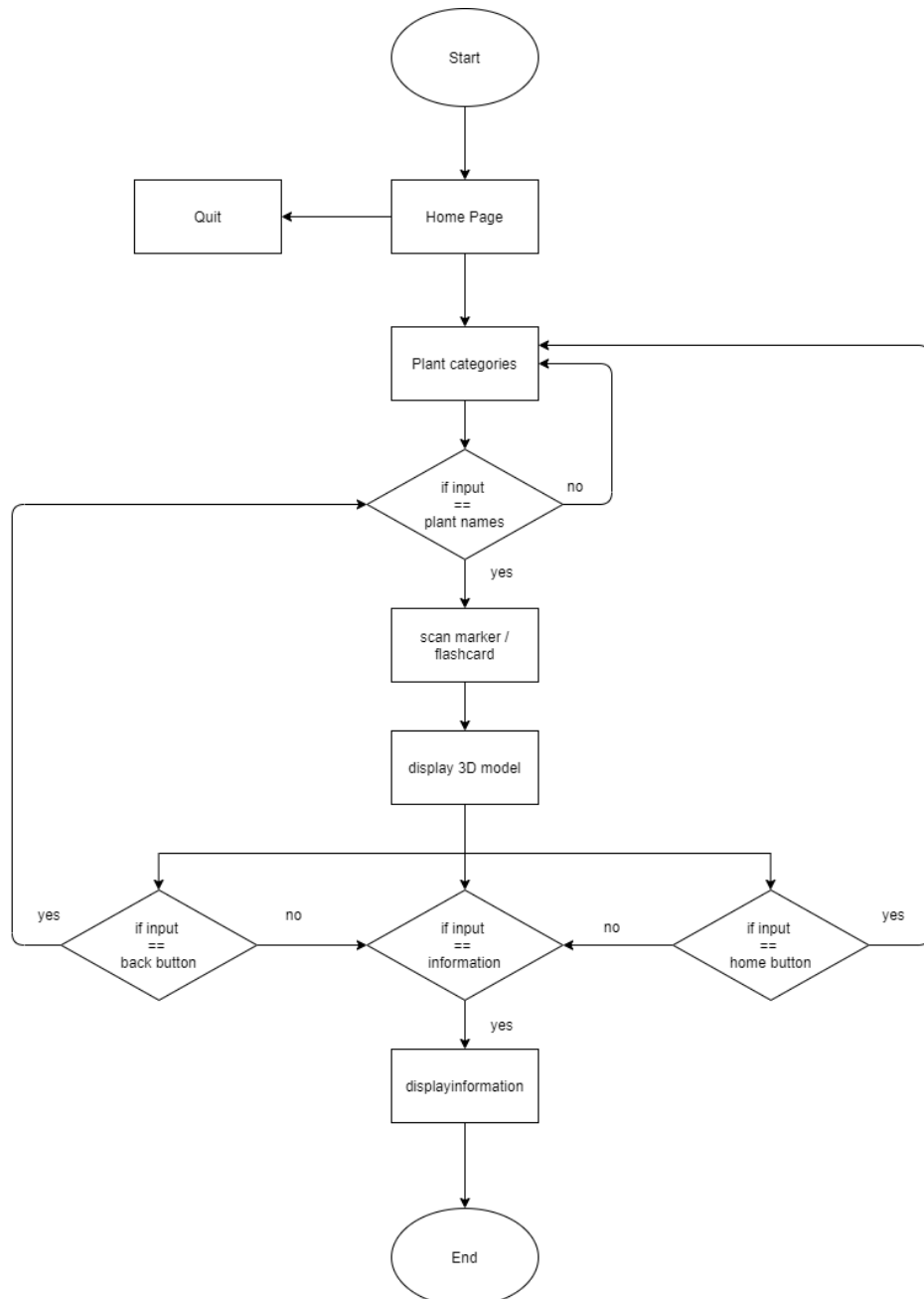


Figure 3.3 Flowchart of AR Nursery In Hand Application

### 3.4.2 Context Diagram

The user is one of the primary components of the context diagram. The user component allows users to engage with the system in a variety of ways. The user can view a 3D image of the object and gain information about it. When the user is in the environment, the user can start and stop the AR application. Figure 3.4 below gives an illustration of the context diagram of the AR Nursery In Hand Application.

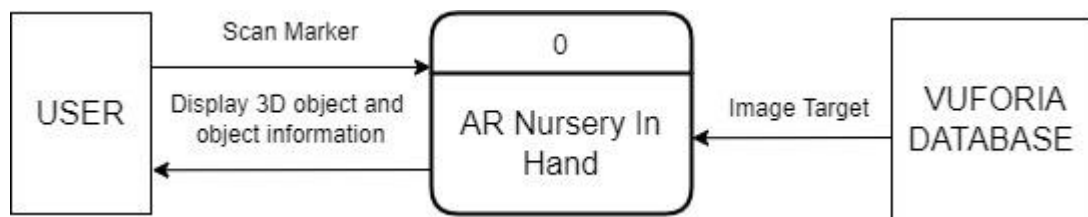


Figure 3.4 Context Diagram of AR Nursery In Hand Application

### 3.4.3 Use Case Diagram

Figure 3.5 shows the use case diagram of the AR Nursery In Hand Application. The use case diagram describes the relationship between the user and the system. After the user loads the application, the user can scan the marker or flashcard to view the 3D model. After scanning the marker or flashcard, a 3D model will pop up on the screen.

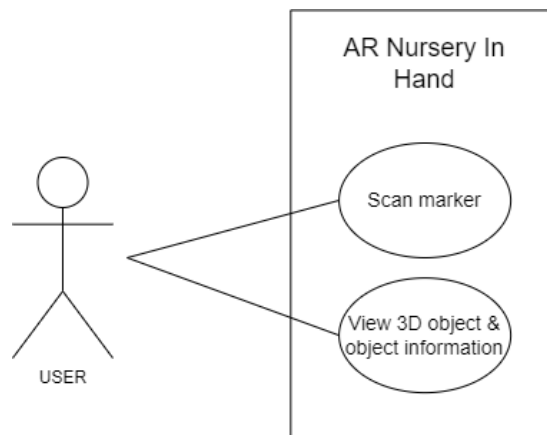


Figure 3.5 Use Case Diagram of AR Nursery In Hand Application

### 3.4.4 Activity Diagram

Figure 3.6 shows the activity diagram of the AR Nursery In Hand Application. The activity diagram represents the flow of actions, processes or workflow within a system. In the activity diagram below, actions and processes between the user and application is shown.

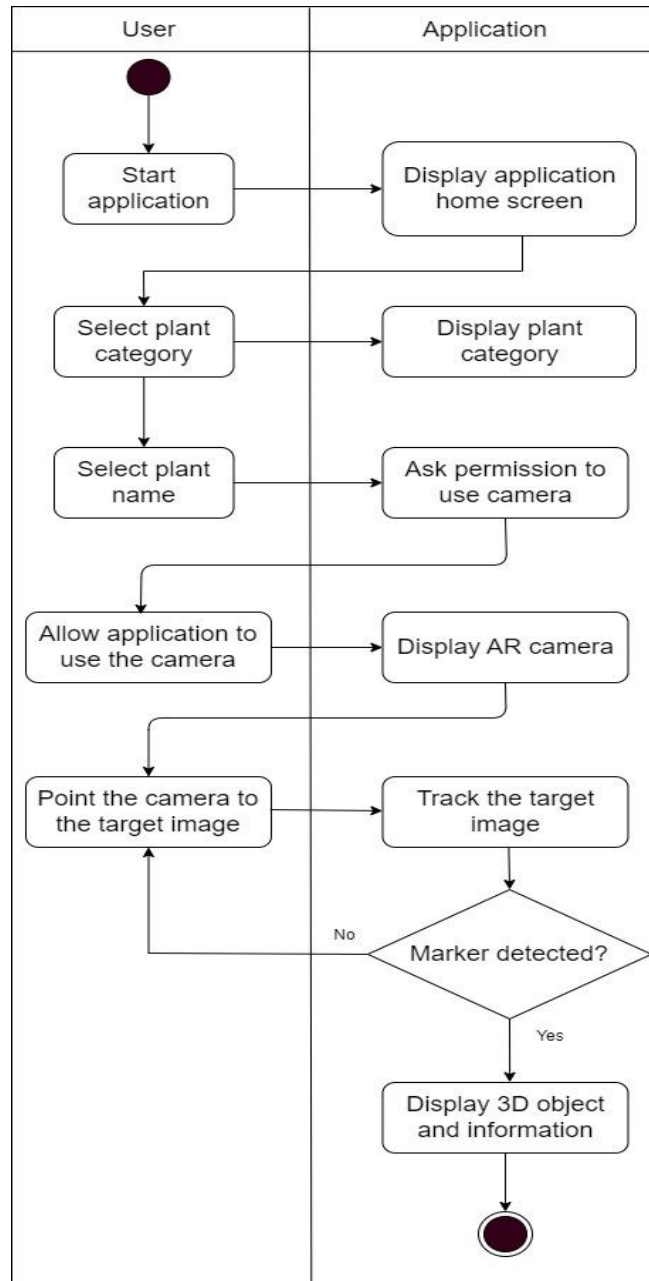


Figure 3.6 Activity diagram for the application



### 3.4.5 Storyboard

Table 3.1 Storyboard of the home page

<b>Screen title:</b>	Home page
<b>Layout:</b>	01
<b>Screen layout:</b>	<div data-bbox="756 573 1174 1281" data-label="Image"></div> <p>Figure 3.7 Home page UI</p>
<b>Screen Description:</b>	This page is the home page of the application. There are two buttons which are the plant category button and the quit button. When the user clicks on the plant category button it navigates to view the categories of plants available. If the user clicks the quit button, it will close the application.

Table 3.2 Storyboard of the plant category page

<b>Screen title:</b>	Plant category page
<b>Layout:</b>	02
<b>Screen layout:</b>	<div data-bbox="742 454 1198 1384" data-label="Image"> </div> <p data-bbox="730 1420 1206 1451" style="text-align: center;">Figure 3.8 Plant category choices UI</p>
<b>Screen Description:</b>	This is the plant category page of this application. Users can choose any one category of plant at a time to be viewed which will direct them to the page containing plant names.

Table 3.3 Storyboard of plant choices page

<b>Screen title:</b>	Plant choices page
<b>Layout:</b>	03
<b>Screen layout:</b>	 <p>Figure 3.9 Plant names UI</p>
<b>Screen Description:</b>	This is the plant choices page of the application. Users can choose any one of the plants and will be directed to the scanning page.

Table 3.4 Storyboard of scan page


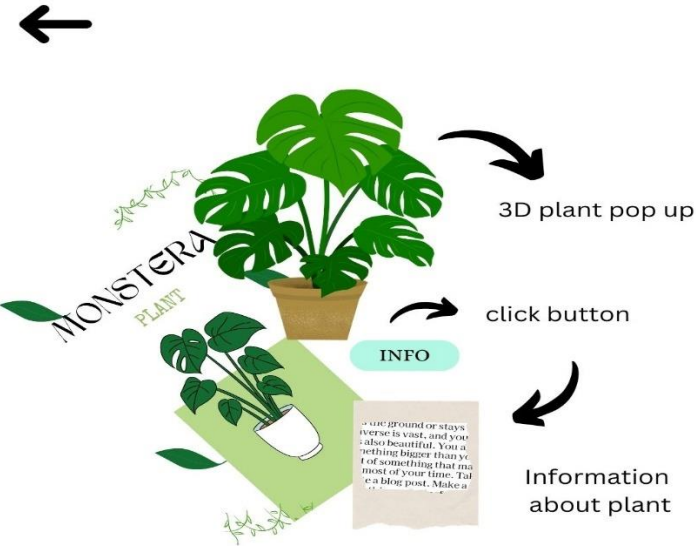
<b>Screen title:</b>	Scan page
<b>Layout:</b>	04
<b>Screen layout:</b>	 <p>The image shows a smartphone screen with a scanning interface. A central white square frame contains a Monstera plant in a white pot on a green base. Above the plant, the text 'MONSTERA' is written in a large, bold, black font, and 'PLANT' is written below it in a smaller, green font. The frame is surrounded by a black border with four corner markers, indicating the scanning area.</p>
<b>Screen Description:</b>	This page shows the scan page of this application. Once the scan page is opened, the target image can be scanned.

Figure 3.10 AR camera scan UI

Table 3.5 Storyboard of the pop-up screen page

<b>Screen title:</b>	Pop-up screen
<b>Layout:</b>	05
<b>Screen layout:</b>	 <p style="text-align: center;">Figure 3.11 Pop-up screen UI</p>
<b>Screen Description:</b>	This page shows the pop-up screen page of this application. This screen will display the 3D image of the scanned target image and display information about the plant and how to take care of the plant.

### 3.5 Data Design

Unity was used to develop this application, and a software development kit (SDK) called Vuforia Engine is used with Unity to enable Augmented Reality. Vuforia is a web-based application to build and manage target databases. In this context, the images that will be on the flashcards are the target marker. This way, when the application's camera pans to the flashcard, whether digital or printed, it will scan and find the target marker. As a result, when the media is scanned, it will appear on the target marker.

### 3.6 Proof of Initial Concept

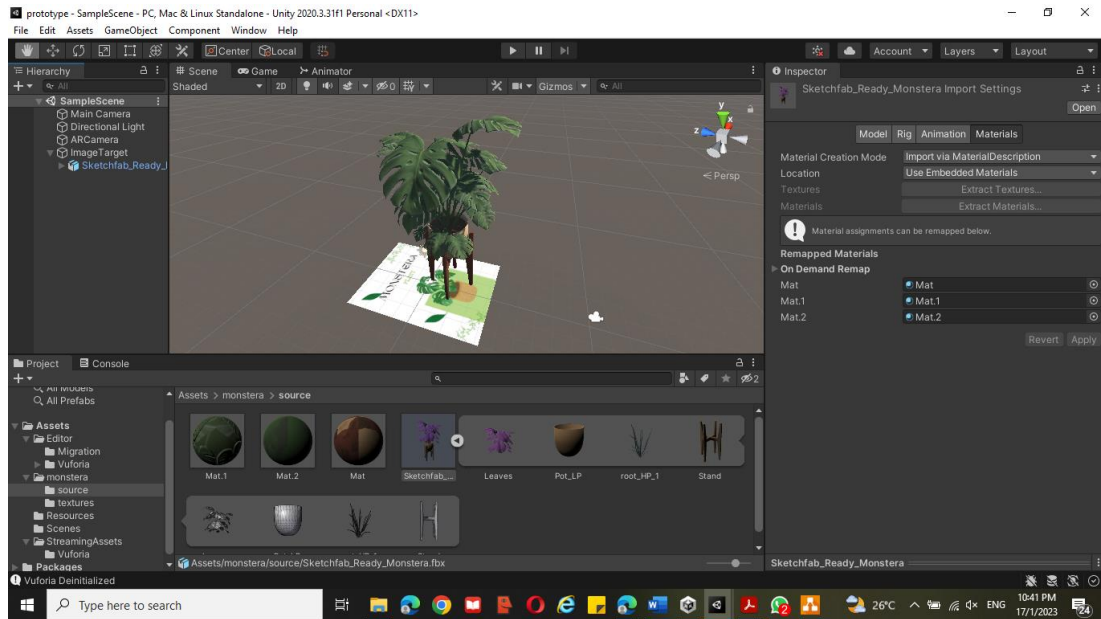


Figure 3.12 Proof of initial concept

For the proof of concept, I have added a marker and target image to Unity Engine with Vuforia Engine. This will enable the 3D plant and information to pop up once the target image is scanned.

### 3.7 Testing/Validation Plan

In this phase, two types of evaluation will be conducted which are formative and summative evaluation. Formative evaluation will be done by evaluating the whole application to make sure there are no bugs or errors present. Other than that, final testing will be done by the target users as well as final maintenance. This testing will be done through the User Acceptance Test (UAT) to make sure the application works perfectly well and adhere to the requirements. After ensuring the application is free from bugs, it can be published. Table 3.7.1 shows the sample UAT questionnaire that will be given to the users during this phase.

Table 3.6 User Acceptance Test (UAT)

Score rate: -

1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

No.	UAT Requirement	1	2	3	4	5
1	The AR interface is creative.					
2	The AR interface is attractive.					
3	The 3D models in the application are great to view.					
4	The information about the plants is easy to understand.					
5	The application is easy to navigate.					

### 3.8 Potential Use of Proposed Solution

Users of this application will be able to view the plant in 3D and learn more about it. Users have the option of seeing plants that are suitable indoors, outdoors, or both. In each of the three choices, there will be a selection of plants accessible, and users may also learn about the care and environment the plant requires as growing plants requires dedication, this will guarantee the user the precise requirements their plant needs. This application is designed to be available on smartphones, so users can use this application anywhere anytime just by scanning the right target image.

### 3.9 Gantt Chart

# Nursery In Hand

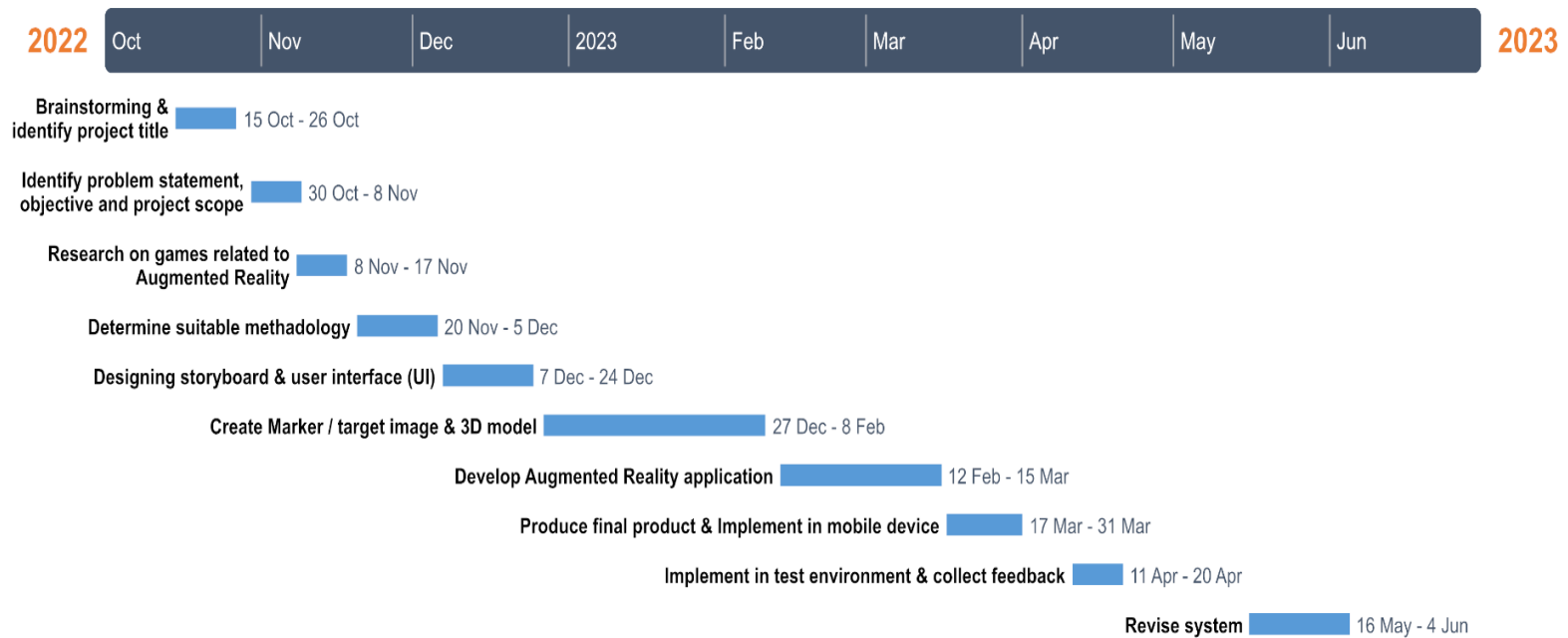


Figure 3.13 Gantt Chart



## **CHAPTER 4**

### **IMPLEMENTATION, RESULT AND DISCUSSION**

#### **4.1 Introduction**

Chapter 4 discusses the development, implementation and testing of the Augmented Reality Nursery In Hand Application. The target marker, interface, 3D models, text, and animation are among the important components that were utilized in the project's development. Visitors to a nursery will be able to use this application. The testing application was used to find the possible error, and it was fixed immediately.

#### **4.2 Implementation Process**

The implementation process entails keeping track of all of the steps that go into creating an Augmented Reality Nursery In Hand Application. A mobile device with an augmented reality camera is used in the application. It also comes with a bunch of markers that the user can scan by pointing the AR camera at the target marker. The user can view animations, 3D models, and other augmented reality content on the target marker.

##### **4.2.1 Development of marker**

The first step in building this application is to create image markers. The image markers created will be used to display the 3D models, animation, and text. There are 21 image markers involved in this augmented reality application which consists of

plants from four categories which are herbs, trees, shrubs, and climbers. These image markers were created using Adobe Photoshop.



Figure 4.1 Target images of trees plant category



Figure 4.2 Target images of climber plant category



Figure 4.3 Target images of herbs plant category



Figure 4.4 Target images of shrubs plant category

After designing the markers, all the markers need to be uploaded and saved in Vuforia Target Manager Database. To upload the markers, a login process is needed as shown in Figure 4.5. After creating a new database as shown in Figure 4.6 and Figure 4.7, a new image target needs to be created to be uploaded as markers as shown in Figure 4.8. The database later will use in developing the AR application. After uploading all markers in Vuforia, the database package will be downloaded in Unity Editor and imported into the Unity project as shown in Figures 4.9 and 4.10

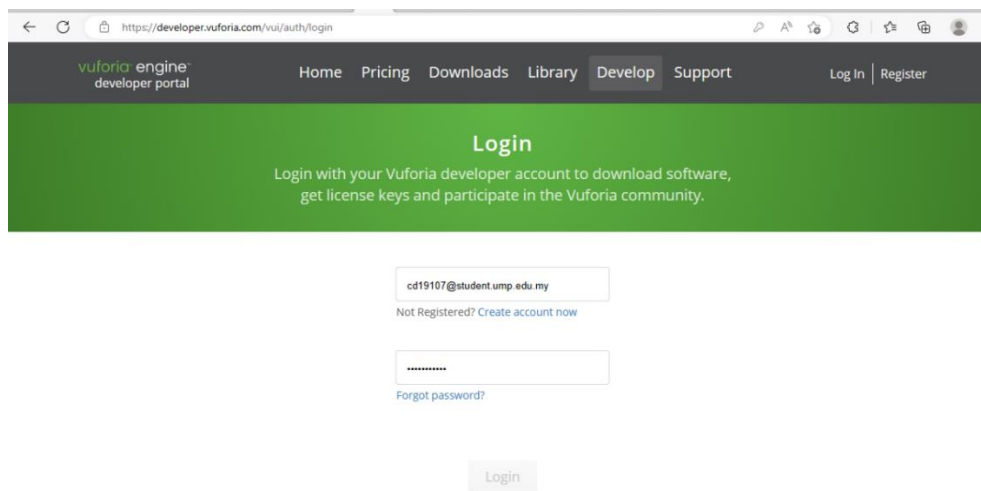


Figure 4.5 Open Vuforia Developer Portal

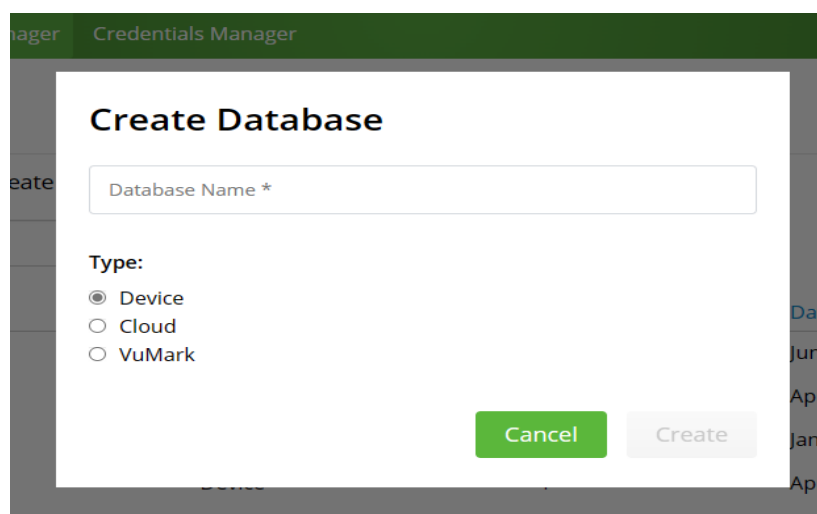


Figure 4.6 Create a new database in Vuforia Developer Portal

## Target Manager

Add Database


Use the Target Manager to create and manage databases and targets.


Database	Type	Targets	Date Modified
ARInterfaceMarker	Device	3	Jun 18, 2022
herbs	Device	6	Apr 26, 2023
prototypeMarker	Device	9	Jan 31, 2023
shrubs	Device	4	Apr 29, 2023
trees	Device	6	Apr 29, 2023


Figure 4.7 Add database in Vuforia Developer Portal


### Add Target

**Type:**

  
Image

  
Multi

  
Cylinder

  
Object

**File:**

.jpg or .png (max file 2mb)

**Width:**

Enter the width of your target in scene units. The size of the target should be on the same scale as your augmented virtual content. Vuforia uses meters as the default unit scale. The target's height will be calculated when you upload your image.

**Name:**

Name must be unique to a database. When a target is detected in your application, this will be reported in the API.

Figure 4.8 Add new image target

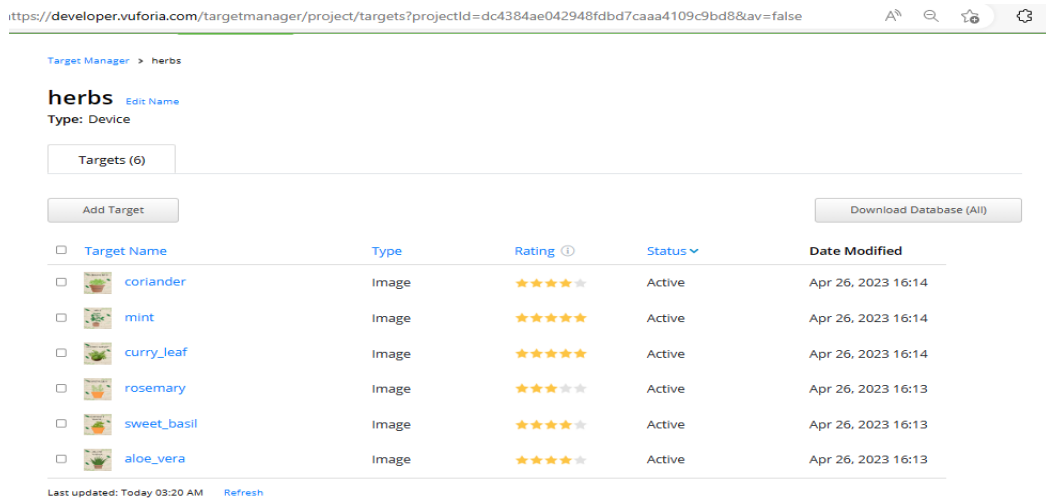


Figure 4.9 Select all markers to download

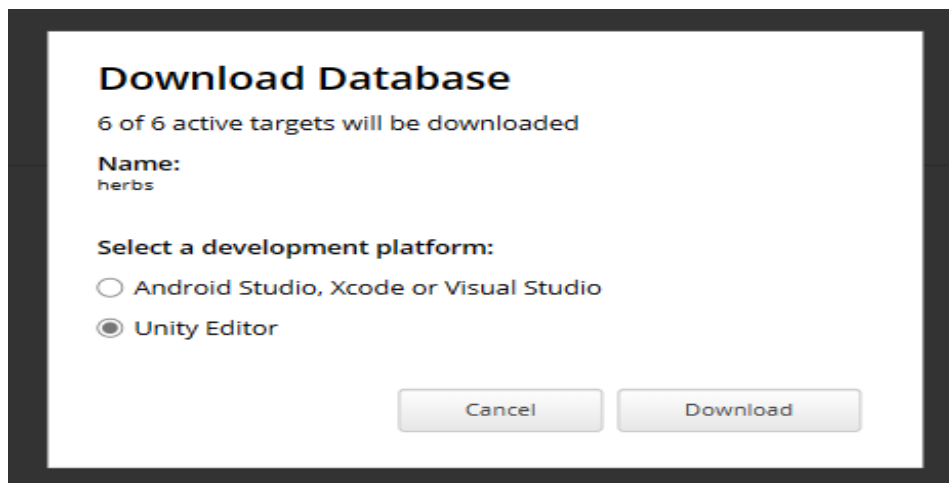


Figure 4.10 Download image target in Unity Editor

## 4.2.2 Development of 3D models

For this process of the application, all of the 3D models were downloaded from an online platform which is Sketchfab. The 3D models were downloaded in either FBX or OBJ formats. The 3D models were downloaded in these respective formats as other formats could not be used in the Unity Engine. The 3D models were exported successfully in Unity software for the development of the application. After exporting, editing, and texturing were done in Unity software to make sure the target images and 3D models match each other.

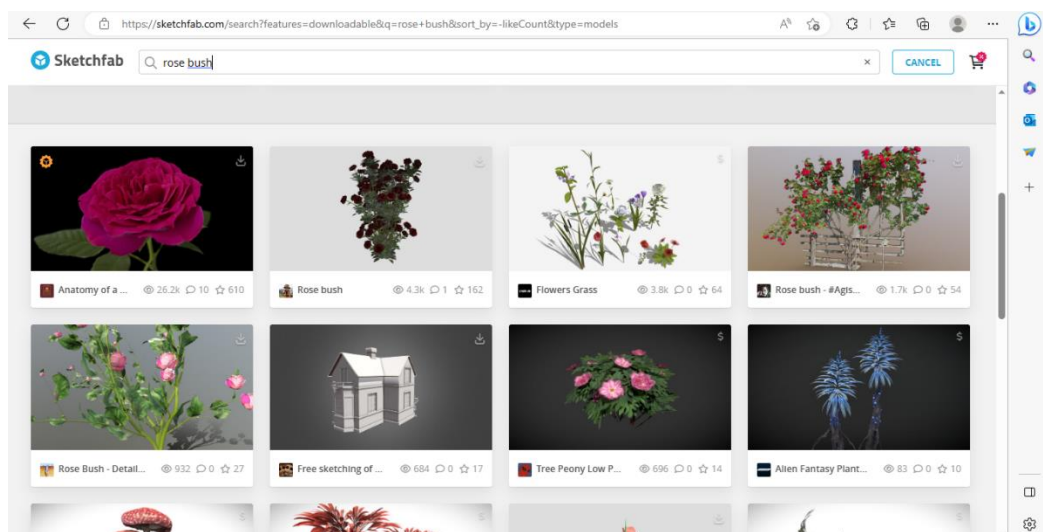


Figure 4.11 The website for 3D models

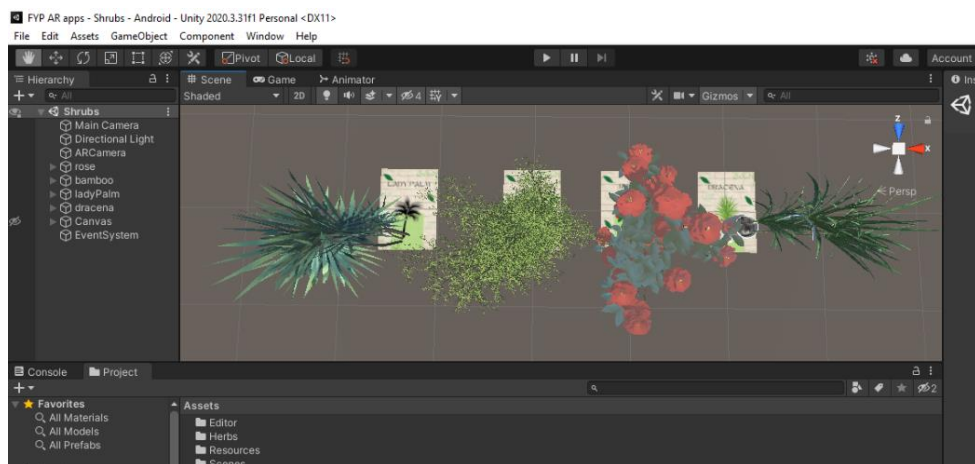


Figure 4.12 3D models exported

### **4.2.3 Development of the application**

Unity software may be used to create applications when the necessary 3D assets have been created. Because Unity can build the project on the Android mobile application platform, it is one of the programs used to develop applications in this project. also, unity may be utilized to create AR features using the Vuforia SDK. Install the Vuforia Software Development Kit (SDK) alongside Unity.

A license key is required to copy into the AR camera configuration in the project for the AR Camera to be operational. A license key may be obtained through the licensing manager in the Vuforia Developer Portal.

Once the procedure is complete, Unity software may be used to begin the project's development. All the target markers and 3D models required to construct an AR environment must be imported into Unity. Following completion of the editing procedure, the project must be converted into an Android platform-compatible APK file.

### **4.2.4 Application of interface**

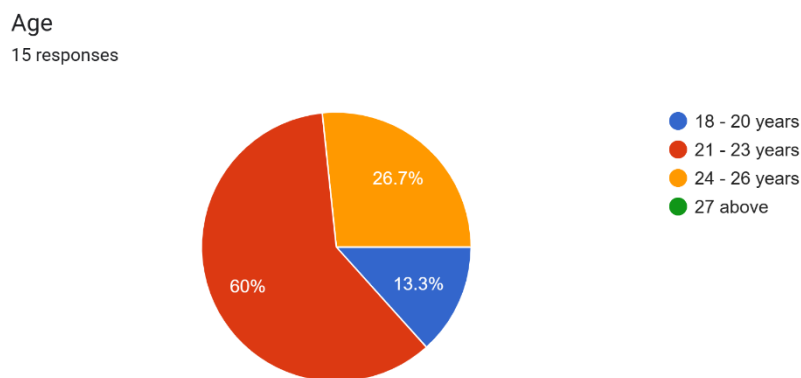
The AR Nursery In Hand application can be accessed after it has been successfully installed on the device. On the scene, the AR Nursery In Hand application screen will be followed by a unity splash screen.

### 4.3 Testing and Result Discussion

The testing phase is used to assess the application's usability and efficacy once the development process is complete. The application's level of testing is determined using the User Acceptance Test (UAT) Form. The user tests the application on a personal device (Vivo V20SE) and a set of feedback forms will be distributed to gather application-related feedback as well as opinions to further improvements (refer to APPENDIX A). From the distributed UAT, 15 responses have been collected.

#### 1. Age group of respondents.

Based on Figure 4.13, most of the respondents are from the age group of 21 – 23 years old which is 9 respondents (60%). For the age group of 24 – 26 years, 4 respondents have answered (26.7%) and 2 respondents (13.3%) for the age group of 18-20 years have answered respectively.

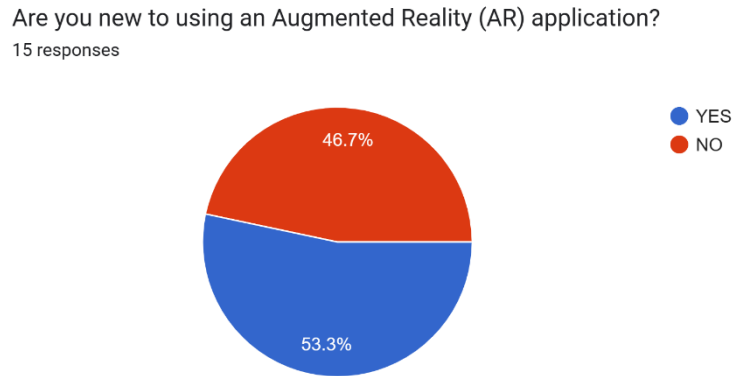


4.13 Age group of respondents for AR Nursery In Hand Application



## 2. Experience in using an AR application.

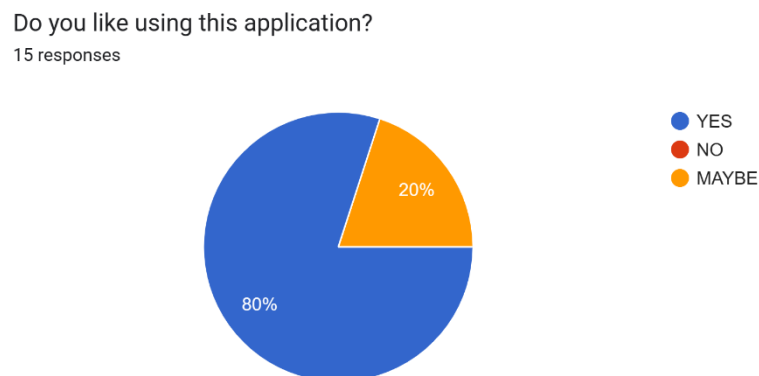
Figure 4.14 shows that almost 8 respondents (53.3%) are new to using an AR application whereas 7 respondents (46.7%) already have experience in using them.



## 4.14 Experience of respondents in using an AR application for AR Nursery In Hand Application

### 3. Do you like using this application?

Figure 4.15 shows that the majority of respondents like using the AR Nursery In Hand Application which is 12 respondents (80%) and only 3 respondents (20%) have responded maybe.

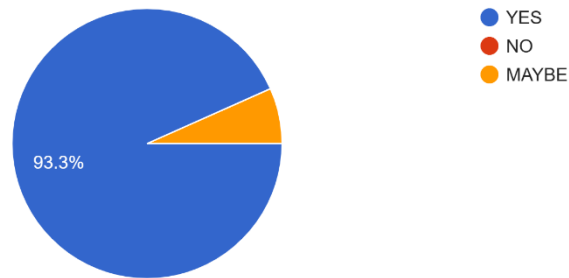


## 4.15 Likeness of respondents towards AR Nursery In Hand Application

#### 4. Was the app intuitive and easy to navigate?

Based on diagram 4.16, 14 respondents (93.3%) answered yes and only 1 (6.7%) respondent answered maybe to the question was the app was intuitive and easy to navigate.

Was the app intuitive and easy to navigate?  
15 responses

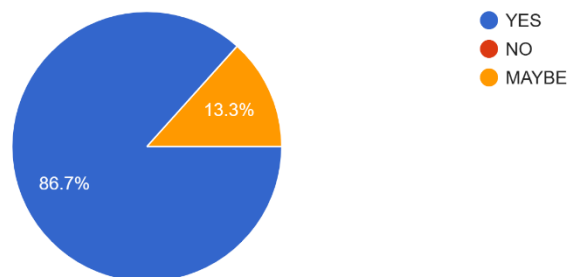


#### 4.16 Intuitiveness and easy navigation of AR Nursery In Hand Application

#### 5. Did the AR feature work well and enhance your experience with the plants?

Based on diagram 4.17, 13 (86.7%) respondents have responded that the application works well and has enhanced their experience with getting to know about plants whereas 2 (13.3%) respondents have answered maybe.

Did the AR feature work well and enhance your experience with the plants?  
15 responses

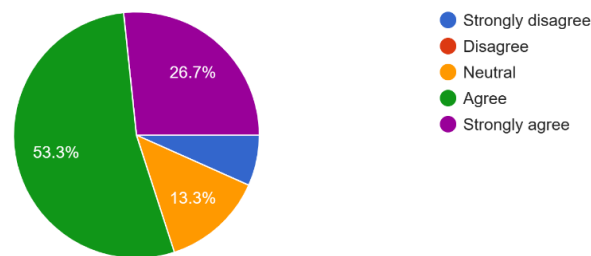


#### 4.17 Experience of using the AR Nursery In Hand Application

6. Was the information provided about the plants accurate and helpful?

Based on diagram 4.18, 8 (53.3%) respondents have agreed that the information provided about the plants is accurate and helpful. 4 (26.7%) respondents strongly agreed whereas 2 (13.3%) respondents have a neutral response and only 1 respondent strongly disagreed that the information provided about the plants is not accurate and not helpful.

Was the information provided about the plants accurate and helpful?  
15 responses

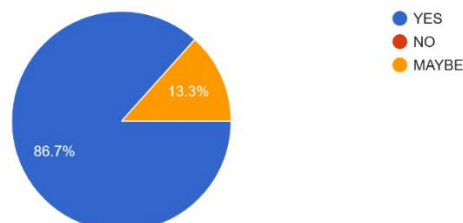


#### 4.18 Accurateness and helpfulness of information provided in the AR Nursery In Hand Application

7. Did you find the app to be engaging and enjoyable to use?

Based on diagram 4.19, 13 (86.7%) respondents have responded that the application works well and has enhanced their experience with getting to know about plants whereas 2 (13.3%) respondents have answered maybe.

Did you find the app to be engaging and enjoyable to use?  
15 responses

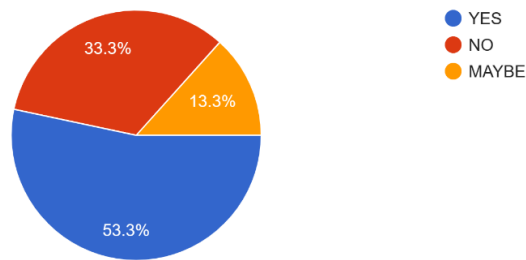


#### 4.19 Engaging and Enjoyability of the AR Nursery In Hand Application

8. Was the app responsive and fast, or did you experience lag or delays?

Based on diagram 4.20, 8 (53.3%) respondents have responded that the application is responsive, fast and did not experience any delays whereas 2 (13.3%) respondents responded maybe and 5 (33.3%) respondents responded that they experienced less responsiveness and delays in the application.

Was the app responsive and fast, or did you experience lag or delays?  
15 responses

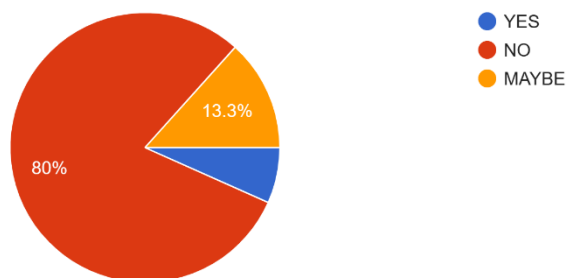


#### 4.20 Responsiveness of the AR Nursery In Hand Application

9. Did you encounter any technical issues while using the app?

Based on Figure 4.21, 12 (80%) respondents did not encounter any technical issues while using the application while 2 (13.3%) respondents responded maybe, and 1 (6.7%) respondent encountered technical issues while using the app.

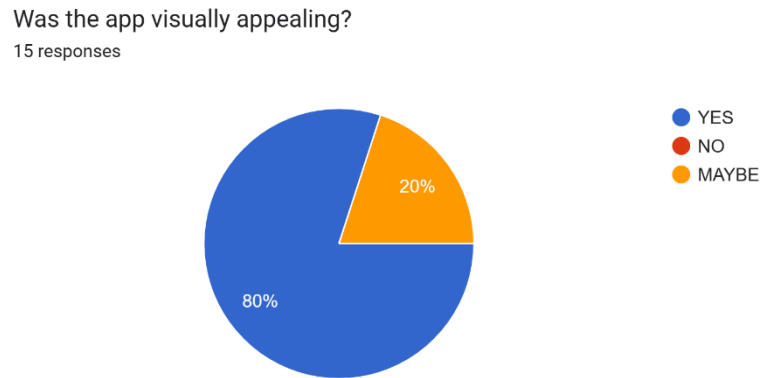
Did you encounter any technical issues while using the app?  
15 responses



#### 4.21 Technical issues encountered while using the AR Nursery In Hand Application

#### 10. Was the app visually appealing?

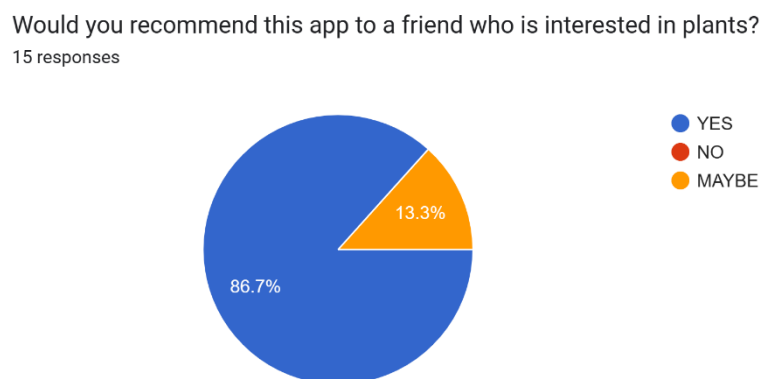
Figure 4.22 shows that majority of the respondents responded yes, the application is visually appealing which is 12 respondents (80%) and only 3 respondents (20%) responded maybe.



#### 4.22 Visual appeal of the AR Nursery In Hand Application

#### 11. Would you recommend this app to a friend who is interested in plants?

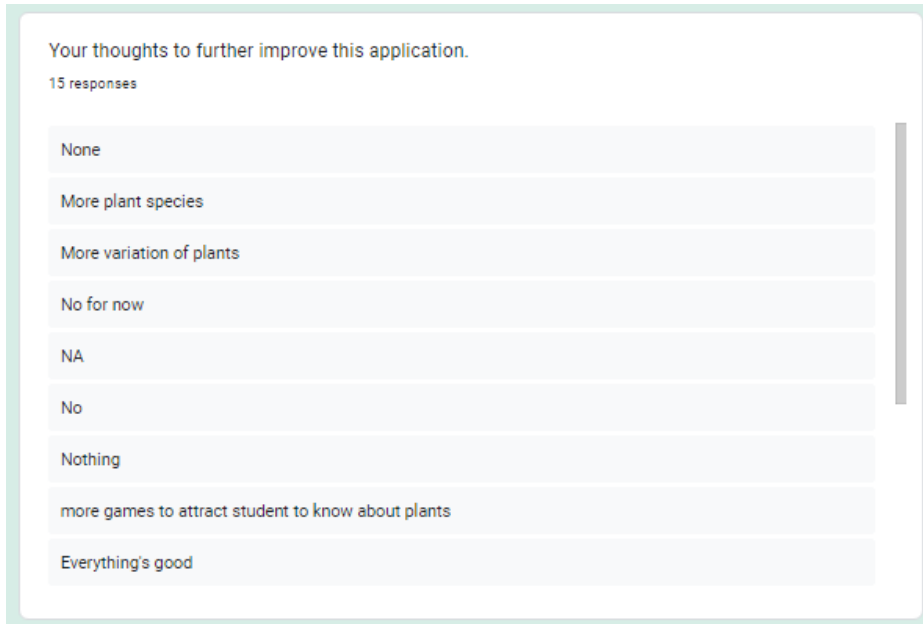
Based on Figure 4.19, 13 (86.7%) respondents have responded that they would recommend the application to friends whereas 2 (13.3%) respondents responded maybe.



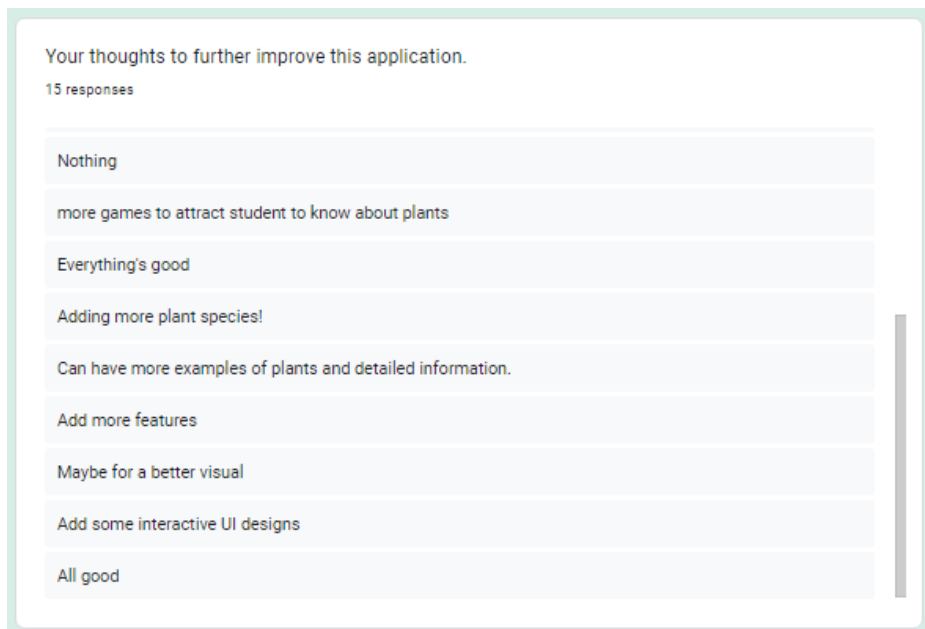
#### 4.23 Recommending the AR Nursery In Hand Application to friends

12. Your thoughts to further improve this application.

Figures 4.24 and 4.25 shows responses for the thoughts respondents have to improve the application in the future.



4.24 Thoughts to further improve the AR Nursery In Hand Application



4.25 Thoughts to further improve the AR Nursery In Hand Application

## **CHAPTER 5**

### **CONCLUSION**

#### **5.1 Introduction**

The findings of creating an Augmented Reality Nursery In Hand Application will be compiled in Chapter 5 in order to accomplish the objectives and address the problems stated in Chapter 1's problem description. Since some people lack the time of researching the best plant for them, this application is a great platform for them. This application contains a 3D image of the plant, rotation animation and an information pop-up screen which contains key points of plant care easing the user in finding the best plant for them. Software used to develop this application is Unity, Vuforia and Autodesk Maya. The ADDIE methodology is followed in developing this application as it can save development time and cost in creating the application. The results of the assessment procedure show that students give good feedback and that the goals of the application are met.

## **5.2 Research Constraint**

The constraints faced throughout the project completion are as below:

i. Limited time

The time limitation resulted in only being able to create four categories of plants and not more. The categories covered in the application are climbers, herbs, shrubs and trees.

ii. Development constraints

Markers uploaded in the Vuforia Developer Portal have to be of good quality. If the markers uploaded do not achieve two stars, the AR camera cannot detect it accurately. Therefore, the markers uploaded need to be of good quality.

iii. Single marker trackers only

In this project, only one marker can be scanned or tracked at a time. This is because once every marker is scanned and the 3D image pops up, there will be a button to view the information about the plant. If multiple markers are being tracked, it will disturb the information that will be displayed.

## **5.3 Future Work**

The Augmented Reality Nursery In Hand Application can be improved in the future in certain ways such as:

- I. Developer can make this application to be available on all types of Android platforms and iOS versions.
- II. Developer can provide more categories and choices of plants.
- III. Developer can add an activity section to test the understanding of user about the plant.



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## APPENDIX A

### USER ACCEPTANCE TEST (UAT) FORM




**Augmented Reality Nursery In Hand Application**

Hello and Good Day, I'm Neeshalini Manimaran, a final year Graphics and Multimedia Technology student from the Faculty of Computing, Universiti Malaysia Pahang. I would like to collect feedbacks on the Augmented Reality Nursery In Hand Application that you have used earlier.

Really appreciate your time and cooperation in answering the following questions. Thank You!

Image title



Age \*

- 18 - 20 years
- 21 - 23 years
- 24 - 26 years
- 27 above

Are you new to using an Augmented Reality (AR) application? \*

- YES
- NO

Do you like using this application? \*

- YES
- NO
- MAYBE

Was the app intuitive and easy to navigate? \*

- YES
- NO
- MAYBE

Did the AR feature work well and enhance your experience with the plants? \*

- YES
- NO
- MAYBE

Was the information provided about the plants accurate and helpful? \*

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Did you find the app to be engaging and enjoyable to use? \*

- YES
- NO
- MAYBE

Was the app responsive and fast, or did you experience lag or delays? \*

- YES
- NO
- MAYBE

Did you encounter any technical issues while using the app? \*

- YES
- NO
- MAYBE

Was the app visually appealing? \*

- YES
- NO
- MAYBE

Would you recommend this app to a friend who is interested in plants? \*

- YES
- NO
- MAYBE

Your thoughts to further improve this application. \*

Short answer text

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