MOBILE-BASED AUGMENTED REALITY COOKING APPLICATION

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This report is submitted in partial fulfilment of the requirement for the Bachelor of Computer Science (Interactive Media) With Honours.

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DEDICATION

To all those who have supported, encouraged, challenged and inspired me especially my beloved parent, and friends for all their guidance, attention which has made it possible for me to make it up this point. I am grateful to my supervisor, Pn.Shahrul Badariah Bt Mat Sah, whose expertise, understanding, generous guidance and support made it possible for me to work on topic that was of great interest to me. It was a pleasure to be supervised by her. Thank you.

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A million thanks to **Pn Shahrul Badariah binti Mat Sah** for helping and guidance me through endless obstacles, the true success of beating the odds really pushes my knowledge boundary even further.

Also a million thanks to my dear father and mother for the support and strong encouragement and motivation throughout this project. To all of heroes or should I be called friends really play a big role for my project who are directly or indirectly in providing ideas and suggestions. All the guidance, advice and guide I will never forget. Hopefully, this project was conducted to get the blessing from God.

ABSTRACT

This project is capable to merging, virtual and real worlds together have new possibilities in improving new quality of teaching and learning activity. This application is using Mobile Augmented Reality as an alternative medium to learn cooking in dynamic way. Moreover, this application can be another medium to deliver content from plain text to augmented reality.

ABSTRAK

Projek ini mampu untuk menggabungkan maya dan dunia sebenar, dimana gabungan ini mempunyai kemungkinan baru dalam meningkatkan kualiti pengajaran dan aktiviti pembelajaran. Aplikasi ini menggunakan elemen “Augmented Realiti” sebagai saluran alternatif untuk belajar memasak dengan cara yang dinamik. Selain itu, aplikasi ini menjadi satu lagi medium untuk menyampaikan kandungan daripada teks biasa dengan maklumat tambahan yang menggunakan elemen “Augmented Reality”.

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LIST OF ABBREVIATIONS

3D	**-**	**Three-Dimensional**
AR	**-**	**Augmented Reality**
API	**-**	**Application Programming Interface**
ID	**-**	**Identification**
SDK	**-**	**Software Development Kit**
VR	**-**	**Virtual Reality**
QR	**-**	**Quick Response**
2D	**-**	**Two-Dimensional**
GPS	**-**	**Global Positioning System**
HMD	**-**	**Head-Mounted Display**
WWW	**-**	**World Wide Web**
IDE	**-**	**Integrated Development Environment**
CMS	**-**	**Content Management System**

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Augmented Reality(AR) takes an image of real world and superimpose it with new information. It is new technology that mix real world with computer generated objects. In contrast with virtual reality, augmented reality overlays new information on top of the existing environment and rather than creates a totally artificial environment. Augmentation is conventionally in real-time and in semantic context with environmental elements that being captured by computer-generated sensory input such as sound, video, graphics or GPS data. Nowadays, the advance AR technology can turn the information about the surrounding real world of the users into interactive and digitally manipulable.

An AR technology should allow a human user to easily and naturally interact with objects in both the real and virtual world. Current globalization era proves that most of the people now own their own smartphone or similar gadgets. You can say that today's generation rely almost everything on their smartphone and seems like important thing in their daily live. Mobile augmented reality has already attracted a great deal of positive feedbacks and also negative feedbacks in equal measure despite of being one of new technology. It is work by overlaying digital information onto the real world, viewed through a camera phone.

Under supervision of Madam Shahrul Badariah Mat Sah, this project will create Mobile-based cooking application with using augmented reality technology. User will get view the printed cooking book dynamically by the additional element of AR in this application. User can get clearer visualization on how to cook by viewing the graphics and videos that could be found in the appliaction. All the users have to do is scan the image in the printed cooking book with using this application and the AR elements will be display.

1.2 Problem Statements

According to the latest trends around the world, it is proved that people nowadays likely to use applications in their smartphones. Even reading novels or books can be done by just installing the application to the phones. Sometimes, the printed books are hard to carry around especially the books that are thick and heavy but with using smartphones, the user only have to use their phones which normally people will carry with them wherever and whenever they go. The applications seem to be more convenient than print books. Purchasing and installing an application can take place in a matter of seconds and these books are often priced less expensively than print copy books.

The application revolution is leaving no sphere of life untouched, not even the kitchen. With the advance features on today's smartphones, it does not take a genius to realize that a good smartphones or other gadgets with the right apps can make such a handy digital cookbook. Such application will not only be useful for home cooks but also for the professional chefs discover and organize recipe. Cooking apps are the next step in the complete mobile takeover, offering step-by-step instructions detailing how to make a certain recipe, curate a weekly meal plan, or even tell when your apple is perfectly ripe.

The print books can only offered static pictures and graphics while using the application, the user can understand more deeply and get clearer vision on what they going to cook with the videos and some graphics that are normally provided in the cooking applications. This project will create new dimension of cooking application as it will be using augmented reality (AR) technologies elements in it. In contrast with the normal cooking books that provide static instructions of cooking, this project will create an application that will provide a non-linear way method which allows the user to perform interaction with the mobile-based AR cooking application.

1.3 Objectives

This task sets out on the accompanying targets:

1. **To create a user-friendly mobile-based AR application that can help user in cooking.**
   Static images will be presented to the user through the printed cooking book. In this project, the images contain hidden information and the information can only be retrieve once the user applies the AR application on it.

2. **To integrate printed cooking book with mobile-based AR application.**
   In order for better imagery detection, special cooking book with marker will be printed solely for this system. The final product will be able to overlap generated info with the cooking book.

3. **To compare the effectiveness between using printed cooking book and mobile-based augmented reality application.**
   One of the ways to transmit information by using linear medium is printed cooking book. The lack of the transmitting information through this medium is that the information conveyed is limited. By the help of augmented reality, the information can be transmited by using a non-linear method which allows the user to perform interaction with the cooking book. As the result, more interesting and effective way of distribution information produced.

1.4 Scope

1.4.1 Target audience

The target audience for this project is individuals without any culinary experience attempt to learn how to cook that own an android smartphone.

1.4.2 Themes

The Malay cuisine will be the focus of this project as the main theme of the cooking book.

1.4.3 Platform

This project will be developing in mobile-based Android platform.

1.5 Project Framework

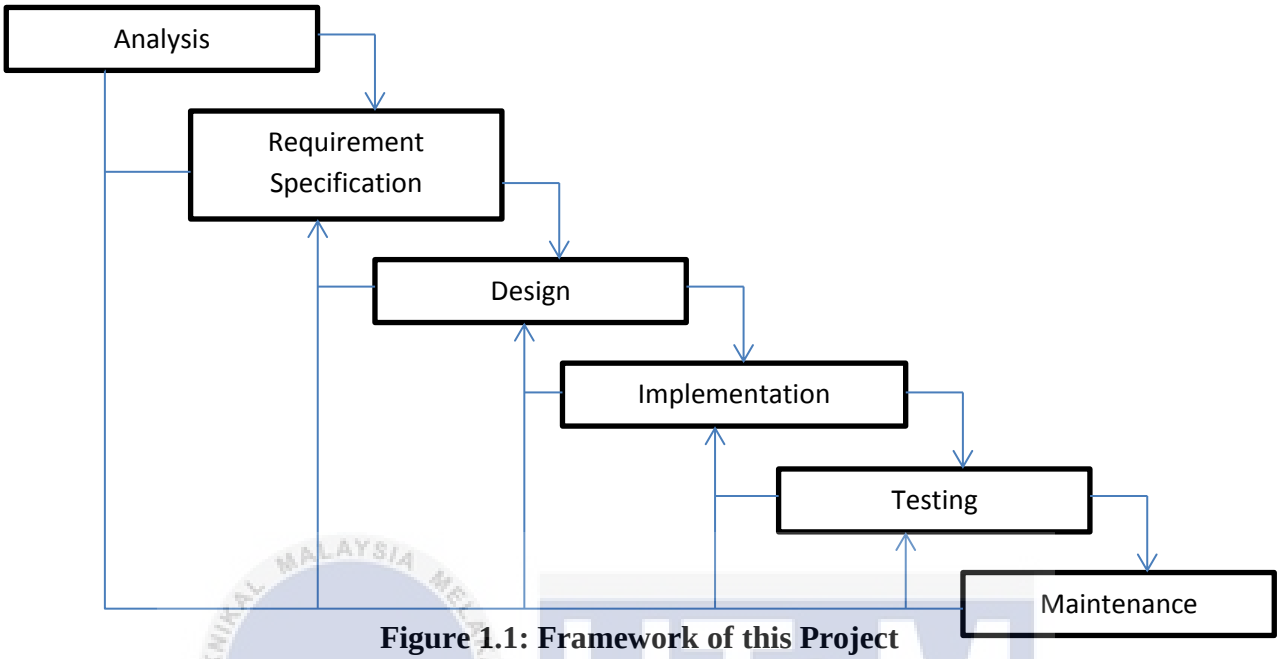


Figure 1.1: Framework of this Project

This project will be using cyclic waterfall model that consist of 6 phases throughout the development process. Firstly, the data about the research topic and analysis the data will be gather in the analysis phase. The requirement specification phase will determined user requirements and equipment requirement. The art work and modeling design are being deal in the design phase while development phase will be implementing the complete art work and applying augmented reality elements on them. A phase where the product being tested with the target user and take in their review towards the application is called testing phase. Lastly, maintenance phase will be updating the product based on the review given.

The details of the process will be discussed further in Chapter 3.

1.6 Project Significant

This project will provide exposure to user that augmented reality can guide them cook in dynamic and more understanding way. In order to attract audience interest in cooking, mobile-based augmented reality cooking application provide easy step by step cooking tutorials and other interactions where they can learn and feel the pleasure.

1.7 Expected Output

The normal result of this venture is a user-friendly mobile-based cooking application with using dynamic augmented reality elements.

1.8 Conclusion

In this chapter, we will get review and understanding about mobile applications as new way to help and guide people to cook replacing the old way that is printed cooking books. The focus of the project is to produce a mobile-based augmented reality application with a suitable content for cooking. In the next chapter, it would be a discussion about type of content that being use by other mobile cooking applications.

CHAPTER 2

LITERATURE REVIEW

This chapter will deliberate the basic concept of augmented reality in aspects of definition and also other issues related with it. Other than that, this chapter will also be covering on the term of cooking and method implementing augmented reality features in the application. Here, existing systems are compared to view functionality and area where AR can be implemented.

2.1 Introduction

Augmented Reality (AR) is new technology that is used to create reality-based interface that can be used in various industries and consumer markets. AR is a combination of real world with computer-generated objects that that exist side by side in the same space. Milgram and Kishino (1994) describe that AR is one part of the general area of mixed reality.

Several studies have shown that there can be various types of technologies could be created by using AR. Krevelen and Poelman (2010) claimed that borders of universal adopting Augmented Reality (AR) technologies to enhance our perception and help us see, hear, and feel our environments in new and enriched ways. AR can be developed in various type of field such as education, maintenance, design and reconnaissance, to name but a few. Their researches covered many topics related to AR such as the definition of AR, How to display the AR, ways to positioning the display and example of AR applications.

AR system can be commonly applied on all capabilities in human sensory input, sight, sound and/or touch. It can be done by three basic methods to visually present an augmented reality in form of video see-through, optical see-through and projective. Meanwhile, head-worn, hand-held, and spatial are the three categories of AR presentation based on their position between the viewer and the real environment.

2.2 Facts and Findings (Based on Topic)

The mobile augmented reality has been widely used in many areas due to the advances in technology of mobile. Most of mobile devices are hand-held and require doing more than one thing at the same time that resulting problem solving as the effects. Shatte, Holdsworth and Lee (2014) describe that Augmented Reality (AR) is an emerging technology that can be used to combine the physical world with virtual worlds through a visual interface. The biggest benefits of hand-held mobile devices for AR are it is pervasive and easily accessible to users.

Investigating the effects of multitasking in mobile AR for problem solving through sorting tasks is the main target of the research. The mobile AR will be widely adopted in various educational settings are expected to create large impact on teaching and learning in university. Besides, a great potential to explore unexplored learning and teaching environments are provided by the Mobile AR. In contrast, multitasking is the one of main issues surfaced in hand-held mobile AR learning.

Since the extra cognitive load caused by multitasking is now shared between the a pair of users, synergetic efforts are more effective for sorting with our hand-held mobile AR system than personalized individual efforts. The framework that have been propose for sorting the mobile AR in this study consist of three main sections that consist of input marker, mobile AR and algorithm and the output of visual cues.

2.2.1 Domain

The domain for this project is developing mobile-based augmented reality cooking application with using images in the cooking book as the marker.

2.2.2 Existing System

As been mentioned before, an augmented reality feature provides a rich medium for learning content. By researching over the internet, there are several data gathered.

i. CounterACTIVE

According to Bonanni, Lee and Selker (2005), CounterACTIVE will demonstrate simple recipes by displaying interactive recipe on the kitchen counter that embedded sith a capacitive touch-sensitive array. The user can be engaged with delicious recipes, colorful pictures, fun music, instructive videos and interesting stories by using a kitchen counter developed by CounterACTIVE. The targets of this technology are to encourage an active participation in the kitchen and enticing people to develop their cooking skills.

The CounterACTIVE research has two components that consist of the interface and the underlying architecture. The user can step their way through recipes interface only by touching the pictures and words on the countertop which is composed of a computer, an overhead projector, and electric field sensing array.

The architecture of an event detection system enable a non-command interface is another aspect of their research. Using an underlying array of sensors distributed throughout the kitchen, the kitchen can assume what events are occurring in the kitchen and respond before the user formulates an explicit command.

Figure 2.1: Augmented Reality Kitchen Counter

Figure 2.2: Virtual Recipe

ii. eyeCOOK

The attentive hypertext-style interface cook book prototype consists of an electronic recipe database. Input from an LC Technologies eye tracker and a wireless microphone using the Microsoft Speech API (SAPI) for speech recognition and production is being sent to the eyeCOOK. These were chosen instead of devices that require physical contact such touch screen and mouse which may be inconvenient and contaminated while preparing food.

Based on Bradbury, Shell and Knowles (2003), their system shows the recipe in one of two attention sensitive display modes after a recipe has been selected from the database. This system will read aloud ingredients and instructions, access additional information such as pictures and definitions of ingredients, cooking terminology, and cooking instruments, nutritional information, the history of the dish, and suggestions of what other food items it could be served with. The system automatically sets timers and reminders once the user begins the actual process of cooking. A simple color-coding scheme implies the relationship between current, previous and future cooking steps and the ingredients they involve. The reason for the dynamic coloring provides a cue situating the user's current cooking task within the recipe as a whole.

Figure 2.3: eyeCOOK in Page Display Mode

2.2.3 Comparison of Existing System

The purpose of comparison is used to differentiate the interactivity and the multimedia elements that use in both existing augmented reality system.

Table 2.1: Comparison between Existing Systems

Elements	counteractive	eyeCOOK
Audio	Yes	Yes
Video	Yes	No
Animations	Yes	No
Text	Yes	Yes
Image	Yes	Yes

2.2.4 Technique

On the part of developing this application, there are several common yet easy recipe from the Malay cuisine had been choose so that it suits the target user who is new and beginner cooks. In addition, this application using marker based approach so that the hidden information behind the marker is revealed when applying AR features to it. A few interview had been taking place in order to collect data user requirements.

2.3 Project Methodology

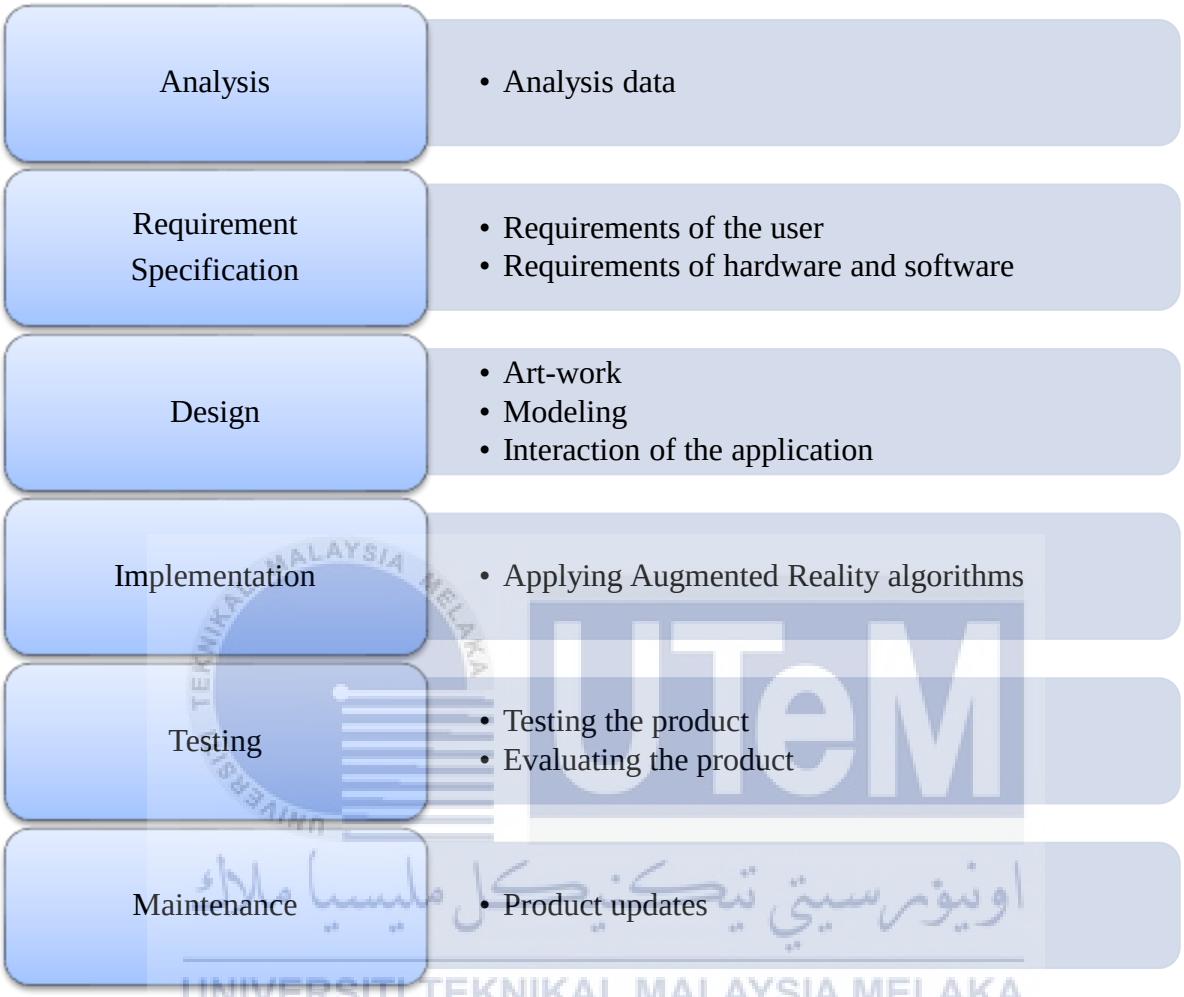


Figure 2.4: Methodology of the projects

2.3.1 Analysis

- **Analysis data**

  Analyzing the data that gathered from the research and decide whether it is relevant to this project or not.

2.3.2 Requirement Specification

- **Requirements of the user**

  Determine the requirements of user by observation and interviews.

- **Requirements of hardware and software**

  Recognize the hardware and software that are going to be used in this project and calculate the estimated budget for this project.

2.3.3 Design

- **Art work**

  Draft the idea to get clearer images on how the project will be like.

- **Modelling**

  Model the 3D object based on the illustration using Autodesk Maya

- **Interaction**

  Distinguish the interaction that can be implemented in the application.

2.3.4 Implementation

- **Apply augmented reality**

  Install all the software and plug-ins needed for this project in the laptop. When all the materials are prepared, both 3D model and the image will be integrated using coding to generate an application that allows user to make interaction with the application.

2.3.5 Testing

- **Testing the product**

  A prototype for this project will be produce, both the printed cooking book as marker and mobile-based application. The prototype will be test on the target user of this project to pay attention to the acceptance and effectiveness of the product.

- **Evaluating the product**

  The feedbacks for the tester are being analyzed and decided that it require changes or modify the products.

2.3.6 Maintenance

- **Update the product**

  Due to the feedback from the tester, the current project becomes better.

2.4 Project Requirement

The requirement phase will list all the software and hardware that is needed to complete this project.

2.4.1 Hardware requirement

- PersonalComputer
- GraphicCard
- Mouse
- Keyboard
- Smartphone
- Webcam
- Printer
- Glossy paper

2.4.2 Software requirement

- Adobe Photoshop CS6
- Adobe Illustrator CS6
- Autodesk Maya 2012 (64-bit)
- Unity 5.3.1f1 (32-bit and 64-bit)
- Android SDK
- Vuforia

2.4.3 Other Requirement

- Cooking books

2.5 Project Schedule and Milestones

Table 2.2: Project Schedule and Milestones

Process / Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Proposal PSM - Submission & Presentation - Proposal assessment and verification																	
2. Proposal correction/ improvement (Chapter 1)																	
3. Submission Report - Chapter 1 (System Development Begins)																	
4. Report for Chapter 1 & Chapter 2																	
5. Report for Chapter 2																	
6. Submission Report Chapter 2 & Proceed with a report Chapter 3																	
7. Project Demo & Chapter 3 Chapter 4																	
8. Mid Semester Break																	
9. Project Demo & Chapter 4																	
10. Project Demo & Chapter 4																	
11. Project Demo																	
12. Project Demo & PSM Report																	
13. Project Demo & PSM Report																	
14. Project Demo & PSM Report																	
15. Final Presentation (PA)																	
16. Revision Week																	
17. Final Examination Semester																	

2.6 Conclusion

The SDK for development of the product in this project is Vuforia which is been chose due to information gathered from the analysis phase. The Cyclic Waterfall model is being used as methodology for this project.

In chapter 3, there will be a discussion and explanation regarding the analysis. The data requirement, functional requirement, non-functional requirement and others requirement will be explained by details in the requirement analysis.

CHAPTER 3

ANALYSIS

3.1 Introduction

For this chapter, all the data collected throughout the previous topic will be made clear in form of project's overall requirements. In the analysis phase, the problem will be analyzed and the possible solution will be determined. This is to obtain any important information from the facts and findings that could be useful in contributing to the project completion. This project also undergoes preliminary investigation for better understanding.

From the observation that has been making, all the data that have been obtained need to be analyze first to make sure all the information will be analyzed well in this phase. Other than observation method, interviewing also take place in order to get a real fact about the content that needed to be in the video. All of project requirement will be studied for better understanding about the research. The research conducted has to be linear with the objective of the project to avoid unrelated data involved.

3.2 Problem Analysis

From the observation that has been making, all the data that have been obtained need to be analyze first to make sure all the information will be analyzed well in this phase. Other than observation method, interviewing also take place in order to get a real fact about the content that needed to be in the video. All of project requirement will be studied for better understanding about the research. The research conducted has to be linear with the objective of the project to avoid unrelated data involved.

By having mobile-based augmented reality features, a full package of information results from the combination of media is needed so that the user can understand the content by using it. Young generations today are addicted to a lot of digital device such as mobile phone and computer. The mobile devices had granted high acceptance from major population due to its role as a platform to convey information in an effective way.

3.3 Requirement Analysis

3.3.1 Data Requirement

The main target for this project is young generation with the age between 15-25 years old. The traditional way to learn how to cook is basically by using printed cooking books. In contrast, this project will produce mobile-based cooking application that consist of augmented reality features to enhance the way of learning how to cook. This project will require a cook book that contains images which act as marker. All the information will be conveyed when integrate the mobile-based augmented reality cooking application with the cook book.

i. **Need Analysis**

The main purpose is to develop a mobile-based augmented reality cooking application is because of the lack information that was provided by normal printed cooking book. By using dynamic elements such as video and graphics, user will get clearer vision on how they are going to cook. This application allows the user to interact with it contrast with traditionally printed cooking book that provides static images.

ii. User Analysis

The major reason of depression causing among the beginner user of culinary art is because they are lack of details on how to cook using the right method. Normally, the cooking books will give the general step by step on how to cook and assume all the user of the cooking books know the basic on how to cook.

iii. Technical Analysis

There are several technical issues that occur during the development. One of the issues is importing video and animation to the Unity software. The developer has to search for alternative way so that the element of AR will be able to be develop as planned in earlier phase.

iv. Resource Analysis

Resource analysis that is being used during the development is multimedia element that is suitable for this content of this project. Besides, the developer should know to identify the capabilities of merging virtual and real world in order to create better quality on learning and develop cooking skill.

v. Requirement Gathering

Requirement gathering that are used to develop this project is cooking books and easy recipes that can be cooked by the beginners. More than that, this application should be user friendly to avoid the additional depression when cooking.

3.3.2 Software Requirement

Below will be the list of software that required to complete this mobile-based augmented reality cooking application.

Table 3.1: Software used in this project

SOFTWARE	DESCRIPTION
Adobe Illustrator CS6 	Used to design the graphics

Adobe Photoshop CS6 	Used to design the marker base
Unity 5.3.1f1 (32- bit and 64-bit) 	Used to develop the Mobile Augmented Reality
Android SDK 	Used to functioning this application on mobile
Autodesk Maya 2012 	Used to do 3D modelling
Java 	Used to functioning this application on mobile
Movie Maker 	Used to create video files for this project

3.3.3 Hardware Requirement

i. Laptop

- Model : ASUS X452L
- Graphic : Intel @ Core i3
- RAM : 6GB
- Processor : Intel ® Core™

Figure 3.1: Laptop that been used during the development

ii. Hand phone Samsung Galaxy Note 5

Figure 3.2: Phone that been used during the development

iii. User Interaction: Touch Screen

3.4 Conclusion

For the conclusion, the analysis phase is very crucial in order to gather all data requirement during the development of the project.

In the next chapter, it will further discuss on how the data gathering are related to one another and it will go through the design process that involve in production part.

CHAPTER 4

DESIGN

4.1 Introduction

This chapter describes the outcome of analysis in previous chapter. Component and application designs are visualized according to the analysis result to match with the requirements and usability of the system.

In preliminary design, overall concept including the application's architecture and flow chart are discussed. The mobile-based augmented reality cooking application design divided into two main groups, which are printed cooking book act as marker and the user interface. For the marker, it is crucial aspect to consider because it will affect the detection performance, while for the android application; the user interface had to cater with human and machine interaction in order to guarantee the level of comfort for user.

4.2 Preliminary Design

4.2.1 System Architecture

This project adapts conventional Input-Process-Output system architecture, which consists of camera, application, and screen. Camera detects the marker on cooking book, which becomes input for the system. The application software will analyzed the marker's image and retrieve corresponding 3D model.

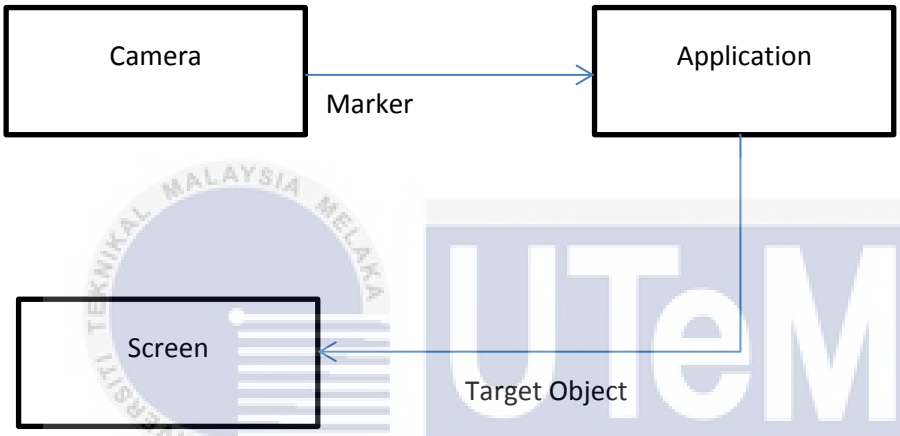


Figure 4.1: System Architecture

4.2.2 Flow Chart

Flow chart is a diagram that represents a process in sequence. It helps viewer to visualize and understand the navigation in a system. Figure below shows the flow chart when user interacts with the application.

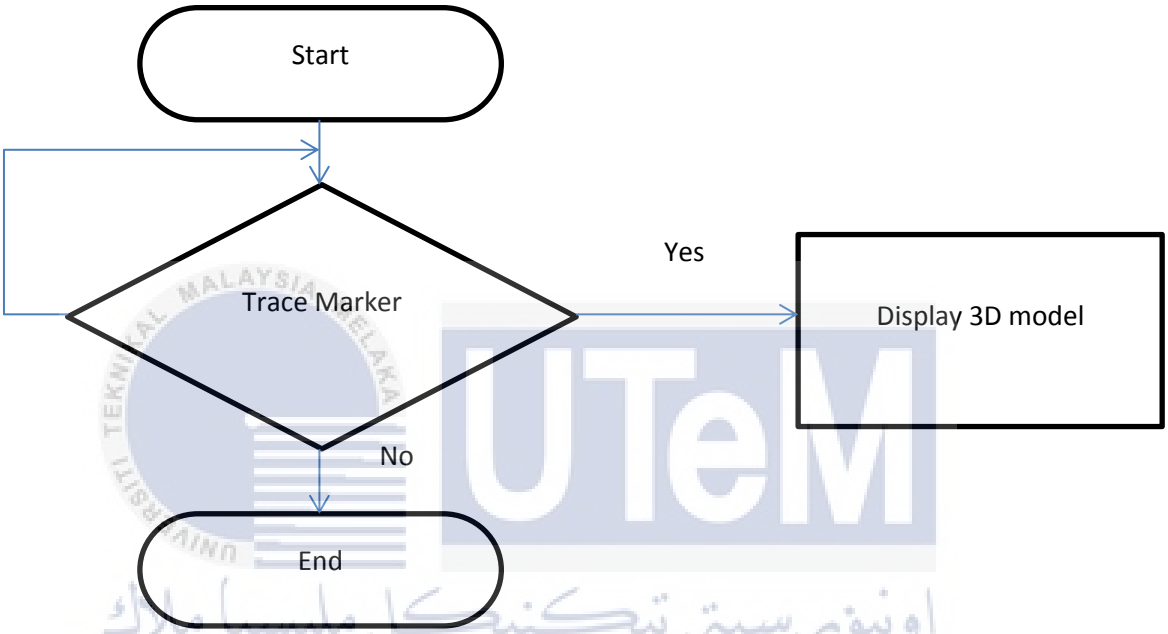


Figure 4.2: Flow Chart

4.3 Detailed design

4.3.1 Marker design

Marker base is one of the major components is Mobile-based Augmented Reality Cooking Application. After considering the issue of paper size in previous chapter, it is decided that A4 will be the appropriate size for this system, since user can grabs the cooking book easily.

Figure 4.3: One of marker for the project

Figure 4.4: The output for the marker

4.3.2 User Interface design

User interface design may be included on 3D modelling, 2D modelling, font and text in order to create an interactive learning tool for the students and teachers.

Figure 4.5: The user interface for instruction

Figure 4.6: Examples of user interface

4.4 Conclusion

The chapter describes conceptual aspect of Mobile-based Augmented Reality Cooking Application in term of the design and workflow. In general, the design is categorized in two parts, which are the cooking book and user interface. Taking consideration on the requirements, the size of the map is set as A4. The design of the marker is also stated in this chapter to clarify the graphic and detection performance.

Interface interaction of this application will not be a burden for the user as they can swap at the button easily with their thumb and have instruction on how to use this application in the beginning part.

CHAPTER 5

IMPLEMENTATION

5.1 Introduction

This chapter review on how the implementation was made in that phase of the project. As depicted in previous chapter, Mobile-based Augmented Reality Cooking Application is divided into two main parts, which are the cooking book and the AR application. Therefore, the project will be developed according to the assigned parts.

The cook book consisting of the system markers, steps involved in developing markers and version control procedure will be included in this chapter. Environment setup and system development level are covered under Application Development section.

5.2 Cook book and Marker Development

Mobile-based Augmented Reality Cooking Application required a custom-made map to function, because there should be unique identifies or markers for the system to detect, and projecting 3D food. The cook book is a composite images obtained by doing the cooking video and photoshoot.

Raw image materials are captured using phone's camera and edited by using Adobe Photoshop.

Figure 5.1: Raw Image before the editing

After the base of cookbook is completed, three individual markers, each represent their own recipe. Before the marker is placed, it has to be tested whether it is capable to provide good tracking properties. The effectiveness of marker's detection is determined by Vuforia's online Target Management System.

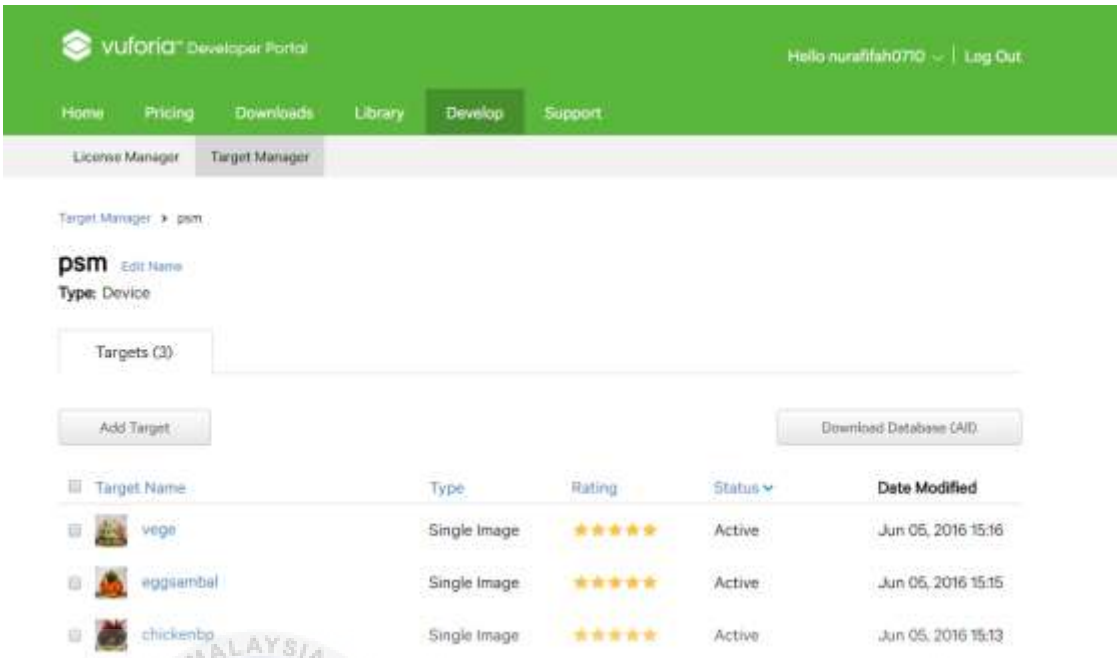


Figure 5.2: Vuforia's Target Management System

Authorized user can create project under Target Management System, and upload images to convert into trackable or markers. The system will automatically check and rate the image. Below is an example of the result of analysis:

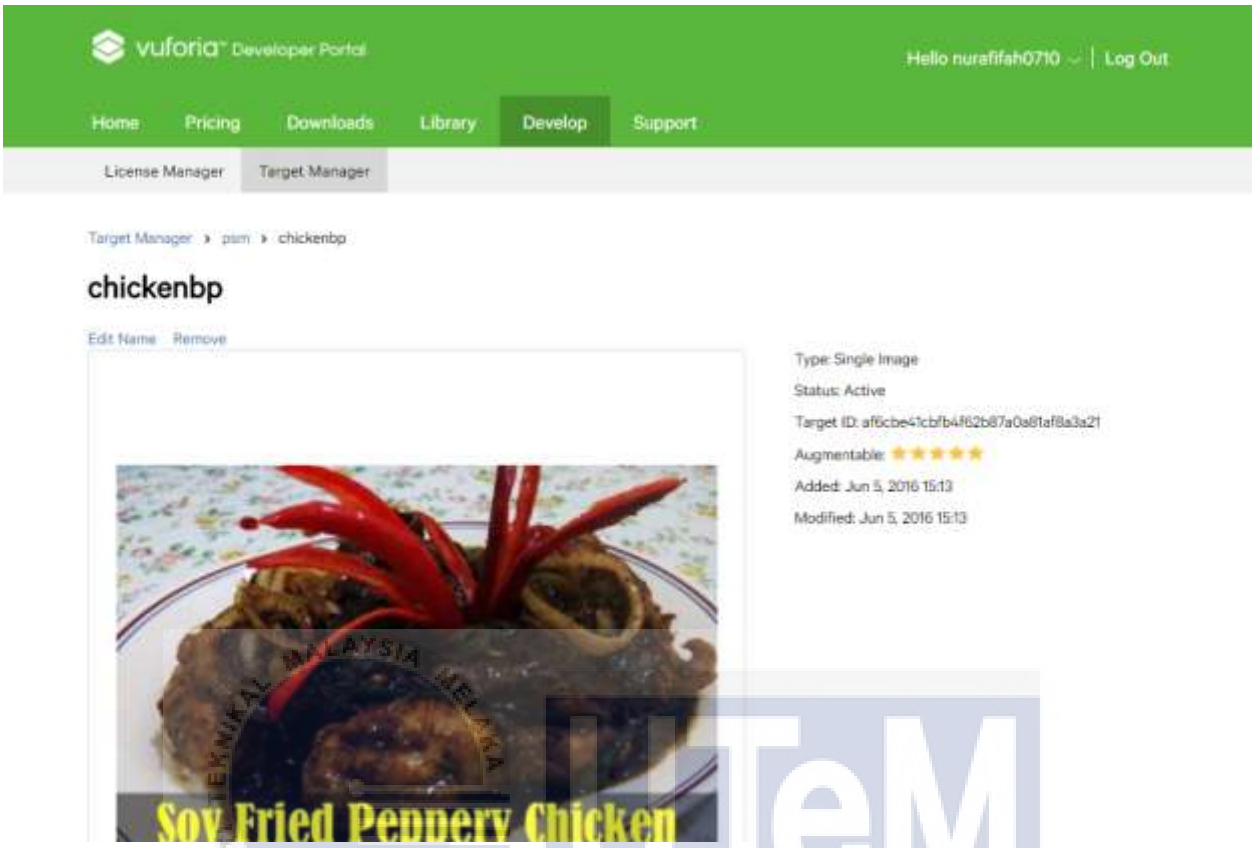


Figure 5.3: Analysis of an uploaded image

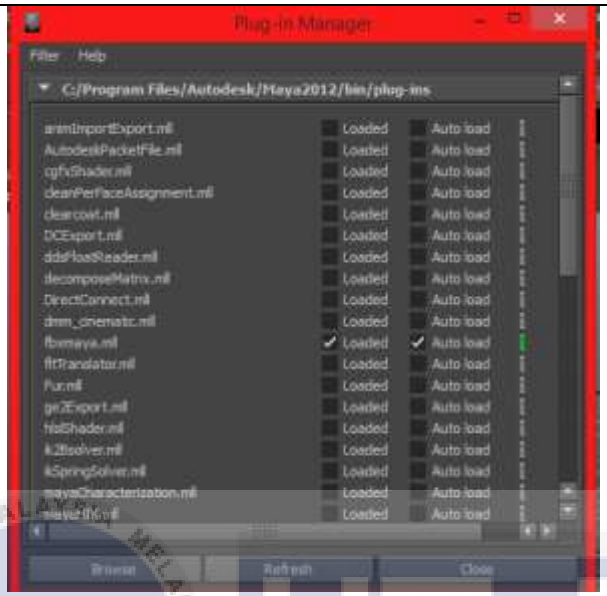
The system will detect whether the image possesses detectable edges and points, as well as color contrast. These factors will greatly affect the tracking abilities of marker.

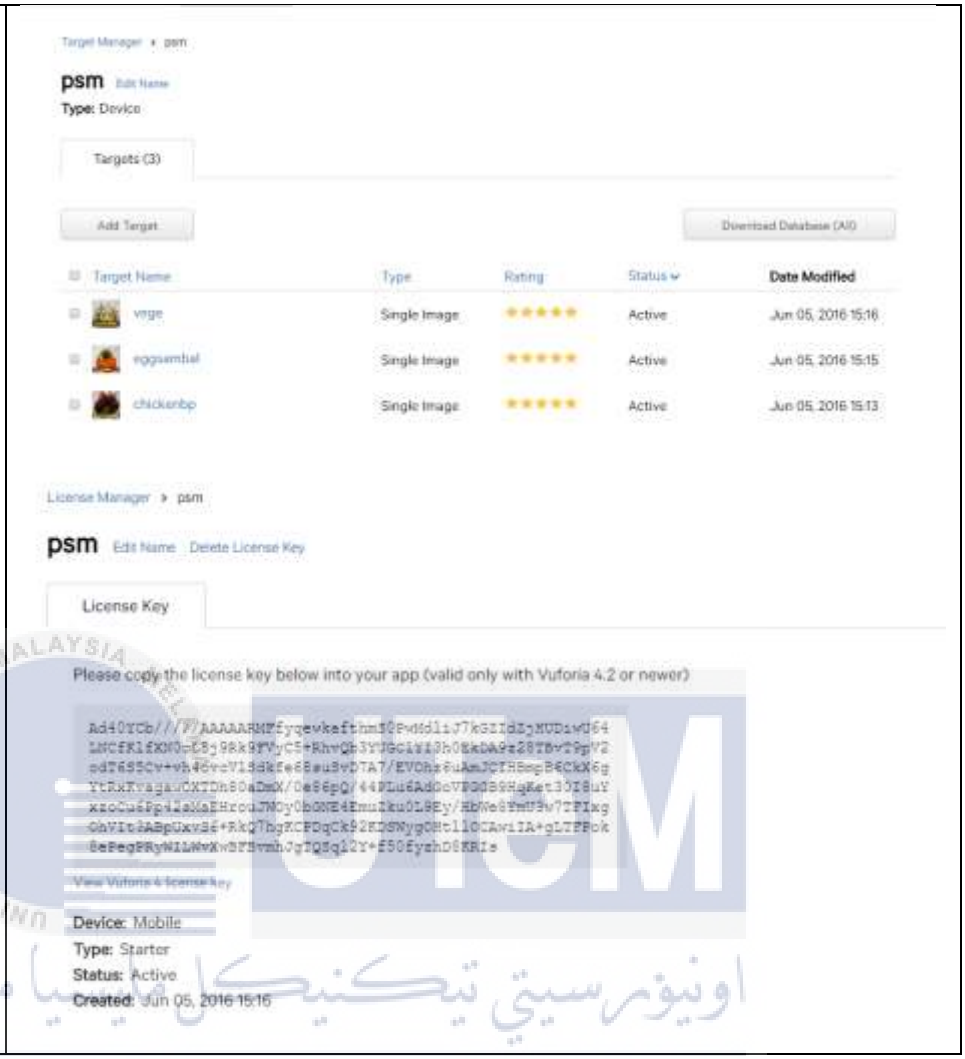
5.3 Product Configuration Management

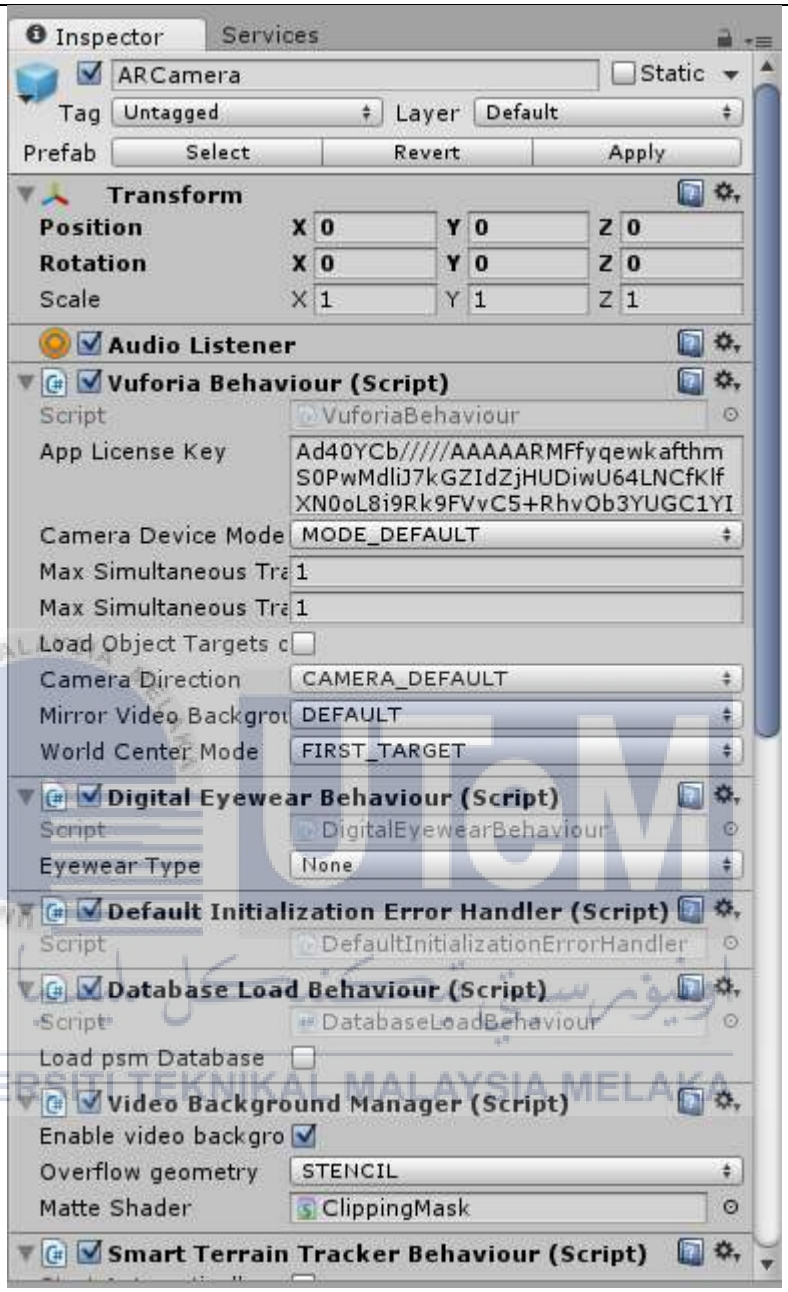
5.3.1 Configuration Environment Setup

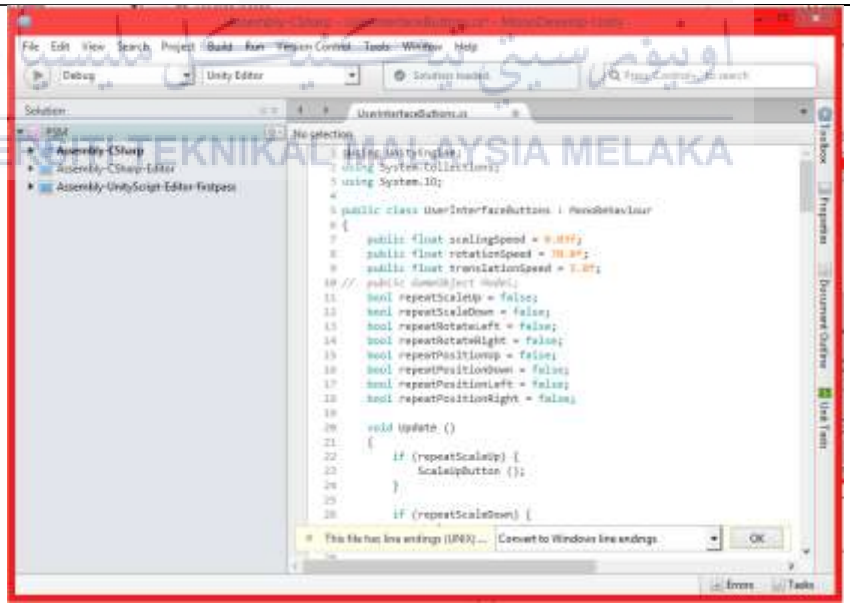
Configuration environment setup tells the setting required on software required on software used to create the application. Figures of the setting are gathered in the table below to have a better view and understanding about the setting on Autodesk Maya, Unity and Vuforia.

Table 5.1: Setting and Plug-ins for this project

Software	Settings
Autodesk Maya (for FBX)	 

Vuforia	

Unity	

	
MonoDevelop (for C# files)	

5.4 Conclusion

Mobile-based Augmented Reality Cooking Application is conducted according to its two components, cook book and AR application. For the developing this project, Android, Vuforia and Unity Extension is configured. With packages downloaded from Vuforia, developing AR in Unity required the 3D model and marker's dataset.

In order to determine the system efficiency, it will be tested. The testing will be discussed further in the next chapter.

CHAPTER 6

TESTING

This chapter will be discussing the testing approach that is used in this project to identify its effectiveness and acceptance. The developer has prepared a test plan that will guide a self-testing towards the application. Unit testing, integration testing and system testing are the three parts that are consist in the testing plan. If the application succeeds the entire test, it is consider as complete. The application will be open to testers to carry out the acceptance testing only after the unit testing completes. The response from the tester will be recorded and proceed with analysis within this chapter.

6.1 Test Plan

Test plan is the basis for formally testing any software or product. It will be functioning as a document describing the testing scope and activities. It also will be used to verify and ensure that a software or product meet its requirements. The weakness of the application can be figured out by the developer with the help of good test plan. There are several parts in the test plan will be cover which are unit testing, integration testing, system testing, user acceptance testing, testing organization, testing environment and testing schedule.

6.1.1 Unit Testing

Unit testing is to test each individual unit of the application to ensure that it performs its intended functionality, carried out by the developer. This topic will discuss about the hardware used, software used and the unit test case.

i. Hardware used

There are two major hardware that undergoes this testing process which are personal laptop and smartphone. Personal laptop act as main device in developing this application and involve with the software testing part like debugging code. As for the personal smartphone, it is use to test the functionality and outlook of the application.

The list of details for the specification for both devices will be in the table below.

Table 6.1: Details of features for hardware used during testing

	Laptop	Smartphone
Model	ASUS 452L	Samsung Galaxy Note 5
CPU	Intel ® Core ™ i3-4030U	Quad-core 1.5 GHz Cortex-A53 & Quad-core 2.1 GHz Cortex-A57

GPU	NVDIA GeForce 820M	Mali-T760MP8
OS	Windows 8.1	Android 6.0.1 (Marshmallow)
RAM	6.00 GB	4.00 GB
Display	14.0" Auto HD (1366x768)	Super AMOLED capacitive touchscreen, 16M colors
Capture Device	VGA Web Camera	16 MP
Extension	Mouse, Speaker	USB cable

ii. Software used

There are several software that need to go through this testing process. Software usually acts as programming language compilers that can identify error occur in the coding. Due to different type of programming language, different software is needed in this project so that it can compile respectively.

Table below will be listing the software used and their function.

Table 6.2: Details about software used

Software	Function
Unity Mono Develop	Compile the C# code that use in Unity
Notepad++	Compile the JAVA code of Vuforia SDK
Microsoft Visual Studio 2008	Compile the C++ code of Vuforia SDK

6.1.2 Integration Testing

Integration testing is a process which is testing in which software components, hardware components, or both are combined and tested to evaluate the interaction between them. The testing will be dividing the navigation into two critical module that are main module

and interaction module. In this part will also cover the navigation structure, integration order and integration test case.

i. Critical Modules

The two modules that are included in this application are:

a. Main Module

b. Interaction Module

ii. Navigation Structure

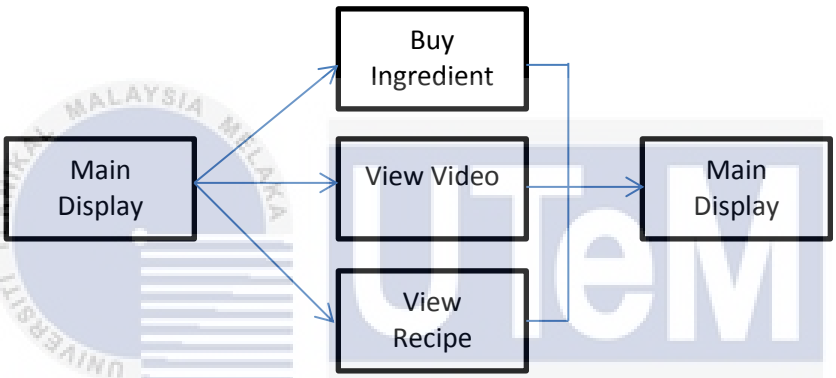


Figure 6.1: Structure of Navigation.

iii. Interface among module

In this application, each module has different structure and interfaces. This session will deliberate further about each module.

a. Main Module

As for the main module, it does only consist of the image captured by the camera and the static 3D model.

First of all, the user has to launch the application that has been installed in the mobile devices. Direct the camera towards the picture in the cooking book and the 3D model will appear on the screen of the mobile devices.

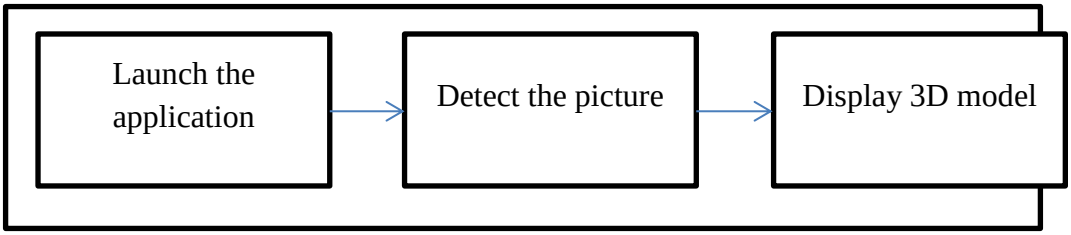


Figure 6.2: Flow of main module

b. Interaction Module

Interaction module will be covering the interaction provided by the virtual button.

User is able to interact with the application by touch the virtual button that appears on the screen of mobile. The feedback given by the application is corresponding with the button chosen.

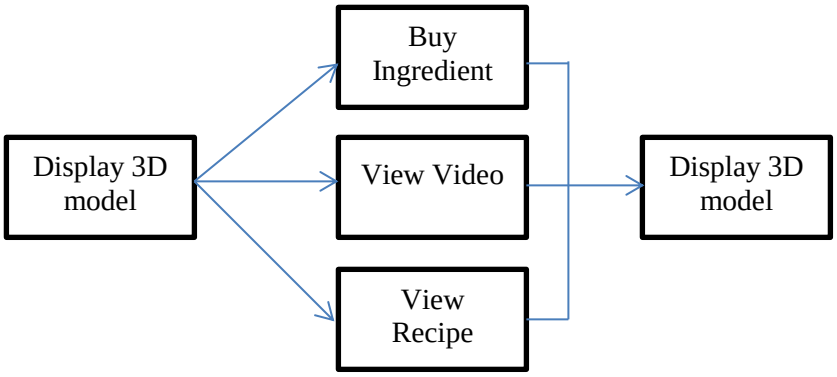


Figure 6.3: Flow of Interaction Module

6.1.3 System Testing

Fully integrated application will undergo a testing session that is called an system testing. For this session, a printed image and smartphone that had been installed with the application are prepared.

i. System test case

System test case will involve testing every single input direct by the user in order to see whether the application send back the right output as requested by the user.

6.1.4 User Acceptance testing

There are 32 young generations including both male and female with age range between 18-25 years old and different races are chosen as the tester for this project. The recruitment of the tester is by using the concept of snowball sampling recruitment that is a recruitment technique where the tester are asked to assist the researcher in identifying other potential tester. Testers will be given image that act as marker and explore the application by themselves. After exploring the application, then the tester is required to fill up the questionnaire.

6.1.5 Testing Organization

Testing organization refers to the organization that involves in the testing process for this application. It can be divided into two categories that are developer and testers. Developer is the person who is responsible in developing this application while the testers is a group of teenagers and adults that range between 18-25 years old with mix gender and races. The difference between the developer and tester that the developer undergoes the entire testing that are link to this application while the testers only involve in user acceptance testing.

6.1.6 Testing Environment

The location and environment which the testing will be carrying out is the definition of testing environment. The environment will influence the testing approaches done by the developer.

For example, the unit testing, integration testing and system testing can be done in workstation because it only involves the developer, software and the hardware.

In contrast, user acceptance testing will be carrying out at random meeting with the tester. After asking permission from the tester, the tester will be other testers, they are required to answer the questionnaire in form of google form. Their response will be recorded together with other responses.given chances to explore the application themselves. Then, the tester is required to answer questionnaire and they also allow to voice out their comment and feedback about this application.

For person who is geographically different but still interested to test the application, a link of google drive consist of the application file and the pictures as the marker will be email directly to them and they still can try it.

6.1.7 Testing Schedule

Testing schedule is prepared to keep the testing session on the track. The schedule is shown in table below.

Table 6.3: Schedule of testing

Task	Date	Duration
Unit Testing	4th August 2016	30 minutes
Integration Testing	4th August 2016	30 minutes
System Testing	4th August 2016	30 minutes
User Acceptance Testing	5th August 2016	3 days

6.2 Test Implementation Process

Test implementation will deliberate in details the testing process undergoes by developer based on the generated test plan previously.

6.2.1 Test Description

The testing will be split into two categories of tester where one is developer becoming a tester and another one is other selected individual becoming the tester. As for the developer, the prototype of application needs to pass all three testing phases that are unit test case, integration test case and system test case. The loop of coding and compilations are included in the testing process. As soon as the developer has complete the design and the coding algorithm, the application will be build and export to mobile devices to find out the output. The application will be altering if the output is not as expected until the expected output is achieved.

The online resource and the forum of Vuforia and Unity play a big help in order the developer to fix the error surfaces in the application. By the end of testing process, the application should be able to display the button and 3D model when camera appoint at the image target as the marker. The application also must be able to perform interaction such as helping the user to buy the ingredients, view the tutorial video and view the recipe.

Soon after the application pass all the three test case, then the developer can move to the next process that is user acceptance testing that involve target user as the tester. Firstly, the developer will contact and ask permission of the individual to participate in the testing activity. If the individual agree to participate the testing, then the developer will try to meet the student face to face. The cooking book that acts as the marker and the application will be provided during the testing process. Developer will stay with the tester to facilitate the tester and solve any problem occurs during the testing.

The same approach is being use while doing the testing process online as the tester is a bit far away from the developer. The tester will be given google drive link that contain both cooking book as the marker and the application file to test the application themselves. The developer will give the guide on how to install the application in the mobile device. After finishing the exploration, the tester is required to answer the questionnaire at the google form given by the developer.

Figure 6.4: The testing process (developer and tester)

6.2.2 Example of questionnaire

Refer to APPENDIX B

6.2.3 Test Data

The acceptance testing will be using five level scale that start with level 1 that stand for strongly disagree until level 5 that is for strongly agree. Those rating will be according to the judgement of tester towards the application that they explore it by themselves. Besides that, the tester also had given chances to voice out their comments and suggestion that can help to improve this application.

6.3 Testing Result and Analysis

In this session, statistic of the result for the questionnaire will be calculated and the data collected will be analyzed to evaluate the user acceptance of the application.

Table 6.4: Details about testers

Number of participant	32 people
Range of age	18-25 years old
Ethnicity	22 Malay, 6 Chinese, 3 Indian, 1 Others

6.3.1 Statistic and Analysis of Questionnaire Result

For Section B, it is divided into two parts which are Printed Cooking Book and Mobile-based Augmented Reality Application.

6.3.1.1 Printed Cooking Book

1. You often use a printed cooking book

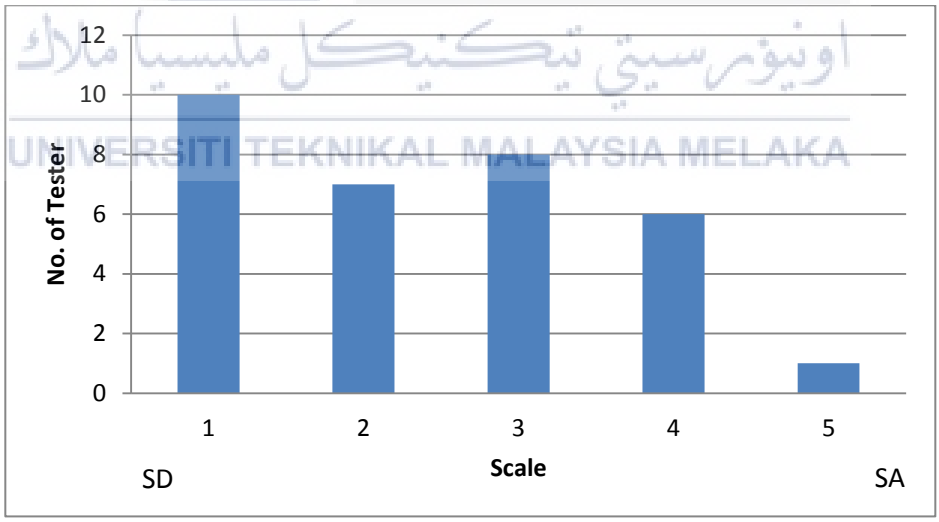


Figure 6.5: Question 1

Based on the result, strongly disagree scale recorded the highest frequency for question 1 with total of 10 testers chooses that scale. It shows that the tester themselves did not use printed cooking book.

2. You easily understand directives given by the cooking book

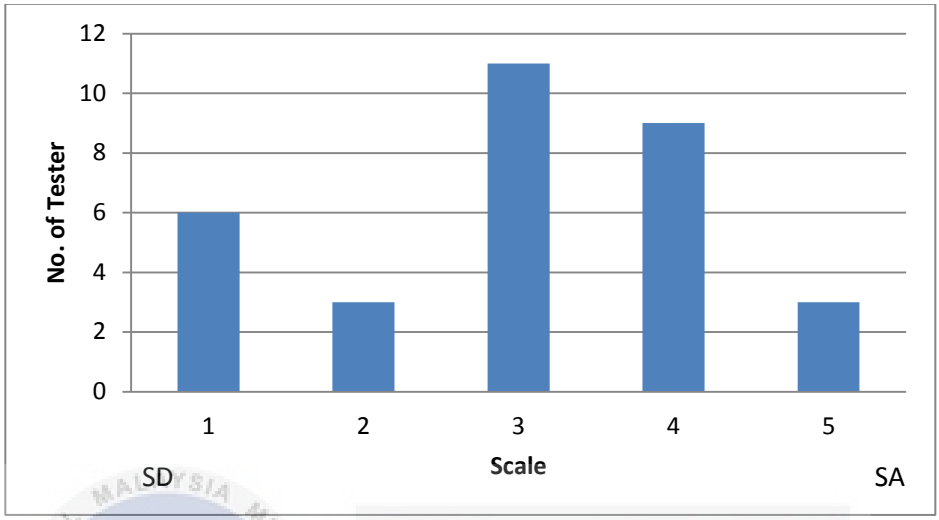


Figure 6.6: Question 2

Based on the result, the tester picks scale neither agree nor disagree as the mode for this question. This is because some people maybe face some difficulties in understanding the directives given by the cooking book especially when there are no images to visualize the directives given.

3. Use a printed cook book as a medium of learning to cook

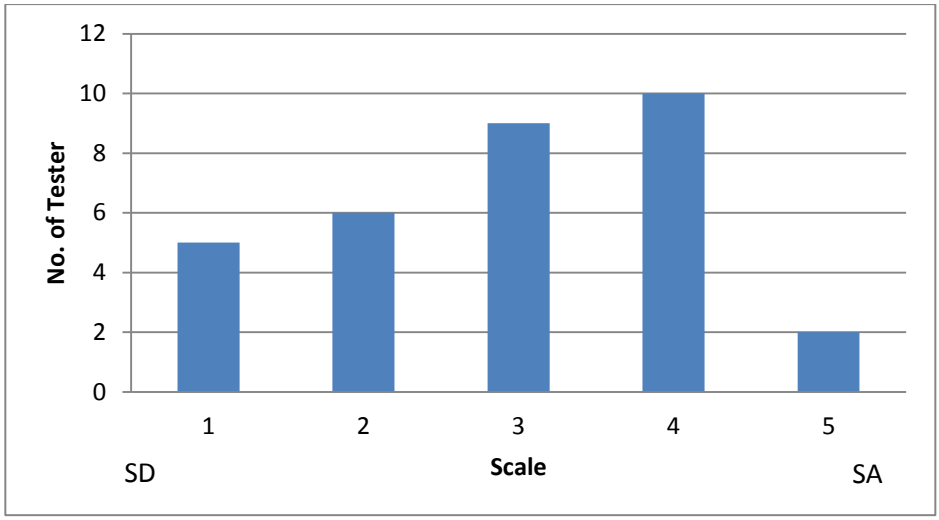


Figure 6.7: Question 3

Based on the result, agree scale recorded the highest frequency for question 3 with total of 10 testers chooses that scale. It shows that people nowadays still agree that printed cooking book as a medium of learning to cook.

4. Pictures in the cooking book can help you understand better the directives given

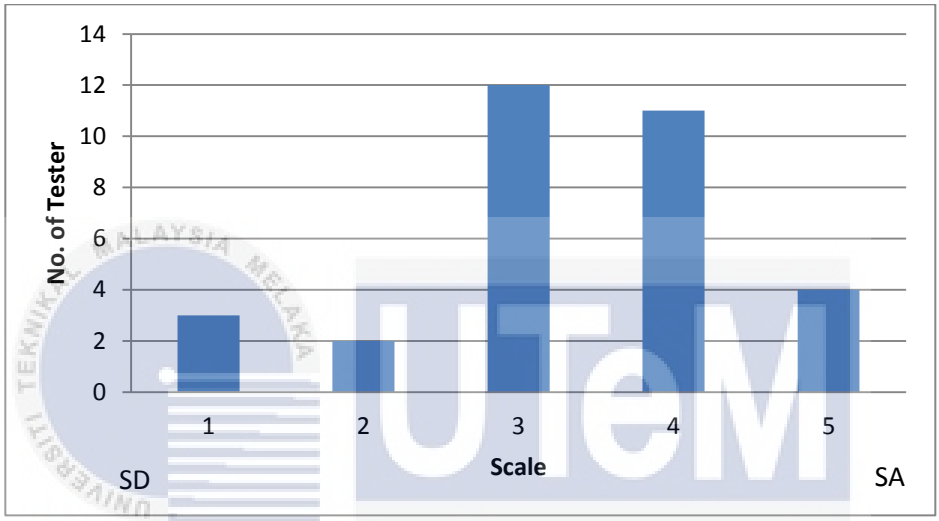


Figure 6.8: Question 4

Based on the result, the tester picks scale neither agree nor disagree as the mode for this question. This is because maybe the pictures provided in the cooking book is not enough detailed to make people get the clear visualization instead just get the general idea.

5. Learn to cook is much easier with using the printed cooking book

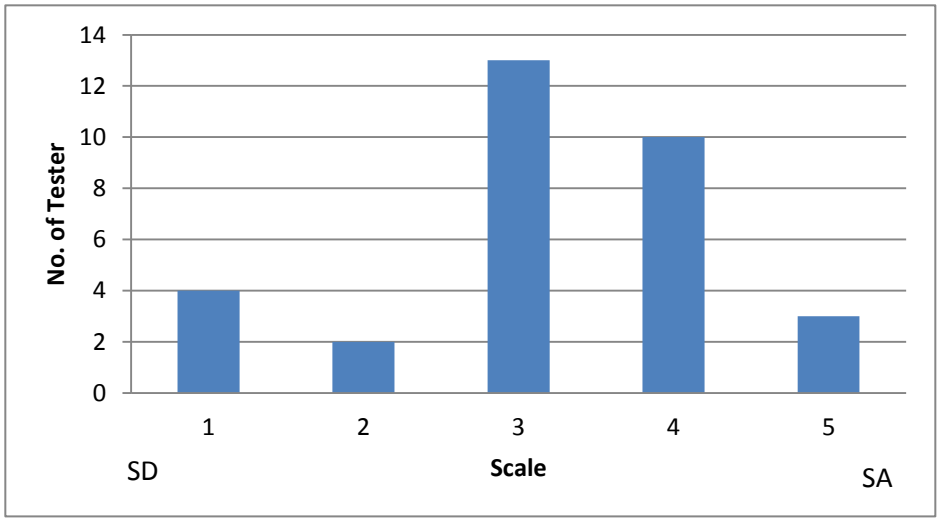


Figure 6.9: Question 5

Based on the result, neither agree nor disagree scale recorded the highest frequency for question 5 with total of 13 testers chooses that scale. It shows that learning how to cook with using printed cooking book is not that easy and at the same time it is not difficult as they think.

6.3.1.2 Mobile-based Augmented Reality Application

At the beginning of this part, the tester has been asked whether they have come across Augmented Reality application and below will be the outcome of the question.

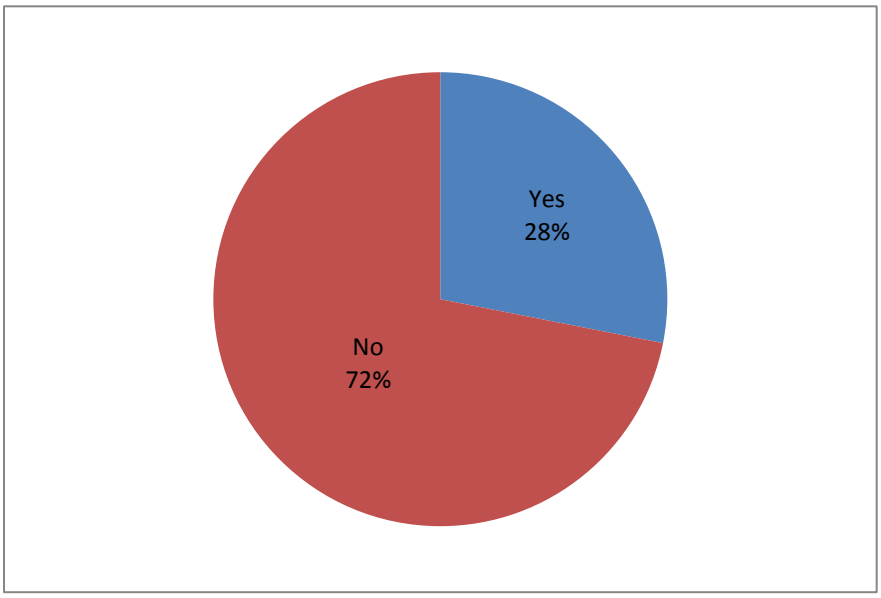


Figure 6.10: Percentage of tester have come across AR application before

Augmented reality is still in early phase of its revolution. Based on the result gathered, only 9 out of 23 testers with the percentage 28% have come across similar augmented reality application. Pokemon Go, Choki-choki AR Boboiboy, and IKEA catalog are the list of applications that they have used before.

1. You often hear the concept of Augmented Reality(AR)

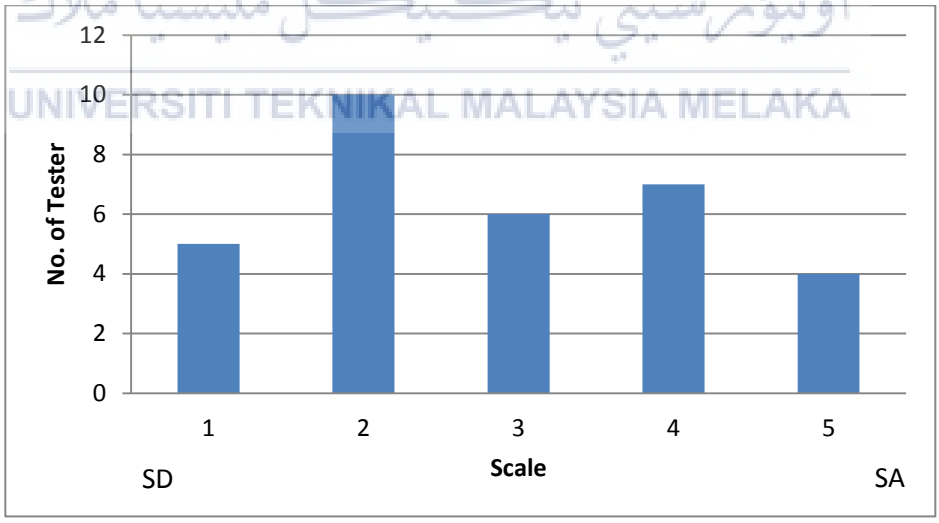


Figure 6.11: Question 1

Based on the result, disagree scale recorded the highest frequency for question 1 with total of 10 testers chooses that scale. It shows that the tester they seldom hear about this Augmented Reality in their daily life.

2. You understand the concept of Augmented Reality(AR)

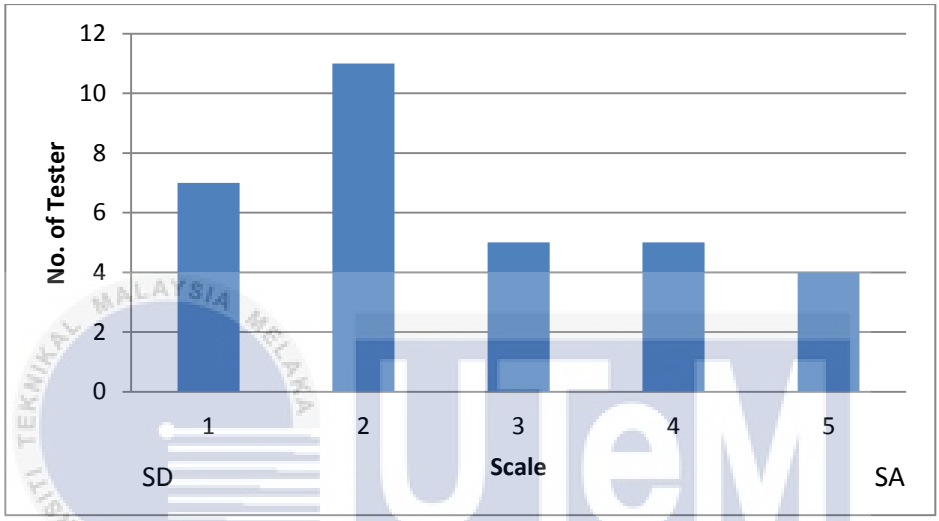


Figure 6.12: Question 2

Based on the result, disagree scale recorded the highest frequency for question 2 with total of 11 testers chooses that scale. It shows that they did not know the actual concept of the Augmented Reality. Some even mistaken AR same as the virtual reality.

3. This application is an improvement in the current learning of cooking that use AR elements to display videos and other additional information.

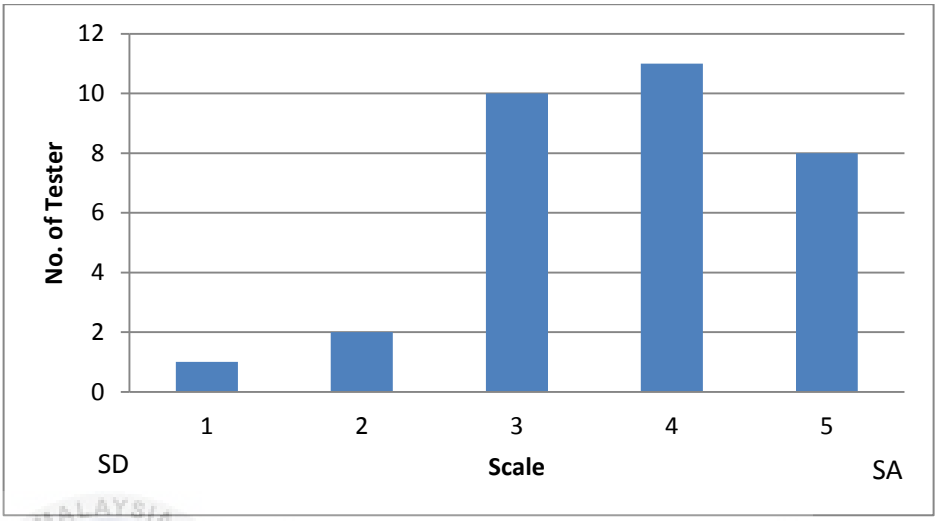


Figure 6.13: Question 3

Based on the result, the tester picks scale agree as the mode for this question with as many as 11 tester vote for it. Tester agrees that this kind of application can improve the current process of learning how to cook.

4. This application is more effective in terms of visualization that not only use static image as the normal learning process.

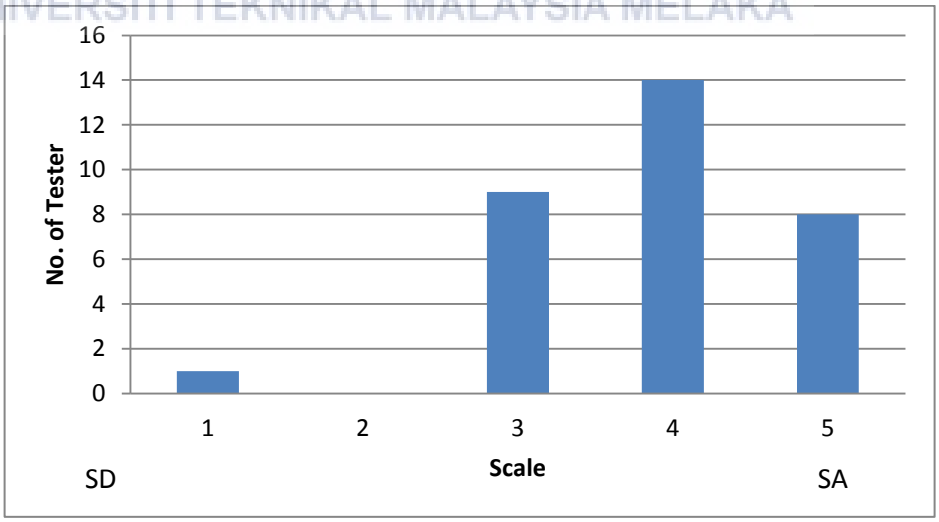


Figure 6.14: Question 4

Based on the result, agree scale recorded the highest frequency for question 4 with total of 14 testers chooses that scale. It shows that by using this application, they have clearer visualization on how to cook rather than using plain text and static images in the printed cooking book.

5. The additional element of AR in this application makes the process of learning more interesting.

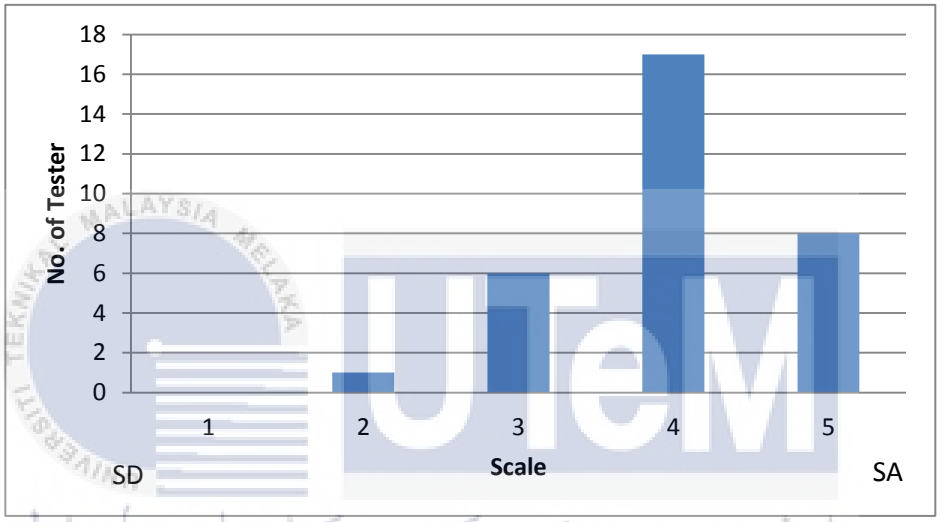


Figure 6.15: Question 5

Based on the result, the tester picks scale agree as the mode for this question with as many as 17 tester vote for it. Tester agrees that with the additional element of AR in this application make the process of learning more interesting.

6. This application can help novice learn how to cook easily.

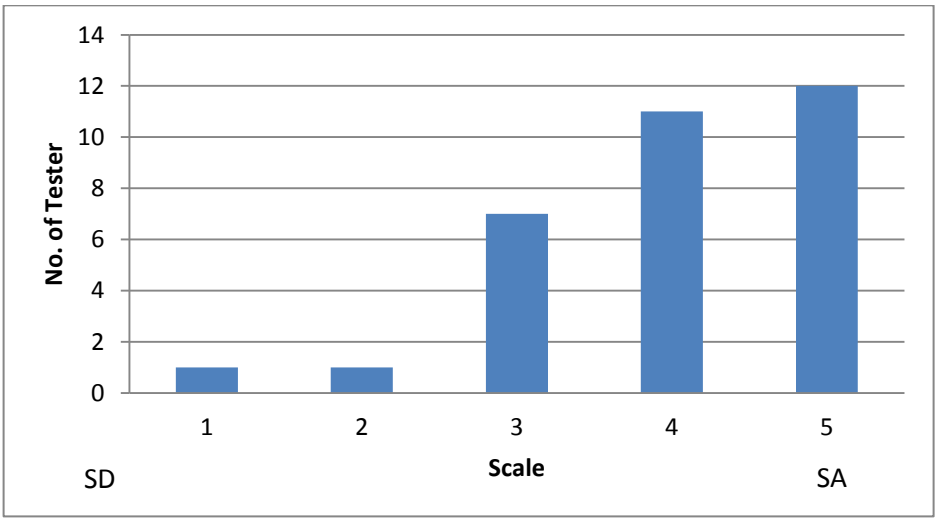


Figure 6.16: Question 6

Based on the result, strongly agree scale recorded the highest frequency for question 6 with total of 12 testers chooses that scale. It shows that this application can help the novice learn how to cook easily.

At the end of the questionnaire, the tester is given chances to give out their suggestion and recommendation that may improve this application. Some of the recommendation and suggestion are to make the application more accessible to people, add more interaction in the application and add more recipes in the cooking application.

Based on data collected during the User Acceptance Testing, it can be concluded that mobile-based augmented reality cooking application is more effective compared to the printed cooking book in learning how to cook. Even though people nowadays rarely use the printed cooking book, they still accept the fact that printed cooking book is one of way that can be used to learn cooking. Lastly, this application has achieved the objectives and requirement in this project.

6.4 Summary

The testing process enables the application to be evaluated by the developer. During this process, developer can detect any defect in this application and fix it until the application works as the developer wants. Throughout this chapter, it is concluded that this application has achieved the objective and requirement in this project.

CHAPTER 7

CONCLUSION

This chapter will conclude the project of Mobile-baser Augmented Reality Cooking Application implementing. In this chapter, the weakness and the strength of this application will be discussed. Besides, the proposition for improvement of this application will be deliberate also in this chapter. As well as the contribution and future work of the application also will be discussed later in this chapter.

7.1 Observation of Weakness and Strength

Based on previous chapter which is testing, the developer discovered some weakness and strength in this application.

The weakness of the application is that the video is not embedded directly in this application rather than just using a button that will link the application to the youtube where the video have been uploaded there. This is because the file size of the video is too large due to its resolution. The developer has tried to use GAW Studio extension that can be bought in Unity Asset store to embed the video into the application. The extension work by slicing the video into pictures and then combine it to make a video. The file size of the video become smaller due to that process, but the resolution become lower and the pictures become redundant and hard to organize. It is better to have high resolution for the video because novice user usually want clear visualize so that they can understand and can get the idea of how to cook. The other weakness of this application is, the background music becomes redundant because of different scene. This application use many scenes so when changing to the new scene, the background music from the previous scene overlapped with the new one.

The ability of partial marker detection is one of the strength of the application. This shows the ability of the augmented reality to display the computer generated information even though it only captures a part of the marker only. Even if half of target image is being covered with something, it will still display the AR elements. Thus, the 3D model will still appear despite the camera did not capture the whole target image. Other than that it provides more than just display the 3D model such as can help the user buy the ingredient and view video tutorial on how to cook.

7.2 Proposition for Improvement

One of the improvements that can be done is enhancing the 3D model of the food. For now the 3D model of food is just static model that did not have any animation due to Unity did not detect the particles in the FBX file which the particles is not considered as keyframe animation. Maybe one day if the Unity Engine has resolve this case, then the animated 3D model can be inserted in this application.

Next, the application would include more type of recipes from other cuisine too. Other than Malay cuisine, by including foreign cuisine can attract more people in using this application.

Other than that, adding interaction that can provide additional information about cooking will give a lot benefits to the novice user. The additional information about tricks in cooking or what to do and what not to do will surely help the user.

7.3 Contribution

This project will certainly be beneficial for individual who is beginner in cooking that range between 18-25 years old who want to learn about cooking in more interesting way. They can easily learn how to cook by using additional elements of AR. Besides, they are able to understand easily by using the video and graphics in this application.

More than that, this application is able to convey information in three ways that are images, 3D model and video. The use of multiple media will directly increase the level of understanding and knowledge of the user. Thus, it is very suitable for learning purpose as well.

7.4 Summary

As a conclusion, the development of Mobile-based Augmented Reality Application is significant in both cooking and learning purpose. For individual aspect, the continuation of work for this project will bring more advantages and contribution to young generations. Therefore, the future improvement and enhancement of this project is strongly encouraged.

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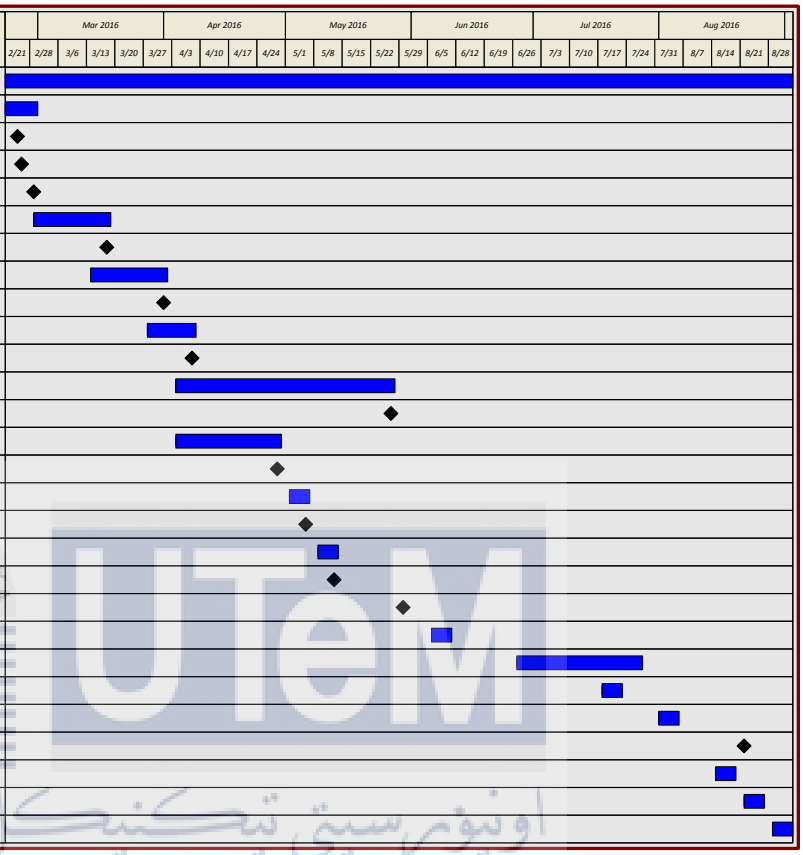
APPENDICES

APPENDIX A: GANTT CHART

ID	Task Name	Start	Finish	Duration
1	**Start**	2/22/2016	9/2/2016	140d
2	**Proposal PSM**	2/22/2016	2/29/2016	6d
3	Submission & Presentation	2/25/2016	2/25/2016	0d
4	Proposal Assessment and verification	2/26/2016	2/26/2016	0d
5	Proposal Correction/Improvement	2/29/2016	2/29/2016	0d
6	**Chapter 1**	2/29/2016	3/18/2016	15d
7	Submission & Presentation & Improvement	3/18/2016	3/18/2016	0d
8	**Chapter 2**	3/14/2016	4/1/2016	15d
9	Submission & Presentation & Improvement	4/1/2016	4/1/2016	0d
10	**Chapter 3**	3/28/2016	4/8/2016	10d
11	Submission & Presentation & Improvement	4/8/2016	4/8/2016	0d
12	**Project Demo**	4/4/2016	5/27/2016	40d
13	Presentation	5/27/2016	5/27/2016	0d
14	**Chapter 4**	4/4/2016	4/29/2016	20d
15	Submission & Presentation & Improvement	4/29/2016	4/29/2016	0d
16	**Student Status**	5/2/2016	5/6/2016	5d
17	Determination of student status	5/6/2016	5/6/2016	0d
18	**PSM Report**	5/9/2016	5/13/2016	5d
19	Submission & Presentation & Improvement	5/13/2016	5/13/2016	0d
20	**Final Presentation**	5/30/2016	5/30/2016	0d
21	**Revision Week**	6/6/2016	6/10/2016	5d
22	Chapter 5	6/27/2016	7/27/2016	23d
23	Chapter 6	7/18/2016	7/22/2016	5d
24	Chapter 7	8/1/2016	8/5/2016	5d
25	PSM II Showcase	8/22/2016	8/22/2016	0d
26	Submission of PSM II Thesis for evaluation	8/15/2016	8/19/2016	5d
27	Complete correction of PSM Thesis	8/22/2016	8/26/2016	5d
28	Upload PSM II Thesis, Log Book	8/29/2016	9/2/2016	5d



APPENDIX B: QUESTIONNAIRE

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FACULTY OF INFORMATION COMMUNICATION TECHNOLOGY (FICT)

LEARNING QUESTIONNAIRE

"Mobile-based Augmented Reality Cooking Application"

All the information gathered from this survey will be totally confidential and the strictest confidentiality and anonymity shall be preserved. Your name shall not be publicized in the final report nor will there be any cross-references made that can link the results of the survey to you. Only academics from university are eligible to participate in the survey.

I certainly hope that you could spare a few minutes of your time to respond to the survey. Your full support and cooperation in completing the survey is highly appreciated.

Researcher: Nur Afifah Binti Zulkifli

1.	I have read and understood the information about the project, as provided in the Information Sheet
2.	I have been given the opportunity to ask questions about the project and my participation.
3.	I voluntarily agree to participate in the project.
4.	I understand I can withdraw at any time without giving reasons and that I will not be penalized for withdrawing nor will I be questioned on why I have withdrawn.
5.	The procedures regarding confidentiality have been clearly explained (e.g. use of names, pseudonyms, anonymization of data, etc.) to me.
6.	If applicable, separate terms of consent for interviews, audio, video or other forms of data collection have been explained and provided to me.
7.	The use of the data in research, publications, sharing and archiving has been explained to me.
8.	I understand that other researchers will have access to this data only if they agree to preserve the confidentiality of the data and if they agree to the terms I have specified in this form.
9.	Select only **one** of the following: • I would like my name used and understand what I have said or written as part of this study will be used in reports, publications and other research outputs so that anything I have contributed to this project can be recognised. ( ) • I do not want my name used in this project. ( )
10.	I, agree to sign and date this informed consent form. **Participant:** _____ _____ _____ Name of Participant Signature Date

SECTION A: DEMOGRAPHY

Tick (√) the answer that is relevant to you or fill in the blanks

1. Gender: Male [ ] Female [ ]

2. Ethnicity: Malay [ ] Chinese [ ] Indian [ ] Others [ ]

3. Age: <18 [ ] 18-25 [ ] 26-35 [ ] >35 [ ]

SECTION B:

This section contains a few questions to answer. Please circle the number that is closest to your opinions. All categories must to be refers in the schedule below:

Score	Point
5	Strongly Agree (SA)
4	
3	
2	
1	Strongly Disagree(SD)

Printed Cooking Book

No.	Description	SD				SA
1	You often use a printed cooking book *Anda sering menggunakan buku masakan bercetak*	1	2	3	4	5
2	You easily understand directives given by the cooking book *Anda mudah faham dengan arahan yang diberikan oleh buku masakan tersebut*	1	2	3	4	5
3	Use a printed cook book as a medium of learning to cook *Menggunakan buku masakan bercetak sebagai medium belajar memasak*	1	2	3	4	5
4	Pictures in the cooking book can help you understand better the directives given *Gambar-gambar di dalam buku masakan dapat membantu anda lebih memahami akan arahan diberi*	1	2	3	4	5
5	Learn to cook is much easier with using the printed cooking book *Belajar memasak lebih mudah sekiranya menggunakan buku masakan bercetak*	1	2	3	4	5

Mobile-based Augmented Reality Application

Have you come across similar Augmented Reality Application that recognizes a particular pattern when a camera points at it, and overlaying a digital image at that point on the screen?
Pernahkah anda menggunakan Aplikasi Augmented Reality yang mengiktiraf corak tertentu apabila mata kamera pada ia, dan melapisi imej digital pada ketika itu pada skrin?
Yes / Ya [ ] No / Tidak [ ]

If yes, what is the name of application that you have come across before?
Jika ya, apakah nama aplikasi yang pernah anda gunakan itu?

_____

No.	Description	SD				SA
1	You often hear the concept of Augmented Reality (AR) *Anda sering mendengar konsep "Augmented Reality (AR)"*	1	2	3	4	5
2	You understand concept of Augmented Reality (AR) *Anda memahami konsep "Augmented Reality (AR)"*	1	2	3	4	5
3	This application is an improvement in the current learning of cooking that use AR elements to display videos and other additional information *Aplikasi ini adalah satu kemajuan dalam pembelajaran semasa memasak yang menggunakan unsur-unsur AR untuk memaparkan video dan maklumat tambahan lain.*	1	2	3	4	5
4	This application is more effective in terms of visualization that not only use static image as the normal learning process. *Aplikasi ini lebih berkesan dari segi visualisasi yang bukan sahaja menggunakan imej statik seperti dalam proses pembelajaran secara normal.*	1	2	3	4	5
5	The additional element of AR in this application make the process of learning more interesting *Element tambahan AR yang terdapat dalam aplikasi ini membuatkan proses pembelajaran lebih menarik*	1	2	3	4	5
6	This application can help novice learn how to cook easily. *Aplikasi ini boleh membantu orang baru belajar bagaimana untuk memasak dengan mudah*					

Recommendations or suggestions:

APPENDIX C: USER MANUAL

1. Copy application package file "psmfinal1.apk" from the Google Drive into Android Smartphone through connecting cable with computer or Bluetooth.
2. Search the apk file inside Android directory and click on it.
3. A dialog box will appear, proceed by select "Install".
4. After the installation had completed, the application named "PSM" can be seen in the application list.

Note:

1. Please ensure that your phone setting is configured to install of non-market applications.

a. Navigate to Setting > Applications.

b. Check the box for "Unknown sources – Allow install of non-marker applications"