Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF INTERACTIVE APPLICATION FOR STEM EDUCATION USING AUGMENTED REALITY

MUHAMMAD NOR AMINSHAH BIN ABU BAKAR

Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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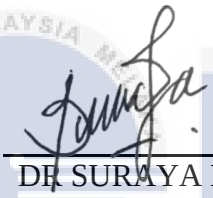
DECLARATION

I declare this project report entitled “Development of Interactive Application for STEM Education using Augmented Reality” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature	:	AminShah
Student Name	:	MUHAMMAD NOR AMINSHAH BIN ABU BAKAR
Date	:	10/1/2023

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in term of scope and quality for the award of the degree of Bachelor Bachelor of Electronic Engineering Technology (Telecommunications) with Honours

Signature	:	
Supervisor Name	:	DR SURAYA BINTI ZAINUDDIN
Date	:	10/1/2023

DEDICATION

I would like to dedicate my Bachelor Degree project to my late father who thought me to be an independent and determined person, and also to my lovely mom. Both of them give me inspiration for not giving up in life and also worked hard to give me some advice and financial support to finish my studies. They always supports me and always thought me that the best knowledge in life which is to learn from our experiences and take that as in positive side of every negative thing. Next to my supervisor Dr Suraya Binti Zainuddin that always taught some knowledge and fresh ideas to complete this project. To my friends and all people that had guided me throughout completion of this project. Besides, t the person that encourages me to persue electronic engineering fields. Lastly, to the person who give me an inspiration for not giving up studying in electronic engineering.

ABSTRACT

Augmented reality (AR) is an enhanced version of the real physical world through digital visual elements, sound, or other sensory stimuli delivered via technology. AR makes learning more engaging and fun. It can be used across all levels of schooling, from preschool education up to college or even at work. Nowadays, students have difficulty on concentrating when online face-to-face learning because there is no interest in their notes and learning methods. In other words, augmented reality is the best platform to make the educational process more engaging and safe. Augmented reality is replacing traditional methods and introducing creative ways to learn. AR encourages students to participate, interact and improve their capacity to master curriculum subjects. It encourages students to allocate more attention to academic subjects while limiting their time on social media platforms. Thus, in this study, AR application will be realised to model electronic component elements, focusing on components in the power supply to emulate the electrical and electronic engineering learning process and to improve learning experience. This project includes the design of AR and identifying the functionality of electronic components for the AR application. Firstly, the project will utilise software Blender to create 3D design modelling of every electronic component in the power supply. Next, it will use Vuforia software for creating augmented reality apps. Vuforia engine can recognize and track a wide range of 3D objects, enabling object targets to be created by scanning physical objects. Then, Vuforia software is a tool to accomplish different types of tasks related to the visual production process. Unity provides game developers with a 2D and 3D platform to create video games and visual platforms. Regarding to the response survey, this AR application provides a learning method on a power supply and components that construct it. Hence, the function of electronic components in the power supply for the design was identified prior to prepare the content of the AR apps. Next, an AR application for STEM leaning specifically on the power supply was designed. Finally, the effect of AR in learning on the scope developed was measured through questionnaire to improvement or drawback of the AR in learning.

ABSTRAK

Augmented reality (AR) adalah versi dunia fizikal sebenar yang dipertingkatkan melalui elemen visual digital, bunyi, atau rangsangan deria lain yang disampaikan melalui teknologi. AR menjadikan pembelajaran lebih menarik dan menyeronokkan. Ia boleh digunakan di semua peringkat persekolahan, dari pendidikan prasekolah hingga kolej atau bahkan di tempat kerja. Pada masa kini, pelajar mengalami kesukaran untuk memberi tumpuan apabila dalam talian atau pembelajaran bersemuka kerana tidak ada minat terhadap nota dan kaedah pembelajaran mereka. Dalam erti kata lain, realiti tambahan adalah platform terbaik untuk menjadikan proses pendidikan lebih menarik dan selamat. Realiti yang dipertingkatkan adalah menggantikan kaedah tradisional dan memperkenalkan cara kreatif untuk belajar. AR menggalakkan pelajar untuk mengambil bahagian, berinteraksi dan meningkatkan keupayaan mereka untuk menguasai mata pelajaran kurikulum. Ia menggalakkan pelajar untuk memperuntukkan lebih banyak perhatian kepada subjek akademik sambil mengehadkan masa mereka di platform media sosial. Oleh itu, dalam kajian ini, aplikasi AR akan direalisasikan untuk memodelkan elemen komponen elektronik, dengan memberi tumpuan kepada komponen dalam bekalan kuasa untuk mencontohi proses pembelajaran kejuruteraan elektrik dan elektronik, dan menambah baik pengalaman pembelajaran. Projek ini termasuk reka bentuk AR dan mengenal pasti fungsi komponen elektronik untuk aplikasi AR. Pertama, projek ini akan menggunakan perisian *Blender* untuk membuat pemodelan reka bentuk 3D setiap komponen elektronik dalam bekalan kuasa. Seterusnya, ia akan menggunakan perisian *Vuforia* untuk membuat aplikasi realiti tambahan. Perisian *Vuforia* boleh mengenali dan mengesan pelbagai objek 3D, membolehkan sasaran menyelesaikan pelbagai jenis tugas yang berkaitan dengan proses pengeluaran visual. *Unity* menyediakan pengurusan permainan dengan platform 2D dan 3D untuk membuat permainan video dan platform visual. Berdasarkan tinjauan respons, aplikasi AR ini menyediakan kaedah pembelajaran mengenai bekalan kuasa dan komponen yang membinanya. Oleh itu, fungsi komponen elektronik dalam bekalan kuasa untuk reka bentuk dikenal pasti sebelum menyediakan kandungan aplikasi AR. Seterusnya, aplikasi AR untuk STEM yang bersandar secara khusus pada bekalan kuasa telah direka bentuk. Akhir sekali, kesan AR dalam pembelajaran terhadap skop yang dibangunkan diukur melalui soal selidik kepada penambahbaikan atau kekurangan AR dalam pembelajaran.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank all the people who have helped me with this project. Starting with my supervisor Dr Suraya Binti Zainuddin who has helped me a lot during this project with advice, fresh ideas and hints to get the best performance.

My highest appreciation goes to my parents and family members for their love and prayer during the period of my study. An honorable mention also goes to Ts Encik Fadzil and Nurfarra Aiza Binti Ahmad Farish as for the advice and sharing knowledge to make Augmented Reality application successful.

Thank you to my colleagues that strive and fighting together from PSM 1 until PSM 2 subject with me, especially from BEET students that really pump our spirit together.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AR	-	Augmented Reality
STEM	-	Science. Technology, Engineering, Mathematic
3D	-	3 Dimensional
AC	-	Alternating Current
DC	-	Direct Current

CHAPTER 1

INTRODUCTION

This chapter will discuss about the background of the project, problem statement, objective, scope of the project and the project outline.

1.1 Research Background

Augmented Reality has developed as a milestone innovation in the engineering world for how visual perception can be improved [1]. Augmented reality has been an extraordinary platform for empowering the education side, especially for engineering students. In higher education, augmented reality is used for a variety of purposes. Faculties create teaching materials using augmented reality platforms and include gamification into the curriculum. Teachers and lecturers can use augmented reality to assist pupils grasp and comprehend difficult courses by making abstract concept tangible. This project uses a 3D model and animation to explain complex topics that need to be better visualised and comprehended.

In the twenty-first century, learning Science, Technology, Engineering, and Mathematics (STEM) has progressed from the traditional textbook to an interactive platform utilising modern devices[2]. This paper describes how to use Android Studio, Unity software, Vuforia software, Blender software, SolidWorks, and mobile application systems to improve the learning experience by projecting Augmented Reality (AR) items onto 3D photos. This augmented reality picture improves students' grasp of STEM courses and increases their excitement for them.

The Vuforia SDK was used to create the application in Unity 3D. The application's development is aided by the use of prefab that can get from SDK itself [3].The design software Blender and SolidWorks were used to construct three-dimensional objects. This project chooses a power supply as the main example of an

electronic device as we know engineering students familiar with electronic components and their functions. This research focuses on the 3D model and the implication of employing augmented reality to illustrate electronic engineering topics. Several aspects of augmented reality have been used to present the circuit content. Although a large amount of work has been reported on the use of AR in education, it is only recently that articles have been published on the use of AR in engineering education [1]. This project shows some topics especially electricity, astronomy, sound and others are worked developed by using technologies to encourage student's attention by these topical issues [4].

In order to achieve clearly stated educational goals, the usage of augmented reality in education should be tightly regulated. Nonetheless, the usage of augmented reality in combination with traditional teaching methods has been shown to have advantages over both traditional teaching and e-learning technology [5]. The concept of using a smartphone application for teaching is not new. It is a well-known and extensively used free programme that contains data from a variety of scientific, mathematical, and engineering fields.

The purpose of this paper is to show the reader how augmented reality could be a useful tool for delivering knowledge unique to the discipline of electronic engineering. In addition, it is required to utilise teaching materials that record and accumulate the use learned by learners, and the use of learning record data and portfolio that record the results and processes of what has been learned so far are drawing attention [6]. This study focuses on the usage of augmented reality in electrical engineering. These are some creative and innovative platforms that could aid lecturers and teachers in making their electronic classes more interactive and exciting.

1.2 Problem Statement

Today's education industry faces several concerns and obstacles, and significant reforms are required to strengthen the education system, as well as the industry's performance and development. Augmented reality has not been widely known in the field of electronic engineering teaching and learning. There are a lot of advantages to using this augmented reality as a learning material for students, especially in electronic engineering topics. In other words, augmented reality creates opportunities for teachers to expose students to the visual concepts in their learning. By using AR technology's involvement and experimentation, teachers and lecturers can improve classroom experiences, teach new skills, boost student brains, and get students excited about exploring new academic interests. Students also struggle to understand the function and the visualise section of component that have in power supplies [7]. This project highlights the key elements that must be addressed to develop an effective improvement approach.

Furthermore, people especially students, are familiar with notes or paper, and now it is time to use the different platforms in educational methods. Students need something different and special in their learning to make it easier to understand. The STEM approach to learning environment for the student's creativity and thinking skills in addition to the core disciplines. It inspires and encourages young people to create new technologies and ideas. Students benefit from inquiry-based coursework because student be able to focus on practice and innovation. STEM education enables student to grasp concepts and motivates them to put what they've learned into practise. The mission of the project may be summed up into words: discovery and experience. Students can establish a distinctive worldview through projects based on learning and problem-solving. It is based on adaptability and curiosity, which prepares students to respond to real-world challenges.

As a result, it is believed that this project would help individuals by increasing engagement and interaction, as well as providing a richer user experience. AR is becoming more and more common and convenient for mainstream audiences and is continuously integrated into more accessible. This technology is hoped can be an ideal tool to be used by many people especially in the education industry.

1.3 Project Objective

The objectives of this project are as follows:

1. To identify the function of electronic components in the power supply for the design.
2. To design an Augmented Reality application for electronic engineering education.
3. To measure the effect of Augmented Reality application in learning on students with related to power supply and its components.

1.4 Scope of Project

The scope of this project is as the follows:

a) To study the function of power supply that have 4 stages which are transformer, rectifier, filter and voltage regulator.
b) Design 3D electronic components in Blender.
c) Determine and select the image target for the 3D component.
d) Check the quality of the image target in Vuforia.
e) Import 3D component design and image target in unity software.
f) Setup AR at unity software till complete.
g) Download as an android package file for android devices.

1.5 Report Outline

This report comprises of five main chapters divided into several sections to provide a detail explanation of the research. The contents of each chapter are summarised below to lay an overview guide of the study.

Chapter one consists of research background, problem statement, project objectives and scope of project.

Chapter two consists of the review of literature and the analysis identification of all the component element that related to this project. . Based on the literature review, it can be summarised that each component and software used have its own function in completing this augmented reality application, which may bring advantages and disadvantages to the system.

Chapter three consists of the methodology such as sample, setting, design and data analysis methods. The project developer creates a project development strategy, project operation development, project determination, and final project integration are the four stages of methodology. The workflow of the conceptual design system is illustrated and explained. The project workflow also explains how the project was organised to meet the deadline.

In chapter four, concluded the outcomes of the project on the "Development of Interactive Application for STEM Education using Augmented Reality". The result shows the final design of components that constructed a power supply by using Blender software, and the assembling process involving Unity 3D software.

Lastly, chapter five concludes this report. A summary of the research is presented, and findings of the study are discussed and interpreted.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Several authors and reports mentioned a scarcity of STEM (Science, Technology, Engineering, and Mathematics) experts and argued that this must be addressed through early intervention in elementary schools. Students benefit from exposure to STEM hands-on experiments since it increases their interest in these subjects[8].

STEM education gives students skills that make them more productive and equipped for today's job market. It encompasses a variety of skills and experiences. In its own way, each STEM component adds to well-rounded education. Science gives students a comprehensive understanding of the world around them. As a result, children must participate in high-quality STEM activities that stimulate creation, non-traditional solutions, high-level communication and vocabulary development, and iterative testing of solutions [9]. The learning environment based on this application AR can be used for a teachers or instructors towards quality AR educational and students to obtain knowledge in study [10].

STEM is a technique of teaching in which disciplines are thought about together rather than separately. Given its historical connection to vocational education, technology and engineering in STEM education might be considered as a product of engineering. The power supply is one of the technology that is well-known in both categories. Educational or instructional technology that is used to improve teaching and learning might be considered technology in STEM education that can be used to increased awareness of power supply.

Power supplies can be found anywhere, and understanding on how the function will help in choosing the best solution based on needs. A power supply is required,

whether it is a high-voltage to power onboard a ship or even a simple charging for a laptop computer. There are various models available in the market with various features and capabilities. Thus, it needs to understand how it distinguishes an ad-dc power supply, and how to select the best supplies based on devices and applications. In this project, it will explore the components that construct the basic power supply. These components help the device step up or down voltage, convert power, reduce ripple voltage, which are energy-wasting residual variations that cause overheating.

2.2 Previous Recent Project

Previous recent projects, which used almost the same software, technology, and equipment to produce and innovate the new project, were picked to generate a concept for improving and mitigating the disadvantages. Table 2.1 tabulates the previous recent studies on augmented reality involving STEM education. Science, Technologies, Engineering, and Mathematics in an integrated interdisciplinary approach to learning, that provides students with hands-on and relevant learning experiences. Furthermore, the beauty of augmented reality is that it provides one of a kind digital experience that merge the digital and physical worlds. Furthermore, no extra hardware or software is required to enjoy the experience, only a smartphone and a few applications are needed.

Table 2.1: Recent project on Augmented reality and STEM education

No.	Author	Title	Year	Software utilised	Target user	Description
1.	Ang, Ivan Jie Xiong, Lim, King Hann	Enhancing STEM Education using Augmented Reality and Machine Learning	2019	➢ 3D model software ➢ ARCore software ➢ Sceneform software ➢ SDK software	➢ Teachers ➢ Students	AUREL (Augmented Reality Learning) is a mobile application solution that enhances the learning experience by projecting Augmented Reality (AR) items over 2D photos.
2.	Nancy K. Dejarnette, ED. D,	Providing early exposure to STEM (Science, Technology, Engineering, and Math) Initiative	2020	-	➢ Students	The implementing STEM initiative into the American education system
3.	Haghanikar, Mojgan Matloob	Cyberlearning and augmented reality in STEM education	2019	➢ 3D software	➢ Students	Developing VISTA LINKS SCIENCE LABS, The new method of

						science lab that enhances student's knowledge structure.
4.	Teresa Restivo, Fatima Chouzal, Jose Rodrigues, Paulo Menezes, J. Bernardino Lopes	Augmented Reality to improve STEM education	-	➢ JavaScript library ➢ JSARtoolkit ➢ Blender software	➢ Students	Creating a DC circuit fundamentals augmented reality (AR) application.
5.	Costa, M. C.Patricio, J. M.Carranca, J. A. Farropo, B.	Augmented reality technologies to promote STEM learning	2018	➢ Gamification software	➢ Students	In an informal learning context, design and execution of an augmented reality astronomy smartphone game.
6.	Alejandro Alvarez-Marin, J. Angel Velazquez-iturbide, Mauricio	Intention to use an interactive AR app for engineering education	2020	➢ Unity 3D software ➢ Vuforia software ➢ SDK software	➢ Students	Augmented reality as an interactive app to improve academic performance an in electronic circuit.

	Castillo-Vergara					
7.	N.S Rigenkov, V.N Tulsky, S.V Borisva	Application of Augmented Reality Technology in the Study of Electrical Engineering.	-	➢ ARkit ➢ ARCore ➢ Unity 3D software ➢ Vuforia ➢ SDK software	➢ Students	Development of a mobile application for a smartphone running the android operating system that uses augmented reality to show transformers operation.
8.	M. Bazzaza, B. Al Delail, M.Zemerly et al	IARBook: An Immersive Augmented Reality system for education	2015	➢ Vuforia Engine software ➢ Unity 3D software	➢ Students ➢ Educators	AR (Augmented Reality) is one such technology that has a wide range of educational uses. This study explains how, when used in conjunction with a book, an immersive augmented reality (iAR) application can work as a new smart learning approach by activating as many of the user's sense

						and human functions as possible.
9.	J.Ping, Y.Liu, D. Weng	Comparison in depth perception between virtual reality and augmented reality systems	2019	➢ Unity 3D software	➢ Audience	Using an optical see-through head-mounted display, this research conducts an experiment to access user's depth perception performance in VR and AR systems (HMD). The results reveal that depth estimate accuracy in AR is higher than in VR.
10.	Pratibha, Samual Jacob, Mandar Warde	Impact of Augmented Reality as ICT tool to deliver Engineering content	2020	➢ Vuforia software ➢ Unity 3D software ➢ Blender software	➢ Students	The application of Augmented Reality in engineering education is discussed in this study. The requirement for visualisation is at the heart of engineering education,

						and there are a number of platform for doing so.
11.	Galvão, Marco Aurélio Zorzal, Ezequiel Roberto	Augmented reality applied to health education	2013	➢ Visual Studio software ➢ Software SDK	➢ Students	This short study indicates the creation of three alternative Augmented Reality-based health education applications. We believe that these applications will assist in bringing health education to student's homes at all levels, as well as reducing some issues associated with anatomy instruction at college, such as the cost of obtaining corpses and the scarcity of qualified professionals.
12.	Fabio Matoseiro Dinis, Ana	Virtual and Augmented Reality game-based	2017	➢ Unity 3D software	➢ Students	In this paper, Virtual Reality (VR) applications developed by first year

	Sofia Guimaraes, Barbara Rangel Carvalho, Joao Pedro Pocas Martins	Application to Civil Engineering				students during an inductor class of the integrated masters in Civil Engineering are described.
13.	D. parades Valastegui, A.Lluma-Noboa, D. Olmedo-Vizueta, D. Avila-Pesentez, J. Hernandes Ambato	Augmented Reality Implementation as Reinforcement Tool for Public Textbooks Education in Ecuador	2018	➢ Unity 3D software ➢ Vuforia software	➢ Students	The technique used in the implementation and testing of an Augmented Reality (AR) application as a reinforcement tool for teaching learning activities is described in this paper.
14.	N. Kommera, F. Kaleem, S. Harooni, Syed Mubashir Syah	Smart augmented reality glasses in cybersecurity and forensic education	2016	➢ Microsoft Hololens software	➢ Students ➢ General people	Smart Glasses and heads-up display devices are not new, but they have seen significant growth in recent years in a variety of

						industries, including education.
15.	Joaquin Cubillo, Sergio Martin, Manuel Castro, Gabriel Diaz, Antonio Colmenar	A Learning Environment for Augmented Reality Mobile Learning	2017	➢ ARToolKit software ➢ ArUeo software ➢ FLARTToolKit and FLARTManager for Adobe Flash software ➢ SDK software	➢ Students	The goal of this work is to propose an augmented reality learning environment that can be utilised by teachers to create high-quality AR educational resources and by students to learn about topic.
16.	F. Khalid, A. Ali, R. Ramzan Ali, Muhammad Syahid Bhatti	AREd: Anatomy Learning Using Augmented Reality	2019	➢ 3DS Max software ➢ Unity 3D ➢ Vuforia software	➢ Students ➢ Instructors	This research describe an augmented reality application for students and instructors that generates 3D models of anatomy.

2.3 Basic Operation of a Power Supply

It's important to understand the difference between a power supply and a power source. The source is where the electricity originates from. The most common electricity sources are an adapter, a battery, or a generator. The power supply converts the voltage and format of the power from the source. Due to many alternatives, the purpose of the power supply is important in determining whether it needs to control or convert energy. People must understand the component and how it contributes to the device's functionality in order to comprehend a power supply and its function.

2.3.1 Power supplies change voltage

The majority of the time, power supplies are utilised to modify voltage. The power source has steady output regardless of the equipment that must be employed. To avoid overload, power supplies also modify the voltage-or, in the opposite, step it up-to match the device's needs.

When too much electricity from a power source can cause serious damage to a gadget. On the other hand, if the power supply does not deliver enough voltage, the gadget will not work properly. The fundamental objective of power supplies is to alter energy, and the transformer that adjusts the voltage as needed makes up the majority of their components.

2.3.2 Power supplies convert power

The incoming electricity is transformed into a format that can be understood by the electrical equipment. Power supplies come in two varieties: DC-DC and AC-DC. They allow you to plug electrical devices into car outlets or other direct current (DC) power sources. However, these power supplies are not the most common

While DC-DC power supply are available, AC-DC power sources are more common, Electrical outlets distribute alternating current, or AC power. The majority of electrical gadgets require direct current to operate. Thus, the AC power is converted into DC via a power supply. The output may fluctuate during this conversion, necessitating adjustment on occasion. On the other hand, a regulated power supply may not be necessary for general use.

2.3.3 Power supplies regulated power

Regulated electricity is required by the large majority of electrical devices. The output of a power supply is not always constant when the voltage and type of energy are changed. Even though it does not completely switch on and off, the outgoing voltage fluctuates uncontrollably. As a result, an uncontrolled power source can give more power than expected. Such a surge delivered to sensitive electronics such as computers and televisions might inflict significant damage to the parts, or possibly permanent impairment that would be irreversible.

The device's price is improved by the presence of power-control function. It does, however, save money by avoiding the need to purchase new electronics replace those that have been damaged by unregulated voltage. Use unregulated power supplies to save money while supplying device with loads that nearly match the power supply's output. On the other hand, electronics demand regulated power. Hence, do not make the blunder of choosing the incorrect supplier. A simple power supply is a device that converts voltage to DC power and back. If controlled power is necessary, the gadget has an additional step of adjusting the voltage to smooth out waves.

2.4 Power Supplies Parts and Functionality

There are several parts to a basic power supply. These parts help the machine convert electricity, step up or down voltage, and reduce ripple voltages, which waste power and cause overheating. Figure 2.1 depicts a 12V power supply circuit diagram. Meanwhile, Figure 2.2 illustrates a power supply stage flow component.

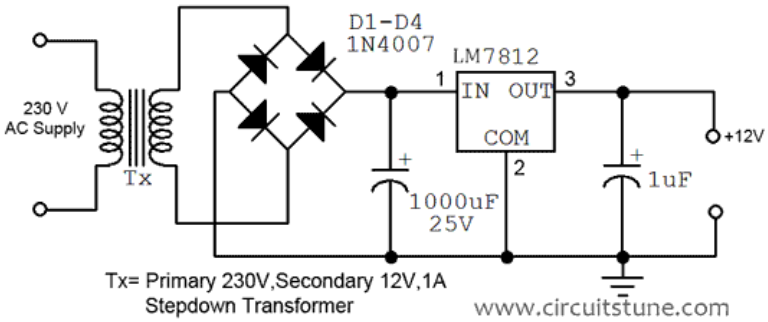


Figure 2.1: 12V power supply circuit diagram

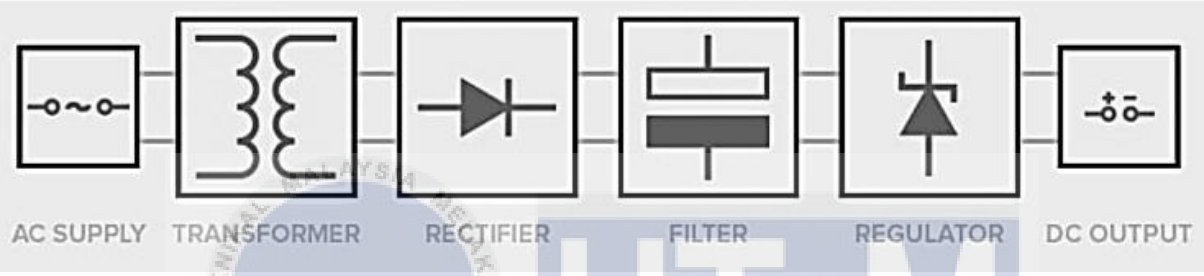


Figure 2.2: Power supply stage flow component

The four main components of transformer, rectifier, filter and voltage regulator are briefly explained in the following sub-sections.

2.4.1 Transformer

The transformer component converts the input voltage to the output voltage necessary. Stepping up or down in voltage is possible with these devices. The DC voltage required is normally way lower than the primary power source's incoming AC voltage to make sure the process of output going smoothly. The voltage required is to increase or decrease by the power supply transformer. Power is produced mostly by electronic equipment on a case-by-case basis. The voltage must be scaled down from 100 volts to 240 volts AC terminals to a much lower level for most modern gadgets. Some of the transformer also can increase the voltage while separating the incoming and departing circuits.

The primary winding is where the transformer's incoming power enters. Incoming electricity is received by secondary winding. There is no physical connection between these two windings. This winding isolation ensures the transformer's safety. As we learn in the physic's topic which is Faraday's Law allows the primary winding's electromagnetic energy to be induced on the secondary winding without a need for contact. When the transformer has finished stepping up or down voltage, the incoming electricity is passed to the rectifier, which transforms the alternating current (AC) to direct current (DC). A diagram of the power supply component which is transformer shown in Figure 2.2 below. This diagram shows the relationship functional between the component in this stage of process. When students move or rotate their phone to the tracking image, a 3D model of the transformer component will appear on the screen of their devices with static and animation [11].

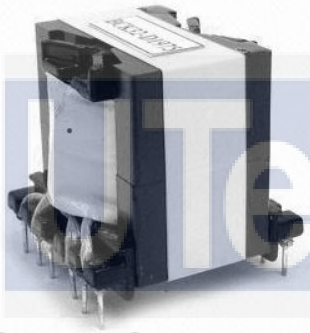


Figure 2.3: Power Supply Transformer

2.4.2 Rectifier

The rectifier in the circuit of power supply, which transform the current type, is an important process of how an alternating current (AC) to direct current (DC) power supply works. To convert alternating current (AC) power to direct current (DC), power supply creators can pick from three types of silicon diodes of rectifiers. Each model of the diodes has its own set of functions and its own advantages. The most efficient rectifier is one that combines the advantages of both half-wave rectifiers cause as we know the concept of rectifier the output of full wave rectifier has low ripple than half wave. The bridge device transforms the whole alternating current (AC) wave without need of a special center-tapped transformer by using four diodes component. A bridge

rectifier is an alternating current (AC) to direct current (DC) converter that transforms the mains AC input to DC output. In the power supplies, bridge rectifiers are often employed to deliver the specified DC voltage power toward the things of electronic components and electronic devices. It can be form from four or more diodes or any other controlled solid-state switch.

The current needs of the load are used to select an appropriate bridge rectifier. When selecting a rectifier power supply for an acceptable electronic circuit's application, consider component ratings and their specifications, breakdown voltage, the temperature ranges, transient current rating, forward current rating, mounting requirements, and other criteria.

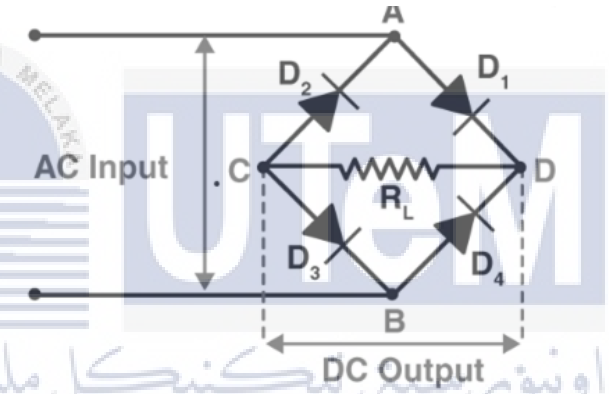


Figure 2.4: Bridge Rectifier construction

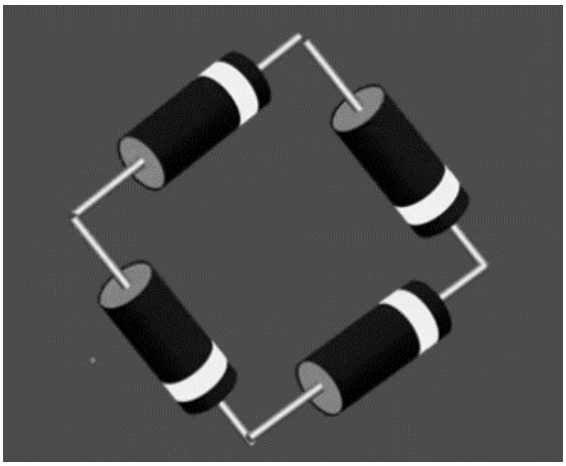


Figure 2.5: 4 diodes connected to form a bridge rectifier

2.4.3 Filter

A Low Pass Filter, also known as an RC filter, is a circuit that can be used to modify, reshape, or reject any unwanted high frequencies in an electrical signal while accepting or passing just the signal desired by the circuit designer. A simple passive RC Low Pass Filter (LPF) can be made by connecting a single resistor and a single capacitor in series, as shown in the diagram below. In this type of filter, the input signal (VIN) is applied to the series combination (both the resistor and the capacitor), while the output signal (VOUT) is taken exclusively across the capacitor. This type of filter is known as a “first order lowpass filter” or “one-pole filter” since there is only “one” reactive component in the circuit.

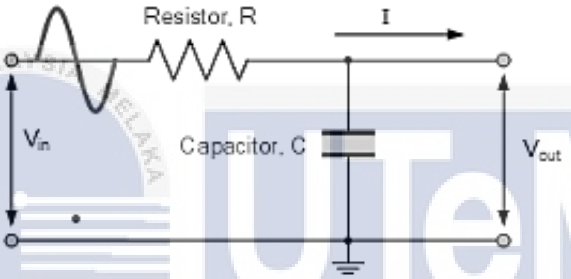


Figure 2.6: RC low pass filter circuit

2.4.4 Voltage Regulator

In a deregulated version, the power supply's job is done when the current leaves the filter. While unregulated power supplies are adequate for most applications, regulated power is required when complete steady electricity that does not fluctuate with the load is required. Linear and switching regulated power supplies are the two types of regulated power supplies that govern energy. A linear power supply transfers electricity in a simple, straightforward manner, reducing ripple voltage to almost nothing. The design of the voltage regulator starts with few components which is transformer to reduce the voltage. Then, the device converts alternating current (AC) AC to direct current (DC) power. After that, a regulator cleans the DC power by lowering the ripple voltage.

This is because of the huge transformer must play its function to step down the power to make this process stable, this regulated power supply option weighs more. Allow-noise operating is a feature of linear power supplies, making them a better alternative when a low-power, clean, continuous supply is required. This type of regulated power supply is very beneficial in medical settings, laboratories, and communication facilities.

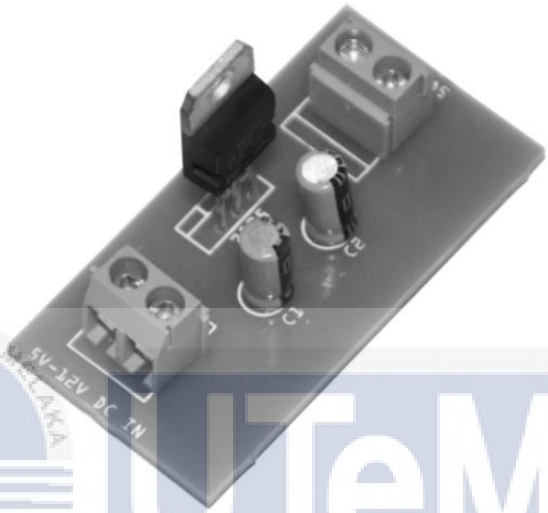


Figure 2.7: Voltage regulator component

2.5 Studies on Augmented Reality Development Software

In order to develop an augmented reality application for STEM, a study has been conducted on available software in the market. Software identified to be utilised for the projects are explained in following sub-sections.

2.5.1 Blender software

Blender is one of the best platform for designers to create a design. It is a free and open-source 3D computer graphics software toolkit that can be used to make animated films, visual effects, art, 3D printed, models, motion graphics, interactive 3D applications, virtual reality, and video games. 3D modelling, UV mapping, texturing, digital drawing, raster graphics, editing, rigging, skinning, smoke simulation, particle

simulation, soft body simulation, sculpting, animation, match movement, rendering, motion graphics, video editing, and compositing are just a few of Blender's features.

Blender's main benefit is that it is a free all-in-one piece of software. It can 3D model, rig, animate, UV, texture, light, and render, among other things. It is a community-driven and tried-and-true open source software that can run a whole CG workflow.

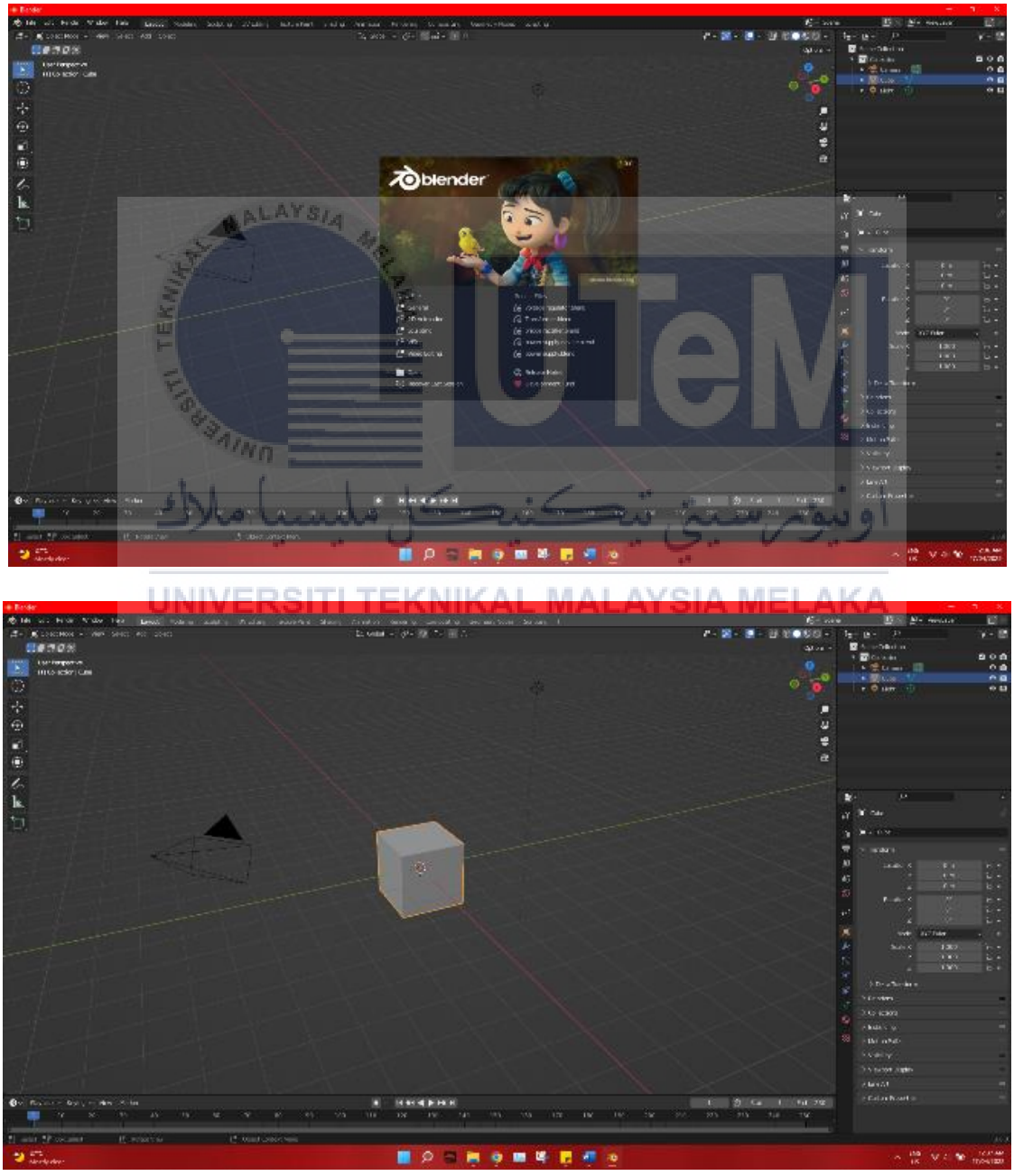


Figure 2.8: Blender software layout interface

2.5.2 SolidWorks software

SolidWorks is a popular CAD programme used in professional settings worldwide. SolidWorks is a popular and well-liked CAD programme with many considering it to be the industry's go0to engineering tool. Dassault Systemes, a French corporation, has introduced a fully flashed-out integration into its cloud 3D Experience works platform, alongside the new SolidWorks 2020 version of the software, seeking to complete with Autodesk's already and popular offering.

SolidWorks is a parametric design tool that allows you to change your design at any time during the process. PhotoView 360 allows for enhanced photo-realistic renderings and animations, while RealView graphics enable for real-time viewing of designs. Both tools will give you a good concept of how a design will turn out before you finish it. Without producing or manufacturing the product, each piece of the design can be evaluated, seeing accurate mass characteristics, and checking for interference, saving time and money and reducing the number of prototypes necessary. All of these will hasten the process.

SolidWorks has a lot of features and can make practically any shape. Nevertheless, its focus on engineering design via geometric parametric modelling means that generating organic forms is not easy as sculpting applications like Blender.

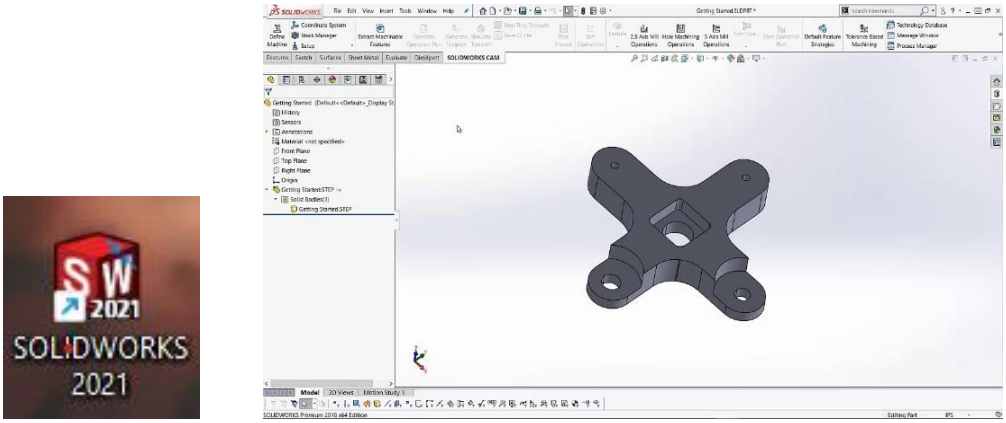


Figure 2.9: SOLIDWORKS icon and software interface

2.5.3 Vuforia software

The Unity Editor is a popular and effective authoring environment for building cutting-edge augmented reality experiences for mobile devices and digital eyewear. Vuforia Engine is a software development kit for Augmented Reality (AR) (SDK). Any software can be enhanced with advanced computer vision technology, allowing it to recognise images and objects as well as interact with real-world environments.

The Positional Device Tracker in Vuforia Engine provides robust and accurate tracking, including tracking a Vuforia target even when the item or content is no longer in the camera view. It is worth nothing that running Vuforia on a Device Tracking-enabled device necessitates the use of several Vuforia functionalities. Vuforia uses and edge-detection technique. Suppose there are more vertices or lines in the high-contrast image, then it is a highly rated image for Vuforia. Therefore, the algorithm is somewhat similar to SIFT. This software also functions as an image detector rating for augmented reality image scans.

Figure 2.10: Vuforia icon

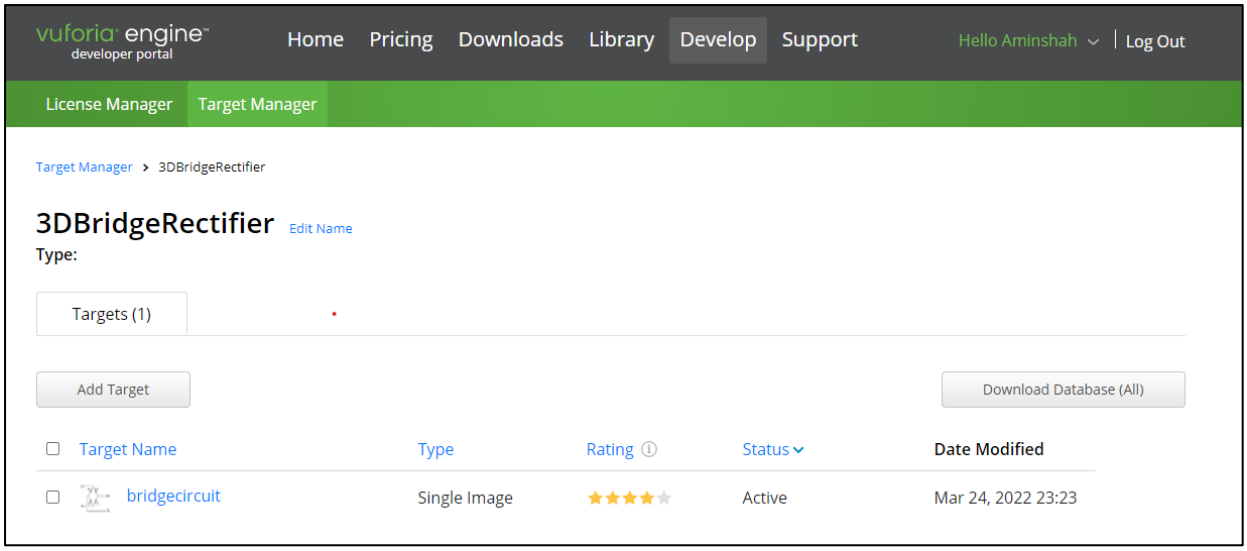


Figure 2.11: Vuforia developer portal

2.5.4 Unity software

Unity is a 3D/2D game engine and a comprehensive platform IDE for creators. Several of the most critical built-in pieces that make a game work are included in Unity. Physics, 3D rendering, and collision detection are some examples. This software very useful to a designer who wants to make 3D design especially for complicated design become into a gamification works. This eliminates the necessity for re-inventing the wheel from the developer's standpoint. It allows recycling an existing project rather than starting from scratch and analysing every last movement of each material or the way light should bounce off different surfaces.

On the other hand, Unity is considerably more powerful because it has a booming “Asset Store”. This is essentially a repository for developers to post their work and make it available to the public. In addition, it provides a library with wonderful assets and ideas.

Figure 2.12: Unity engine icon

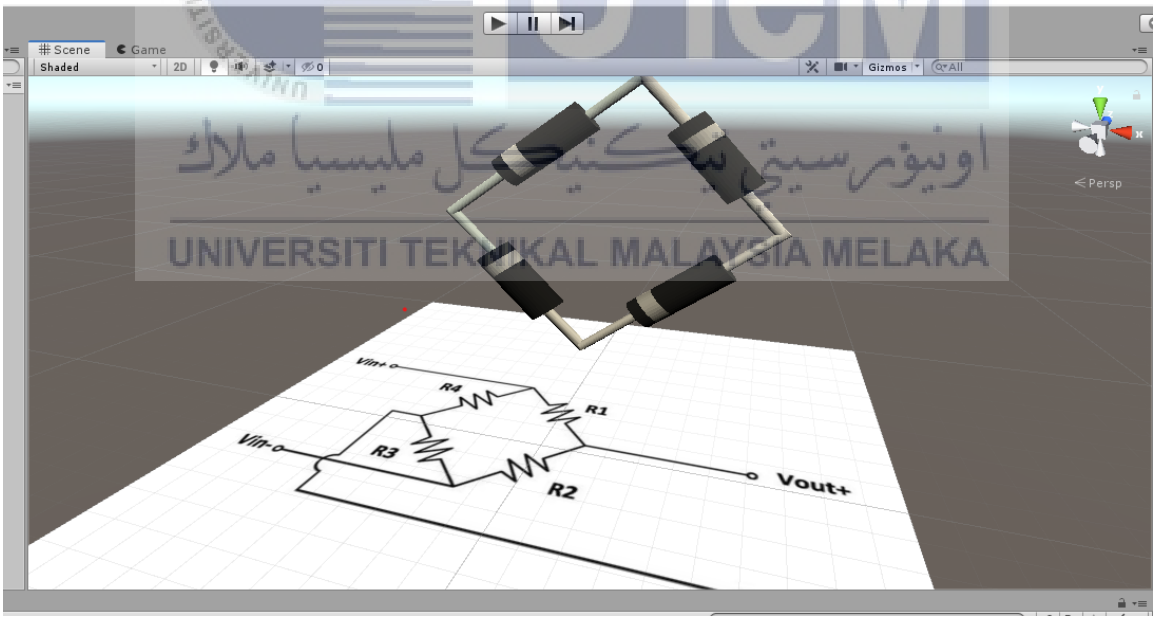


Figure 2.13: Unity editor workspace

2.6 Summary

Practical and theory that frequently used in the development of interactive application for STEM education using augmented reality are studied and analysed through this chapter. Based on the literature review, it can be summarised that each component and software used have its own function in completing this augmented reality application, which may bring advantages and disadvantages to the system. The software utilised and method used in this augmented reality application for each articles are checked and observed. In addition, all works in journals are successfully achieved their objectives on make augmented reality as a learning platform in education fields.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Various techniques and simulations have been explored by previous works with regards to augmented reality. In order to achieve the objectives of this project, this chapter presents the conceptual design of 3D diagram, design components, tracking image and the process of application using augmented reality. This chapter also focuses on the project planning and the workflow. The project involves producing the conceptual design based on literatures, simulation of the design to ensure the performance in the software and finally, the development of the application.

3.2 Project Workflow

This process is separated into five major stages: planning, research, analysis, design, and execution. The planning stage is the most important. The planning phase establishes the project's expected milestones and timeframe for completion. It is to ensure that all operations are completed on time and that the project is successfully delivered as per plan. Figure 3.1 illustrates the high level of project process flow.

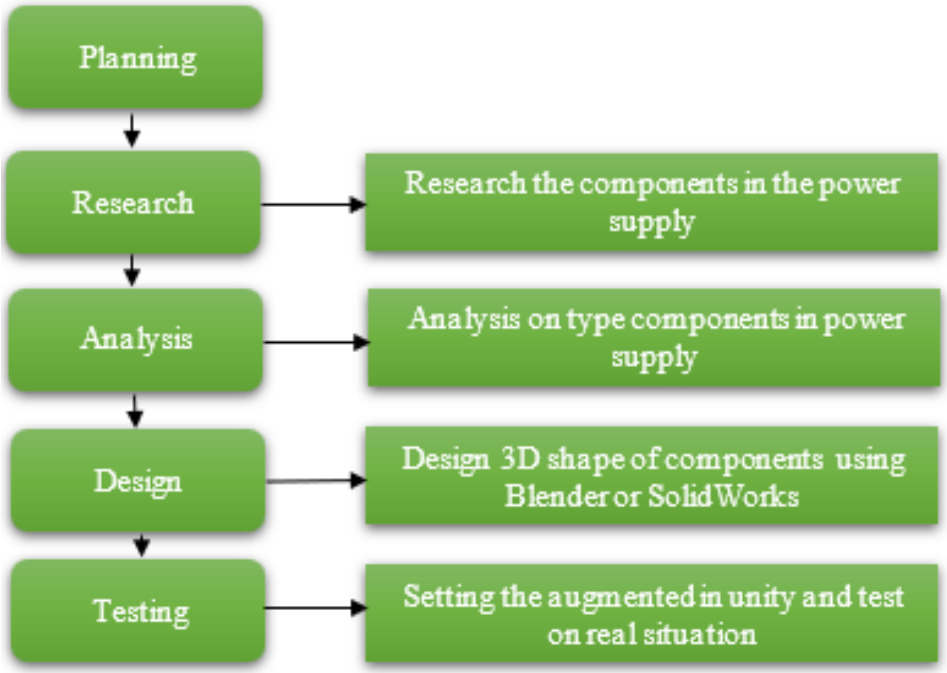


Figure 3.1: Process Flow

3.2.1 Project Planning and Flow Chart

Project is organised to ensure the timeline can be met. Figure 3.2 illustrates the project flowchart while Table 3.1 is the project Gant Chart which summarized the activities and the timeline.

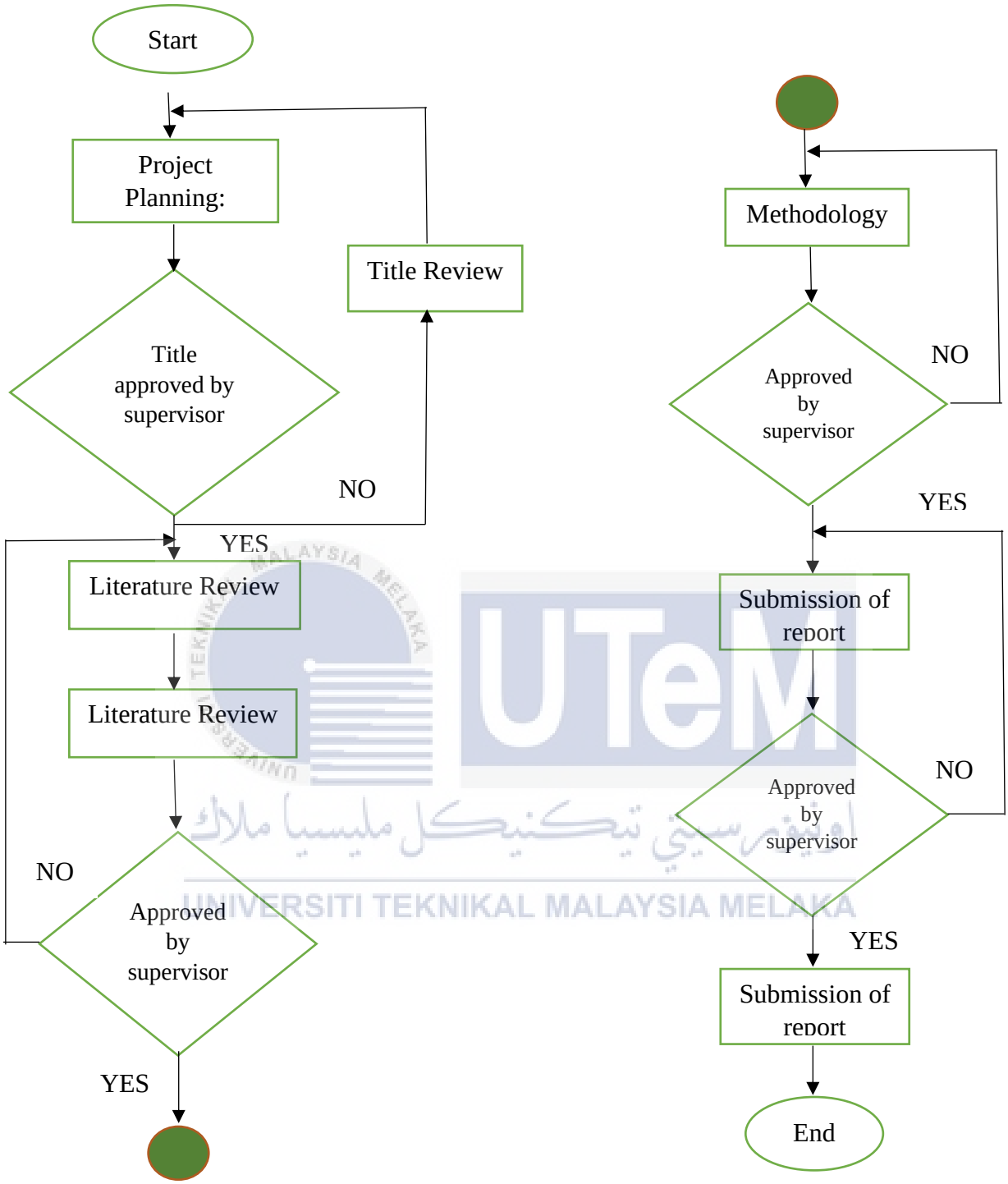


Figure 3.2: Project Flowchart

Table 3.1: Project Gantt Chart (a) Phase 1 (BDP1) and (b) Phase 2 (BDP2)

(a)

PROJECT ACTIVITIES	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11	WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16
BDP Briefing									M							S
Meeting with Supervisor									I							T
Distribution of project titles									D							U
PSM 1 Rubrics Explanation									B							D
Project planning									R							Y
Proposal preparation									E							
Abstract									A							W
Literature Review									K							E
Design Project Modelling																E
Flowchart									S							K
Design Software									E							
Construct the application									M							

(b)

PROJECT ACTIVITIES	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
INTRODUCTION															
Subject briefing by lecturer								M							
BDP 2 solving problem								I							
DEVELOPMENT															
Idea Brainstorming								D							
Manage Unity software															
INTEGRATE SOFTWARE															
Programming/C# Coding Writing								T							
Complete 3D model in Blender								E							
Attach coding into 3D model															
CREATE AN APPLICATION															
Design the application								R							
Assemble 3D model & material in Software								M							
TEST THE APPLICATION															
Test the Application								B							
Comments and Improvements								R							
REGIONAL EVALUATION															
Evaluation								E							
Final Poster								A							
Final Video								K							
Presentation Project															

3.2 The proposed project operational workflow

This project use AR implementation which stands for Augmented Reality. It is used to enhance the natural environments or situations and offer perceptually enriched experiences. Therefore, augmented reality is recommended as a learning method nowadays because it's have a lots of benefit. AR technologies are fast evolving and have applications in a variety of fields. AR system is one of the most suitable solutions for education problem in various contexts [12]. A solution from AR captures of the environment with a camera on a smartphone, tablet, or other electronic device. The captured of the environment is then scanned to identify a point where additional information can be superimposed using markers or trackers. By using this AR applications students start engaging themselves and use AR as their tool and interpret their learning through the use of augmented reality (AR)[13]. Nowadays, technological advancements have improved learning methods, which are beginning to replace old techniques through the use of augmented reality (AR) [14].

Before starting the 3D modelling for the project, it is required to identify the component that will be used to implement in augmented reality. It also needs to know the function of every component in the power supply since it is used after when tracking the image in AR book. The power supply have 4 stages from the input to output which are transformer, rectifier, filter, and voltage regulator. Next, the design of the components will be created in the 3D modelling software known as Blender. Before its move from 3D modelling phase to assembly phase, the format for all components are ensured in .fbx format to be assembled in Unity software. This process will use augmented reality as a substitute platform of authentic work experience with teaching and learning methods, that will assist in the learning process of reasoning and decision-making [15].

The process of assembling the application together and animating it begins by exporting into the Unity. The Vuforia Marker is a model that involves in creating a database and as a launch point for each step of the application. The AR application also assists students in connecting, disparate pieces of knowledge as they point their cell phone toward a target on tracking image [16]. The model of electronic

components is then exported, together with its textures and animations, to a 3D blender for modelling and texture. Once both of components are in assemble in Unity, the interaction of the software used in this study is carried out at the appropriate level based on the components electronic necessary, as illustrated in Figure 3.3.

The animation on frames is done by modelling software at the Unity Animator stage, which allows you to modify existing animations, create new animations, and fix problems. The AR application enables students and instructors to obtain 3D model of the component structure and detail information of the component which can reduce time in learning session[17]. The Unity State Machine's next steps are to create all of components animation sequences, which can be static or repetitive, depending on the level of interaction necessary for each level of application. Several literature stated on the utilization Unity 3D and the Vuforia software development kit (SDK) to develop AR application[18].

The Unity codification stage completes the application's coding. It is done in C# due to Unity platform compatibility. The execution functions in the interface and the movement of the components are created by the surrounding of the corresponding scene. Finally, the last stage involving the build of Android Package (APK) in Execution, where it is executed in the editor. This stage is to identify mistakes and correct scenarios (APK). Augmented Reality (AR) creates incentives for teaching in science and engineering because these disciplines place a strong emphasis on hands-on learning and non-classroom instruction [19].

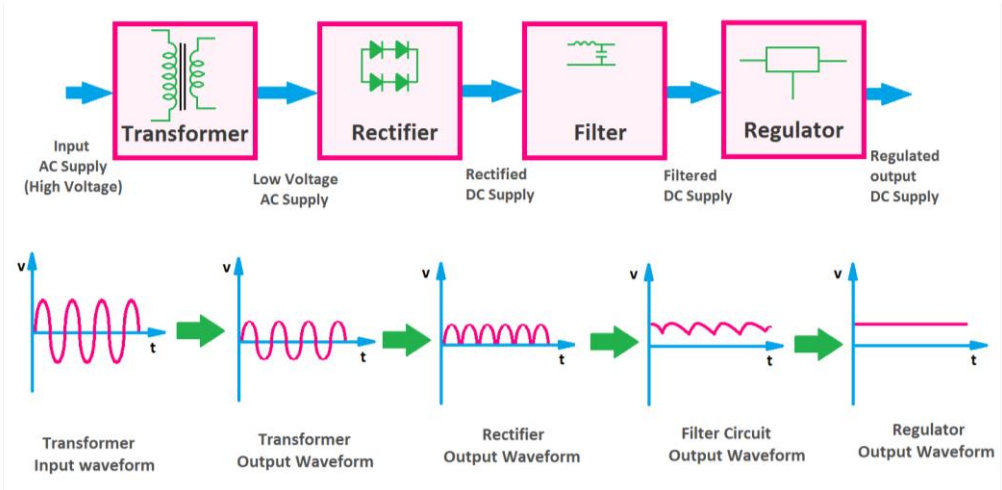


Figure 3.3: Power Supply Block Diagram

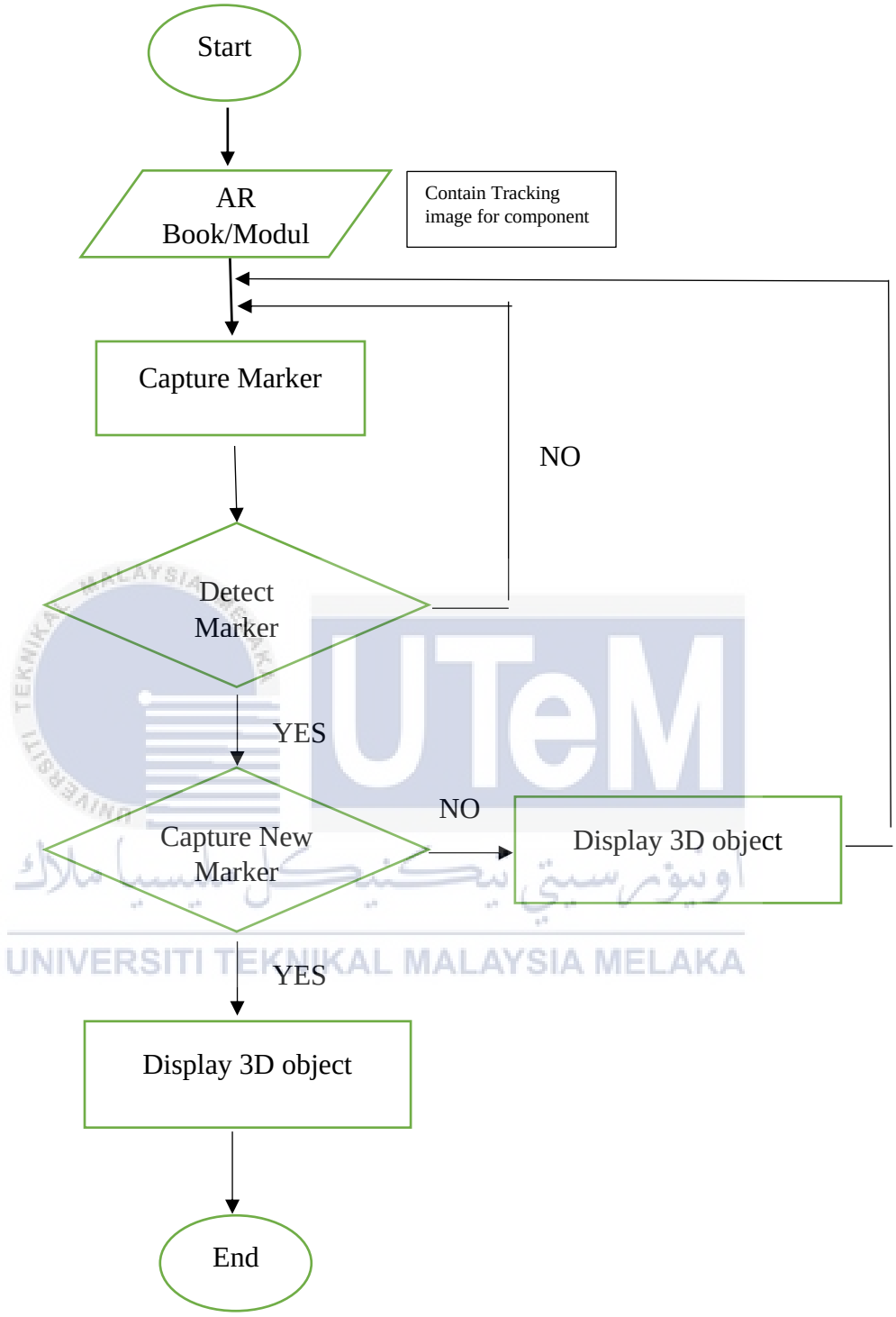


Figure 3.4: Project Flowchart

3.3 Software specifications

The schematic software is utilised for the creation of the application presented in this project of augmented reality, focusing on the development of applications which pick power supplies as the main topic by using augmented reality concept, as illustrated in Figure 3.5. By using seven software and components, below its specific purpose in Table 3.2. The software and components are Vuforia Marker, 3D Modelling (Blender software, the Microsoft Visual Studio Development, Unity Development Platform, Android Studio and Mobile Application.

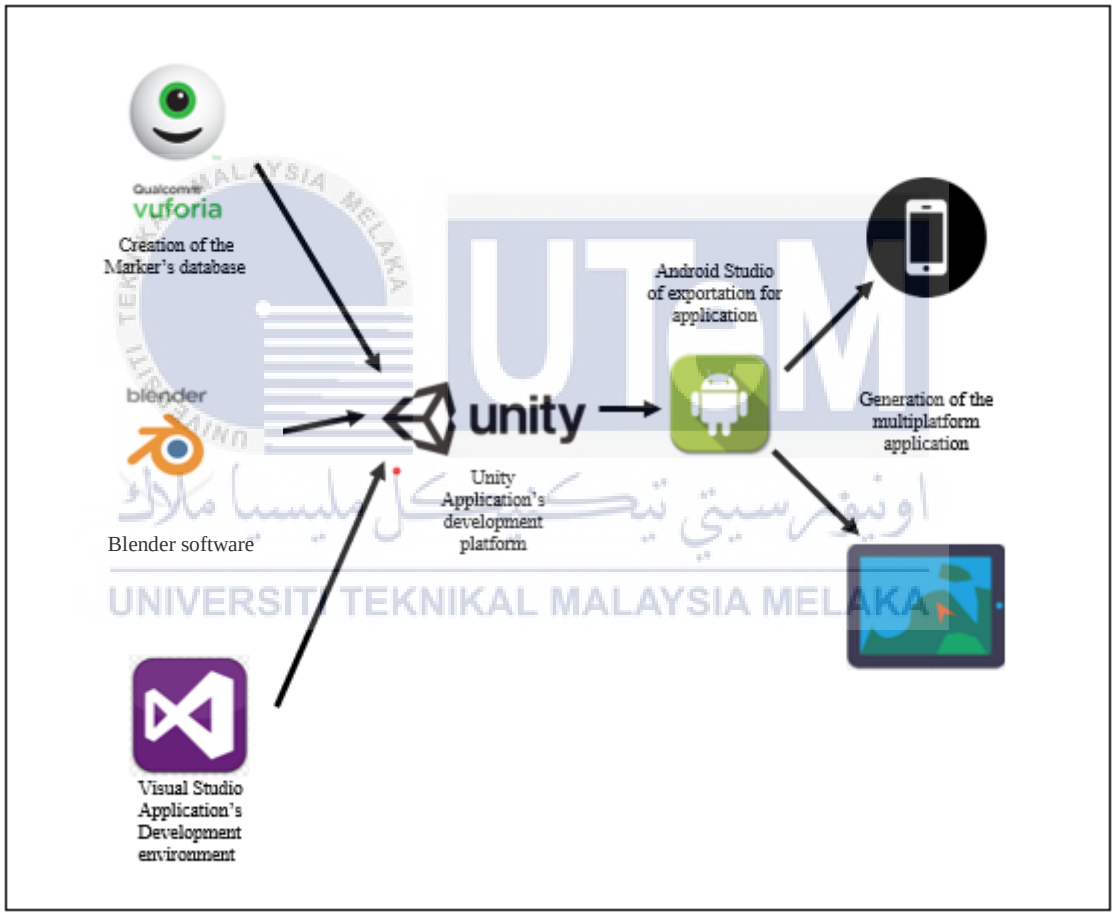


Figure 3.5: Software schematic uses in the development of Augmented Reality

Table 3.2: Description of the software

Software	Description
Vuforia Marker	The component's objective is to construct a marker that acts as the application's starting point and allows working with the Unity environment, which is being used in augmented reality by establishing the proposed scene in the environment.
Modelling of 3D Blender	The objective of this component is to model four stage power supply components using the quadrant modelling method, which allows for more dynamic component manipulation and a better finish when exporting them to Unity
Microsoft Visual Studio	This component's goal is to make it easier to write scripts (code) that manage the GUI (Graphical User Interface) and its interactions. Because it has a direct relationships to Unity, it also cuts down on development time.
Unity development platform	The goal of this component is to connect the objects created by the various IDEs (Integrated Development Environments). Allows for the improvement and correction of both animation and texture issues. Obtaining a level of quality coherence that ensures the multiplatform compatibility of the generated programme
Android Studio	The objective of this component is to create an Android Package (APK) that is interoperable with all types of Android-based mobile devices.

Mobile Application	The purpose of this component is to download the application (APK) for mobile devices, Application Server.

3.4 Software Development

3.4.1 Register Vuforia Developer Portal

Vuforia Engine is a software development kit (SDK) for creating augmented reality applications. With the SDK, it integrates snipping computer vision capabilities into the application, enabling it to identify pictures, objects, and locations with simple configuration options for interacting with the physical world.

This software supports augmented reality application development for Android, iOS, Linux, Lumin, WebGL, Windows and Mac. Firstly, create the username in Vuforia Developer to get the license manager, target manager and database. This element is important as an asset in Unity software for the assembly process.

Next step is creating and managing the licenses using the tools and information available in the license manager. A license key can be used to deploy an application multiple times. Even when deploying to various OS versions, it only needs to create one special license key for Vuforia Engine apps. The License Manager provides the tools and information that are needed to create and manage licences.

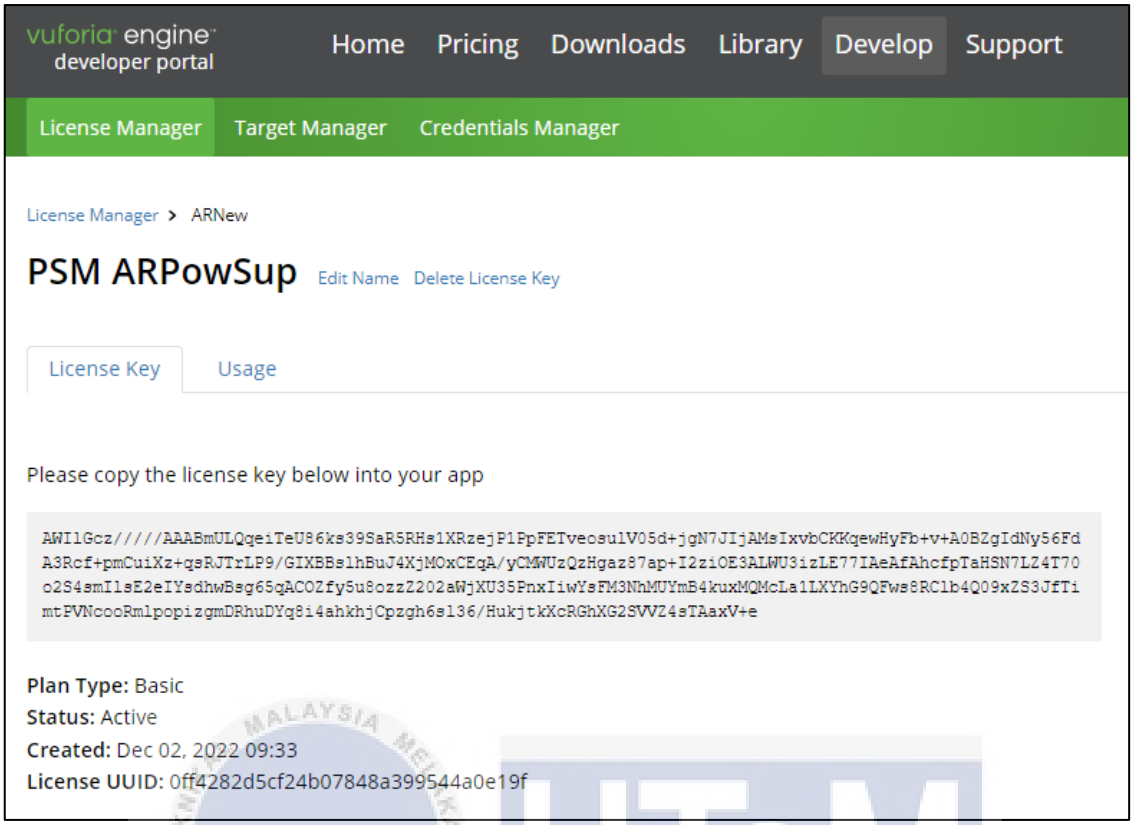


Figure 3.6: License Manager Vuforia Developer

In order to create data and visual representations of the target's features, the Target Manager processes the images. Additionally, the target's anticipated detection and tracking performance score. After that, the image target can be downloaded as a package ready for Unity and native integration.

Any planar image that offers the Vuforia Engine enough detail to detect it can be used as an image target. There are two steps in the creation of image targets. Firstly is designing or choosing your target images, and ensure they are optimized to the guidelines for sizing, defining, and optimising the images.

A Device database is a collection of runtime resources and authoring files for a Vuforia target, also known as datasets in the SDK. Targets that your application is tracking are stored in a database that is locally accessible. The databases can be downloaded from the Target Manager or obtained using one of the database generating Vuforia tools. Device Databases for image based Vuforia Targets can be created, managed, and downloaded using the Vuforia Target Manager.

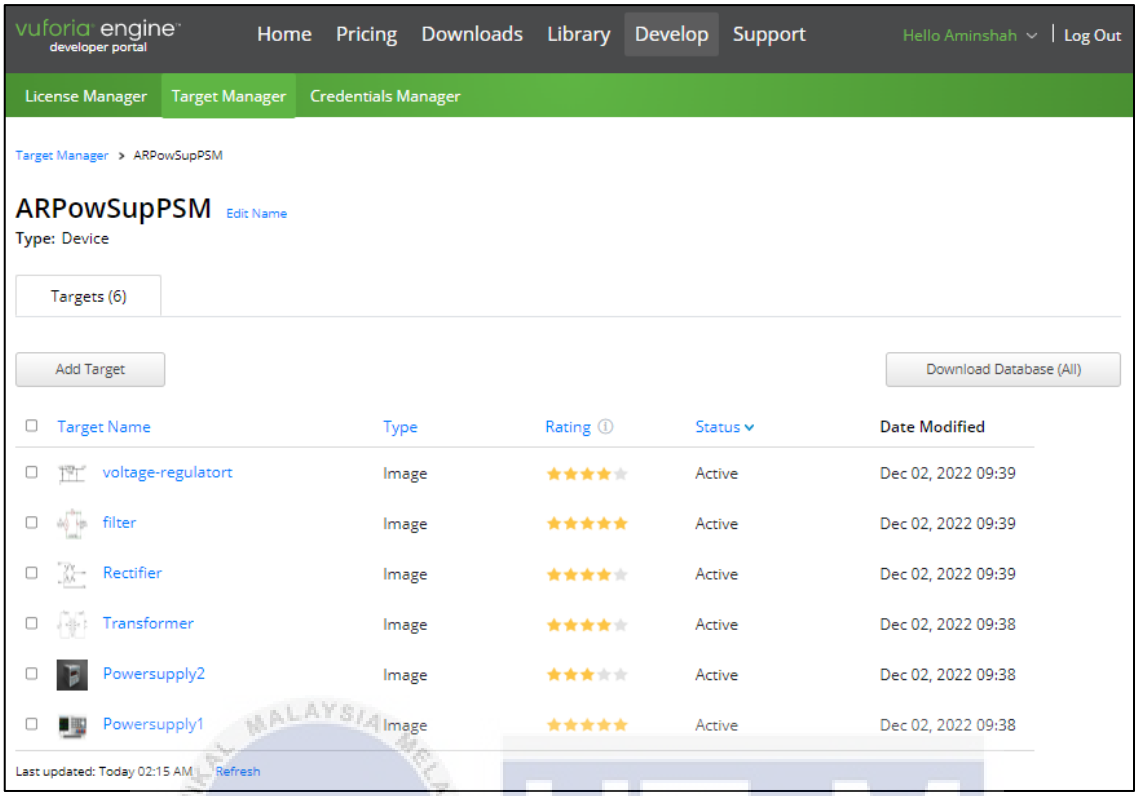


Figure 3.7: Target Manager Vuforia Developer

Image target in Vuforia have status and rating on it, the higher the number of star, indicates the easier the image target can be detected by android and formed the modelling of components. While, the number of star below 2 is considered as status is not active.

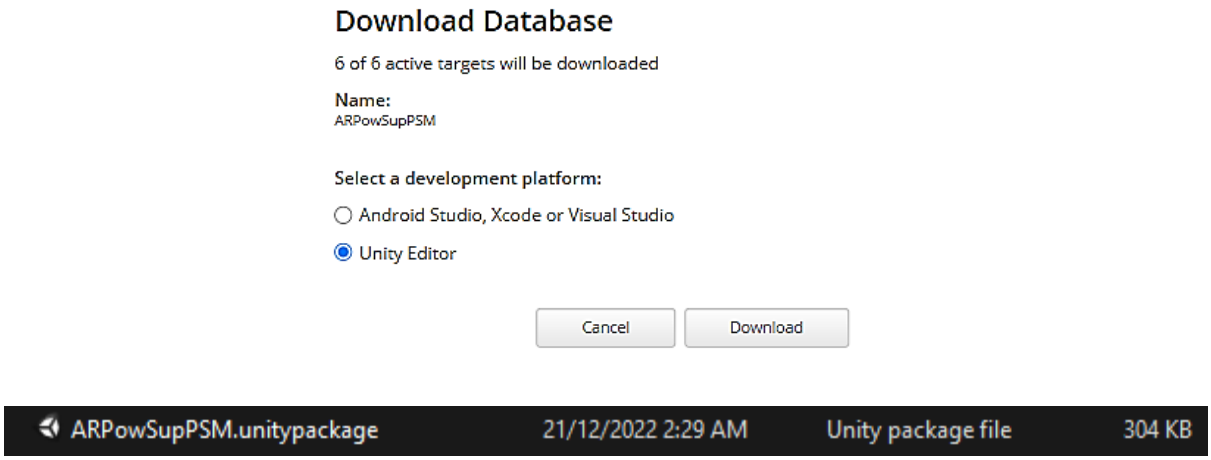
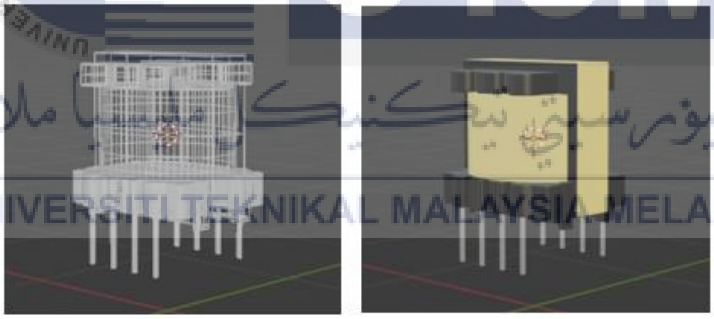


Figure 3.8: Download Database notification and Database package

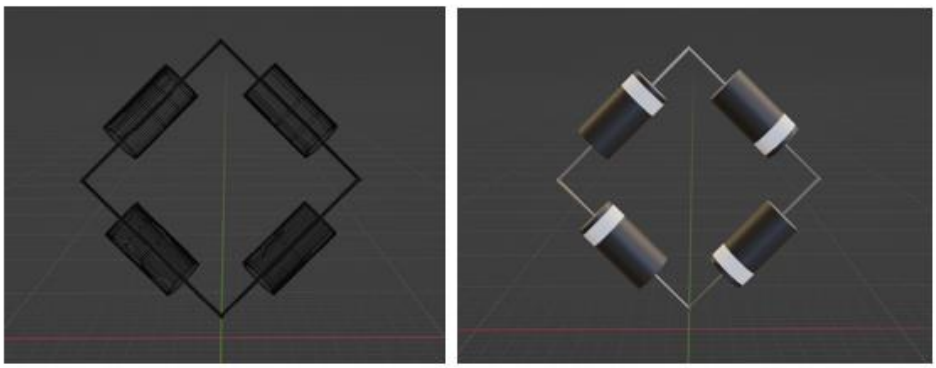
In addition, the Device Database can be imported from the Unity Editor by selecting Import > Custom Package, or by downloading it as a unity package, and then double-click it. The database file will be automatically imported by the Unity package into your project's Streaming Assets folder.

3.5 Create a 3D Model of the Power Supply component

This project is using the Blender software as design software for the 3D modelling component of the power supply. It is an open-source and free 3D creation tool. Modelling, rigging, animation, simulation, rendering, compositing, motion tracking, even video editing, and game development features are all supported by this software. In this project, the process of transformation from AC to DC voltage involving the electronic components needs to be designed as a 3D model. Components created are transformer, rectifier, filter and voltage regulator. Figure 3.9 presents example of 3D model components created.



Wire edges and Material Preview display



Wire edges and Material Preview display

Figure 3.9: Example of 3D models creation.

3.6 Create a C# script in Visual Studio

To utilise a script by Unity, it needs to be attached to a GameObject in the scene. Unity can only understand a specific language of scripting. The script communicates with the system and provides instructions through the language. The C# is the language that is utilised in Unity (pronounced C-sharp). All of the scripting languages that Unity uses are object-oriented. The main components of a scripting language's syntax, or parts of speech, are known as variables, functions, and classes. Figure 3.10 presents the example of trackable script for audio source and Figure 3.11 presents the example of main menu script.

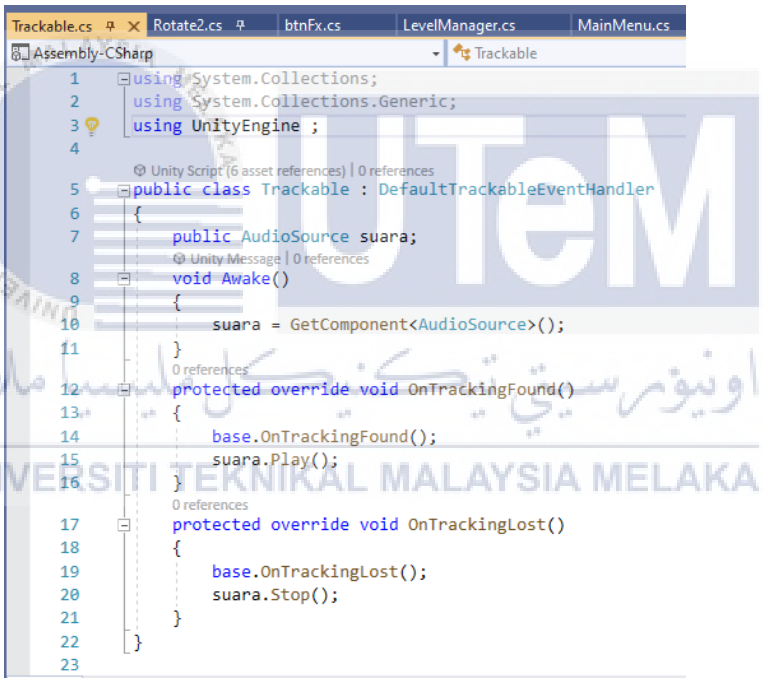


Figure 3.10: Example Trackable script for Audio Source

Figure 3.11: Example of main menu script

Objects (which can be thought of as “bigger” variables) are references to values that are stored in variables. They hold something four us to use, like a box. Lowercase letters are used to denote variables. Code segments that compare and work with these variables are gathered into functions. Uppercase letter is used to indicate functions. Code is organised into functions so that it can be easily reused throughout the programme in various locations. Classes are way to organise code so that collections of variables and functions can be combined to form a template that specifies an object’s properties.

3.7 Assembly in Unity 3D software

Any item you use in your Unity project to make your game or app is referred to as an asset. The visual or audio components of your project that assets can represent include 3D models, textures, sprites, sound effects, and music. Additionally, assets can represent more arbitrary text or numeric data for any purpose, as well as colour gradients, animation masks, and other more abstract objects. A 3D model, audio file, or image created outside of Unity may be the source of an asset. Furthermore, you can create some asset types in the Unity Editor, including, Animator Controllers, Audio Mixers, and Render Textures. a unique class of texture that is generated and

modified in real time. Create a new Render Texture and choose one of your Cameras to render into it before you can use them.

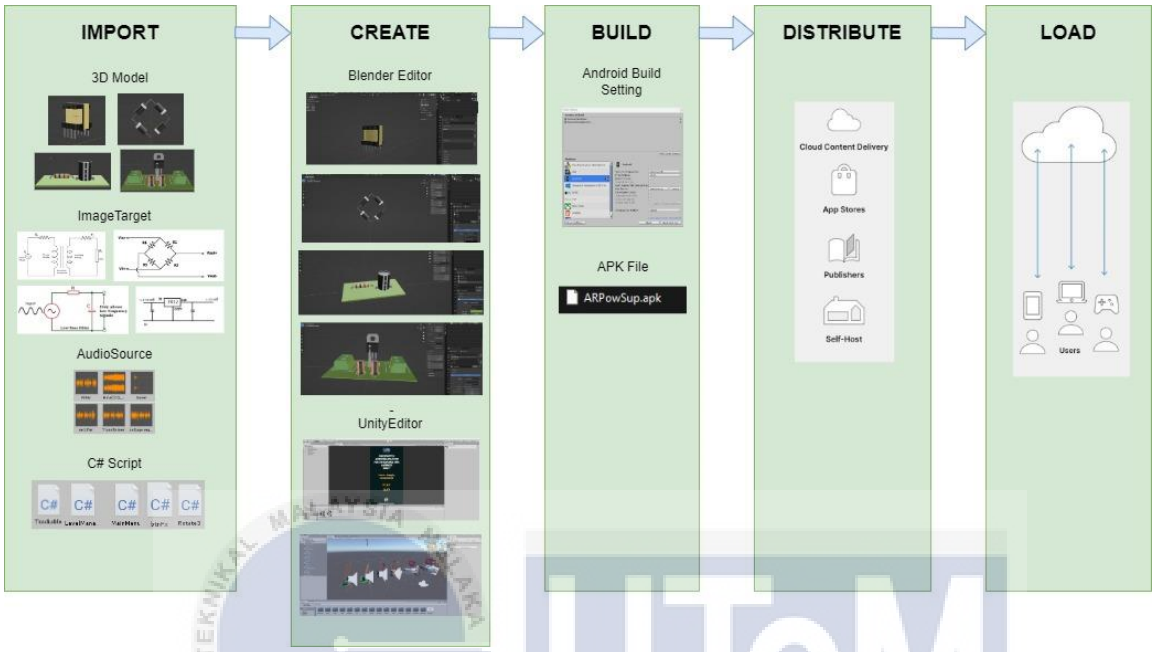


Figure 3.12: Asset Work Flow in Unity

3.7.1 Importing Assets

Attempting to bring source files into the Unity Editor to work with is the process of "importing." Unity imports the file save or copy into project's Assets folder, enabling to work with it in the Editor. It's critical to understand the fundamentals of importing assets into Unity, including where to store the files in our project, how to customise the import settings for each type of asset, the purpose of the meta files, and how the Asset Database stores imported data. Figure 3.13 to Figure 3.16 depict importing asset for the components involved.

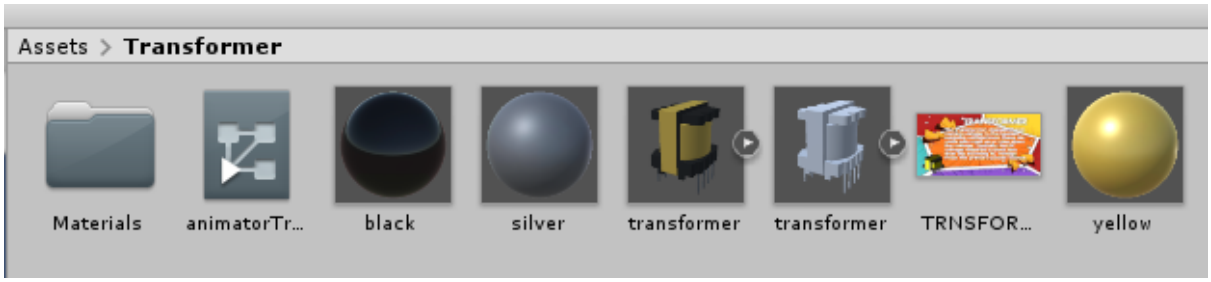


Figure 3.13: Importing Assets for Transformer

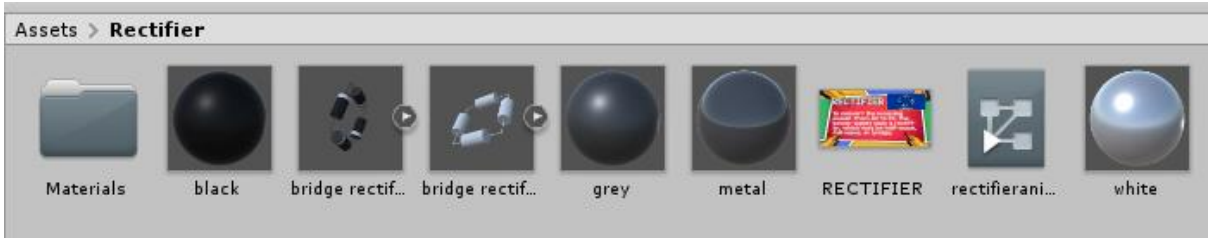


Figure 3.14: Importing Assets for Rectifier

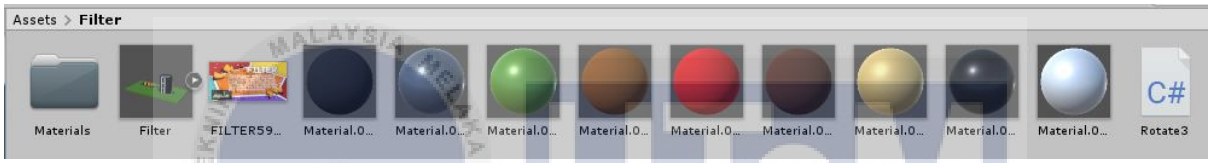


Figure 3.15: Importing Assets for Filter

Figure 3.16: Importing Assets for Voltage Regulator

3.7.2 Create a Menu Scene and Sample scene In Unity

Since it's frequently the first thing students see when loading the application, the Main Menu is one of the UI's most noticeable elements. The User Interface (UI), which consists of buttons, text, and graphics, is essential to creating a fun application environment. Create a custom background for the application with Menu buttons synchronous with button sounds and functions.

Figure 3.17: Design the Main Menu

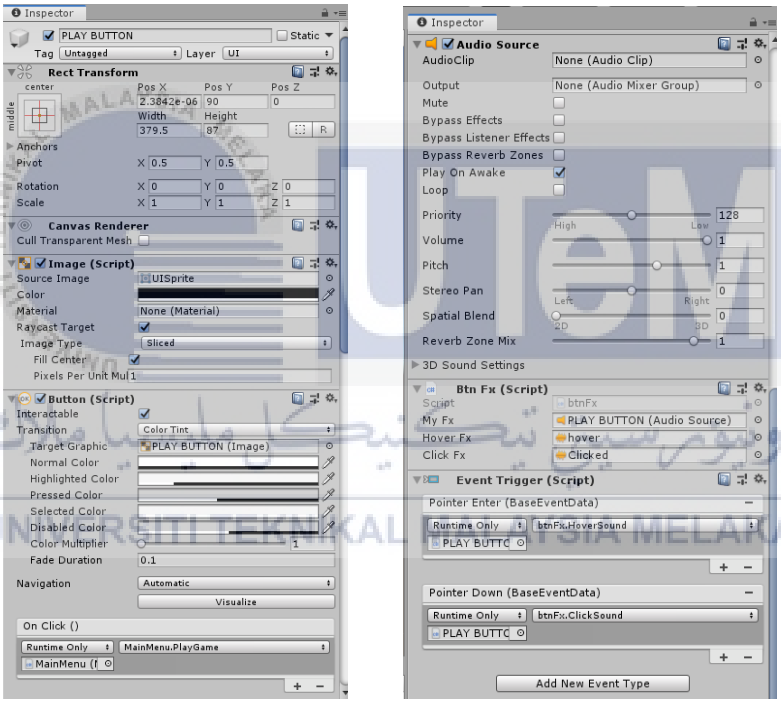


Figure 3.18: Button Setting

In addition, the process need to make the Buttons functional by creating a script. Create a new script and assign the object with the Main Menu script to the button "On Click ()" and select the function that corresponds to the button (‘PlayNowButton()” for Play Button, “QuitButton()” for Quit Button and “MainMenuButton()” to back button in Menu. These script function as a scene changes from Main Menu to Target Scene.

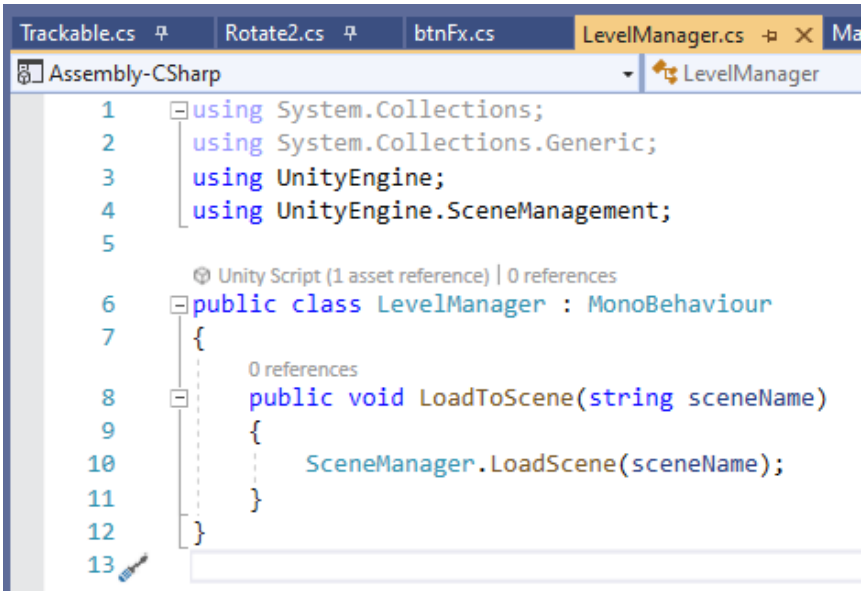


Figure 3.19: Level Manager script

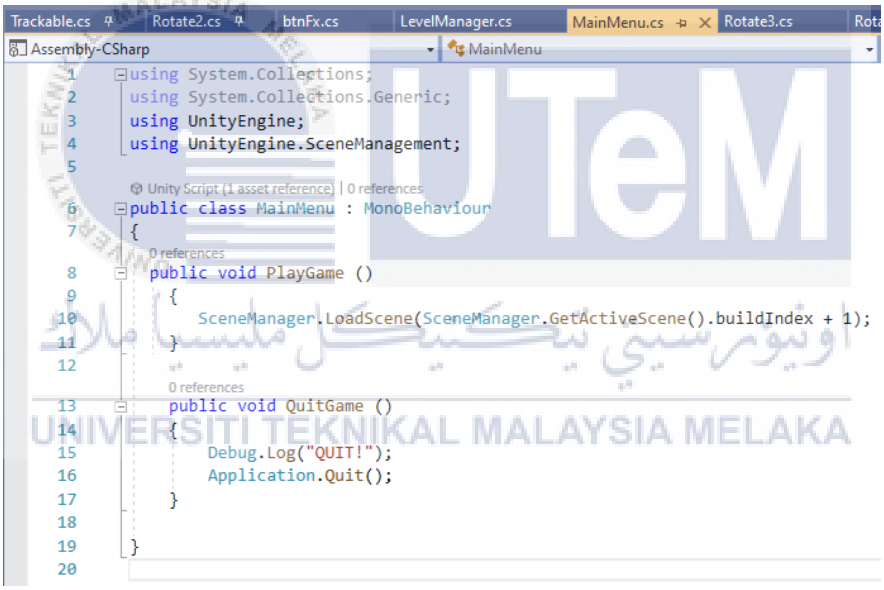


Figure 3.20: Main Menu script

After all the button has functioned as onclick and no error on C# script code, the project proceeds with the process of assembling the material in the Sample scene. The process starts with adding an image target and all the components of the power supply component which are Power Supply 1, Power supply 2, Transformer, Rectifier, Filter and Voltage Regulator. Next, the image target and 3D model need to arrange the position together to make sure when the camera detect the Image, 3D model will appear on the screen.

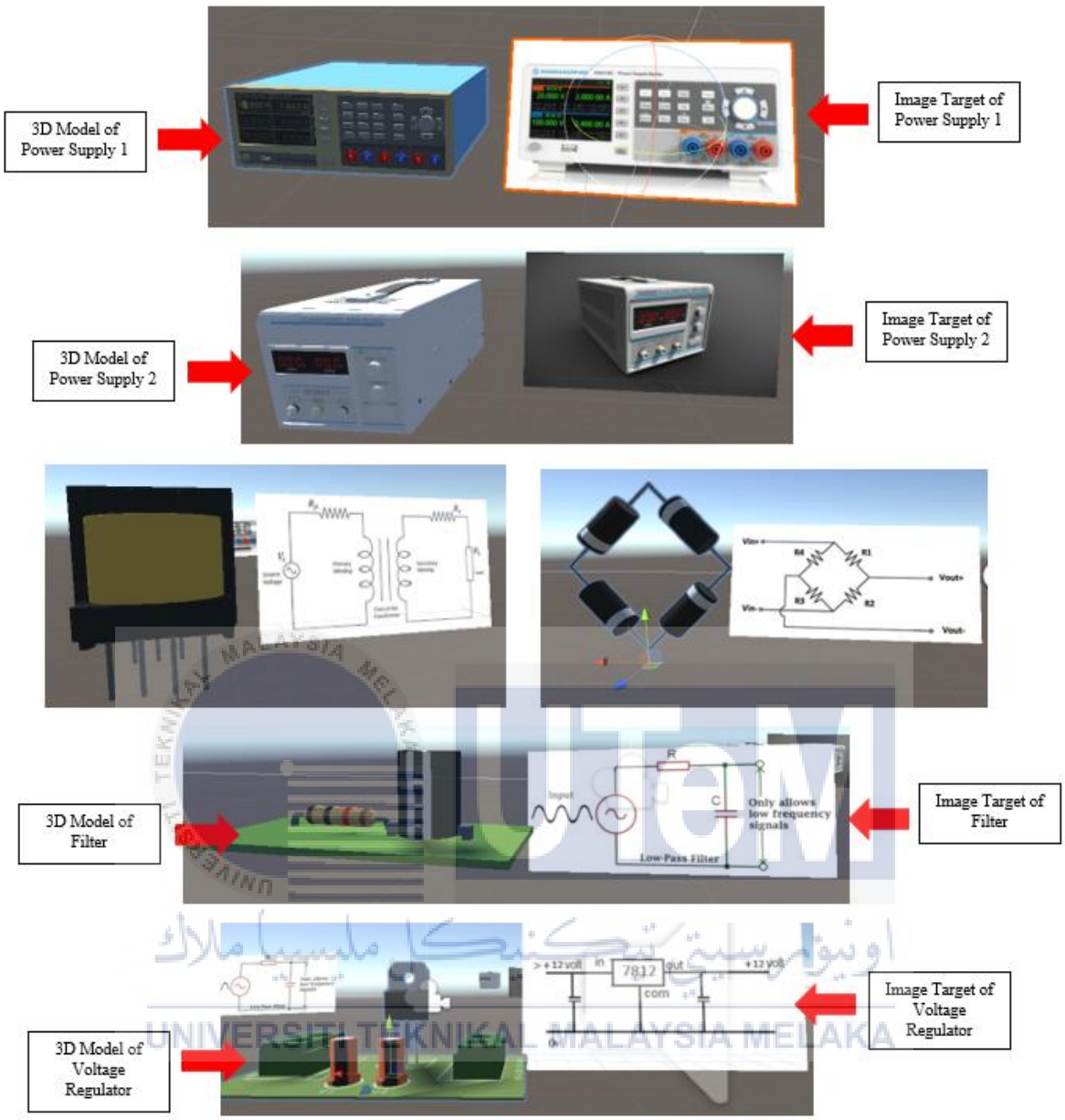


Figure 3.21: Assemble Image Target and 3D Model for Sample scene

3.7.3 Build an APK File

All the components, materials and script are assembled together in the workspace. The apk.file also can generate by choose at android platform in the build setting. Next, open the player setting to fill the application title and logo. Open other setting and select the target API level to API level 30 which is compatible with android version 12.

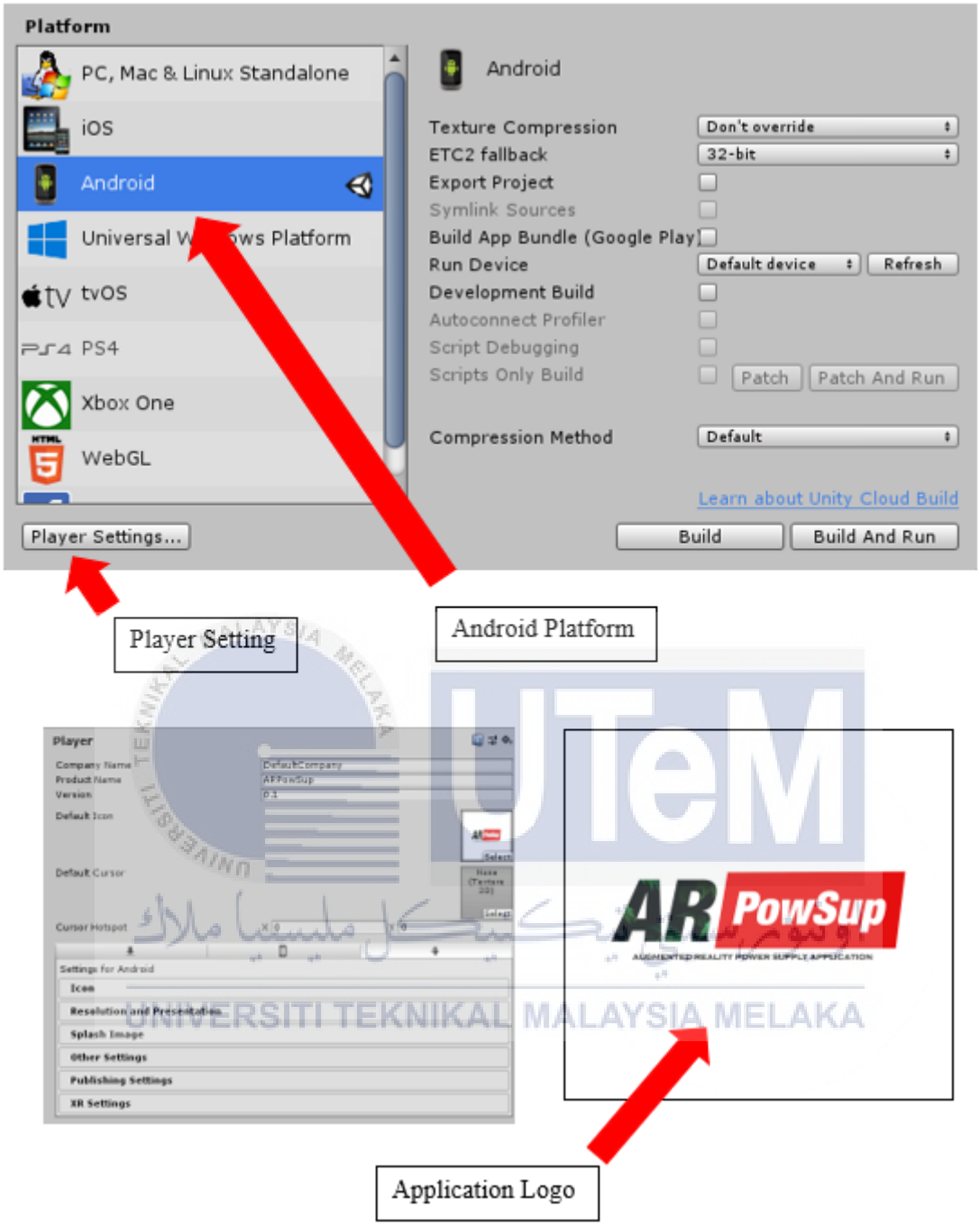


Figure 3.22: Switching platform and Add application logo

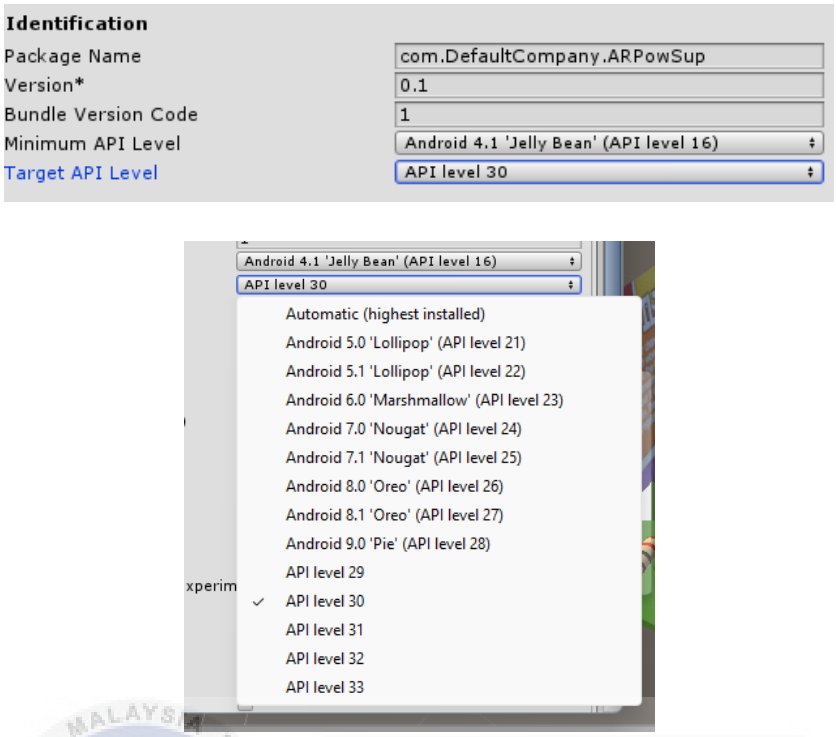


Figure 3.23: API level setting in Unity

3.8 Summary

This chapter describes the process for creating an augmented reality power supply application. One of the most important chapters in project management is project methodology, which ensures that the project to finish in a methodical way by having the appropriate sequence of project technique. Four stages of methodology which are the project developer generates a project development strategy, project operation development, project determination and final project integration. The conceptual design system workflow is picturised and explained. The project workflow also has been explained on how the project was organized to meet the given timeline.

Based on previous research and literature review, control parameter was determined in the certain of the project in the creation of the project structure plan. The development of project later was enhanced. The key part of this stage is the analysis and identification of all the component and control element that related to this project. Last but not least, the complete project integration is repeatedly checked and confirmed the 3D component, in order to reach the main objectives of the project.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter explains the results obtained from the project that was implemented, developed, tested, animated and troubleshot. This chapter is important in order to prove objectives stated in chapter one are fulfilled or not. This chapter also determines the project's functionality and the effectiveness of the assembly process in Unity software. All the components such as the database, image target, 3D model of power supply component, audio source, scenes, sound, animations and coding will be constructed in Unity to export as an Android Package Kit (APK) file. This topic presents the use of augmented reality technologies allows students to reach a higher level of technical knowledge and proficiency, which improves the learning environments.

4.2 Registration Vuforia Developer

Once the project already registered in Vuforia Developer portal, creating an account will enable to use the License Manager and Target Manager and to download the Vuforia SDKs and Samples. A license key be used in multiple app deployments. Once have created a license key, it can assign Device, VuMark, and Cloud Databases to the application using the Vuforia Target Manager. Vuforia Engine apps use a licence key to uniquely identify the apps and allow them to access Vuforia Engine features.

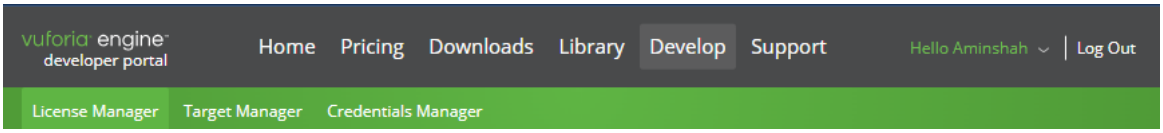


Figure 4.1: License Manager registered

4.3 Image Targets

Image Targets are images that the Vuforia Engine able to recognise and track. By comparing extracted natural features from the camera image against a known target resource database, the system detects and tracks the image. Once the Image Target is detected, the Vuforia Engine will track the image and seamlessly augment your content using the best image tracking technology available.

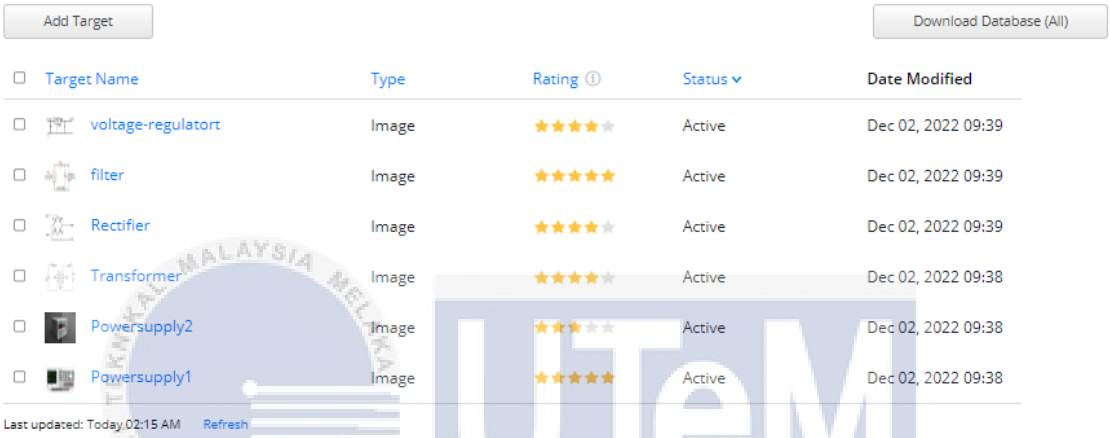
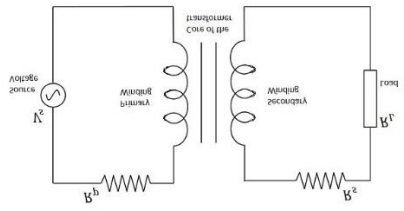
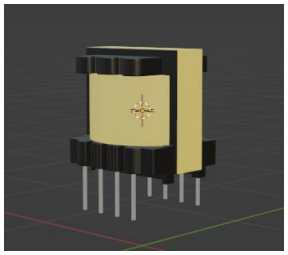
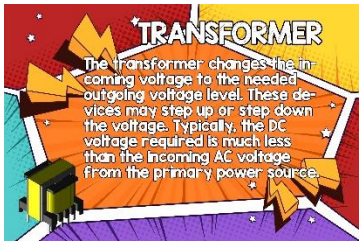
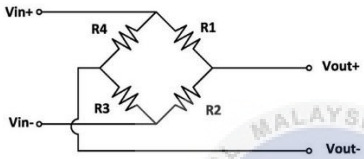
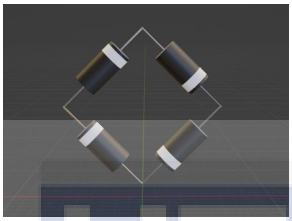
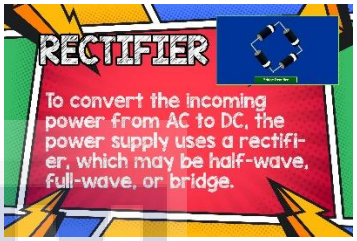
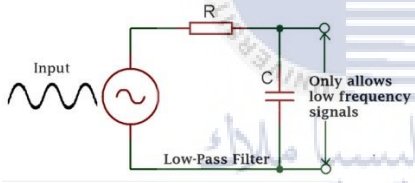
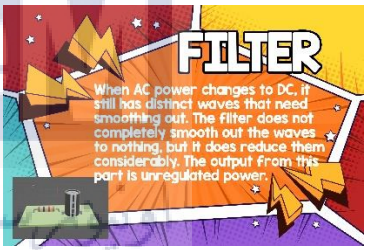
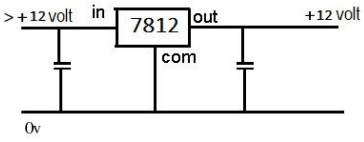
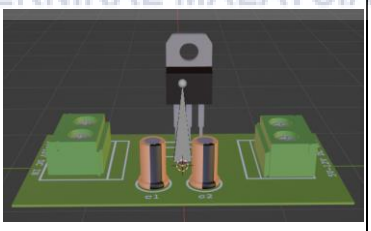
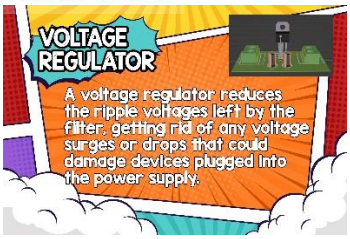


Figure 4.2 : Image Target rating star

The star rating can range from 0 to 5. A higher rating is better because the image target is easier to detect and tracks more consistently. A target can only be detected by the Vuforia Engine if it has at least one star. Any zero-star targets are ineligible for use. Based on the image target, all images are above 3 star and compatible to use in Unity. Table 4.1 summarized the graphical targets created for the application.

Table 4.1: Summary of Graphical Target in Developed STEM Application

Image Target	3D model	Descriptions
		
		
		
		

4.4 3D Model of Power Supply components

This project components in the "Development of Interactive Application for STEM Education using Augmented Reality" can be design in Blender software. This project are using Blender software as design software for the 3D modelling component of the power supply. The open-source and free 3D creation tool is called Blender. Modelling, rigging, animation, simulation, rendering, compositing, motion tracking,

even video editing, and game development are all supported. There are a few components that represent stages of power supply which are the Transformer, Rectifier, Filter and Voltage regulator. This kind of process of transformation from AC to DC voltage involving the electronic components needs to be designed as a 3D model.

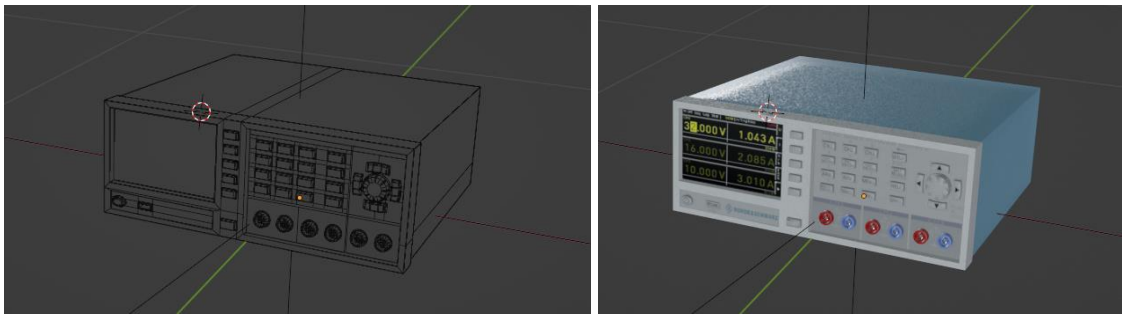


Figure 4.3: Power supply 1 model

Figure 4.4: Power supply 2 model

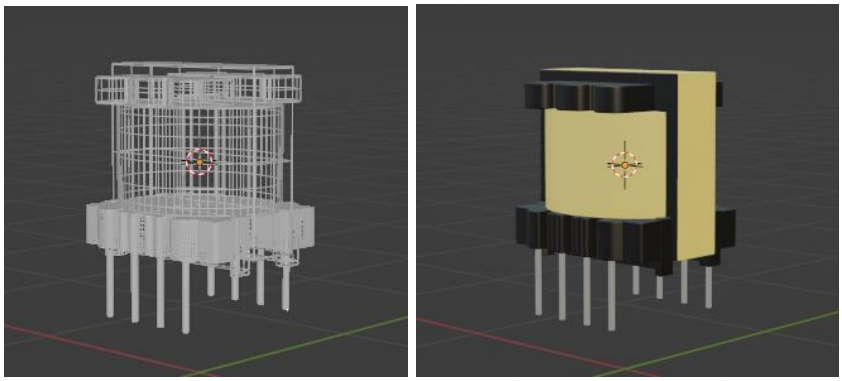


Figure 4.5: Transformer Model

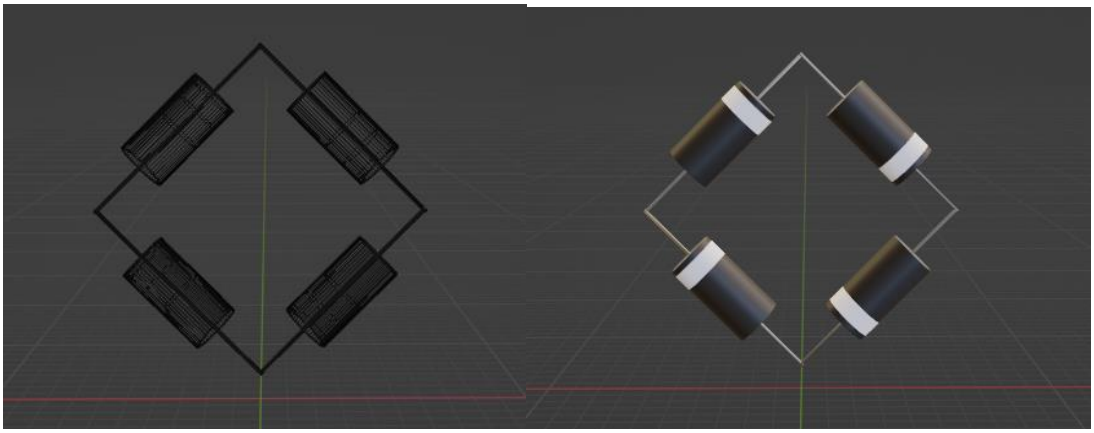


Figure 4.6: Rectifier Model

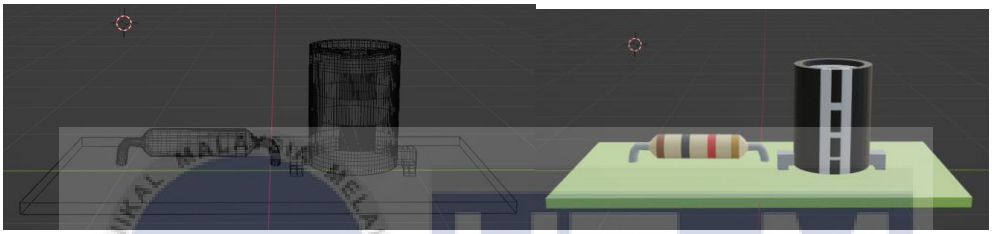
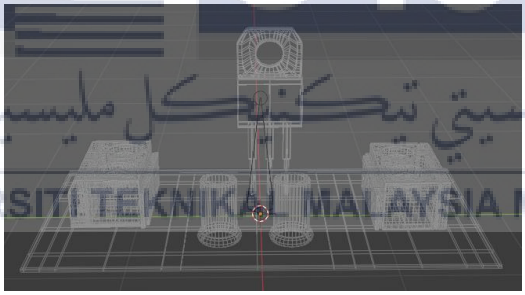


Figure 4.7: Filter Model



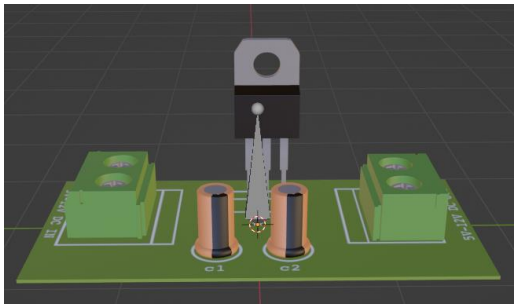


Figure 4.8: Voltage Regulator Model

4.5 C# script in Visual Studio

Scripting instructs our GameObjects on how to behave using the scripts and components attached to the GameObjects, as well as how it interact with one another. Scripting in Unity is now clearly different from pure programming. To be called by Unity, a script must be attached to a GameObject in the scene. Scripts are written in a language that only Unity understands. Developer can communicate with the system and give it instructions using this language.

C# is the programming language used in Unity (pronounced C-sharp). All of the languages used by Unity are object-oriented scripting languages. Scripting languages, like any other language, have syntax, or parts of speech, with the primary parts being variables, functions, and classes.

Table 4.2: Item features configured in Unity

Item	Features	Coding
Moving scene	Screen transition, moving one scene to another scene.	**REFER APPENDICES B for full coding**
Back scene	Back screen transition, moving back from one scene original scene.	
Audio source	Audio description play when target detect an image.	
Button sound	Button making sound when clicked	
Rotation animator	3D model rotate 360 degree	

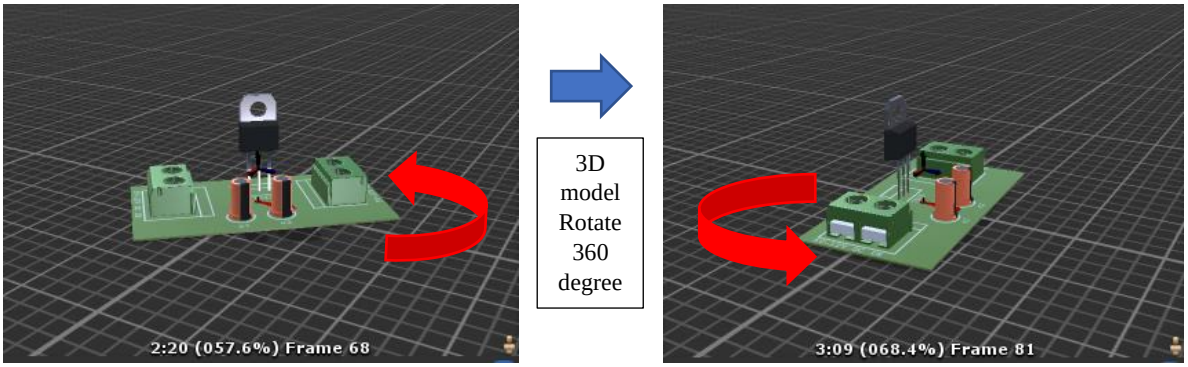


Figure 4.9: Example of Rotation animator

4.6 Unity Assemble

Furthermore, the project are assembled with a few part such as a description, animator and audio source. The description explains about the function of the components in the power supply process. The arrangement of components should be in a straight line to make the display on an android device become easier to detect.

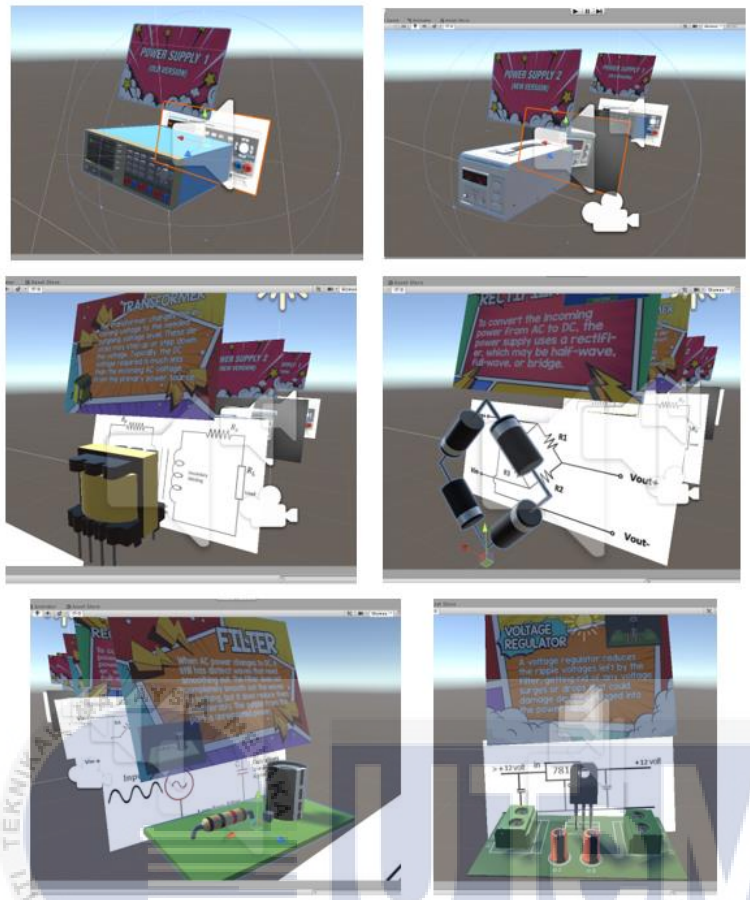


Figure 4.10: Description, audio source and animator on components

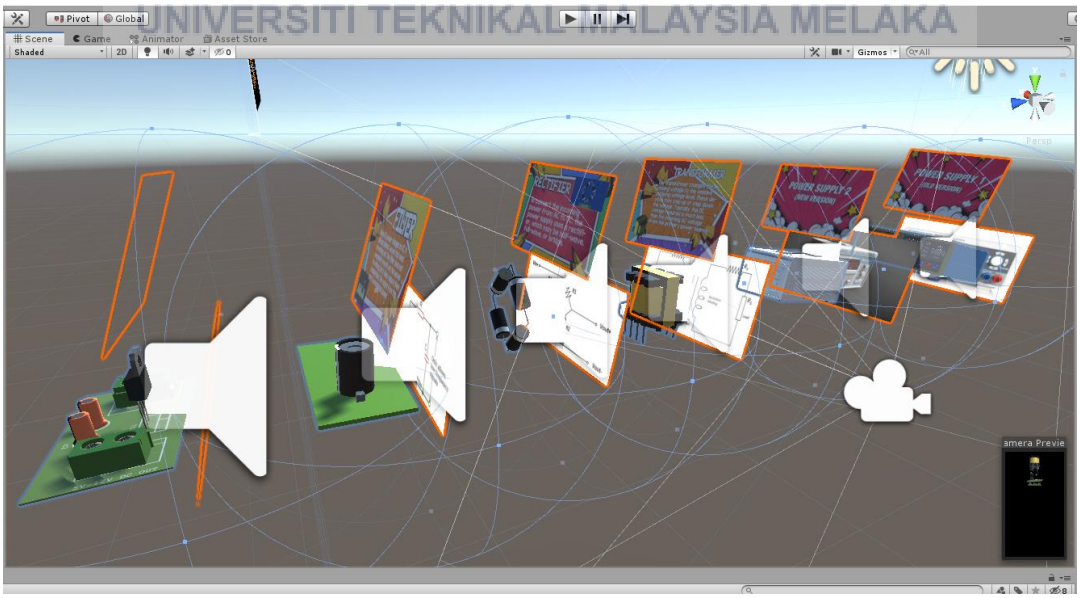


Figure 4.11: All the components are assembled

4.7 User Experience

Once the assembly process has completed in the Unity software, the APK file is generated and install in an android device. The journey of the application started with the mobile application lands on the Main menu scene. User can click play button to access the detection scene. When in the detection scene, the user can scan the image target of power supply component to detect 3D model component, component description and voice over.

Once the image target already detected, the 3D model of component will appear with the ability to rotate 360 degree on the screen as per configured. The voice over will explain the description depends on what component is detected. This is applicable for all the component in the power supply stages process.

The back button in detection scene purposes is to go back to the main menu. Once the button clicked, the scene will change to main menu screen.

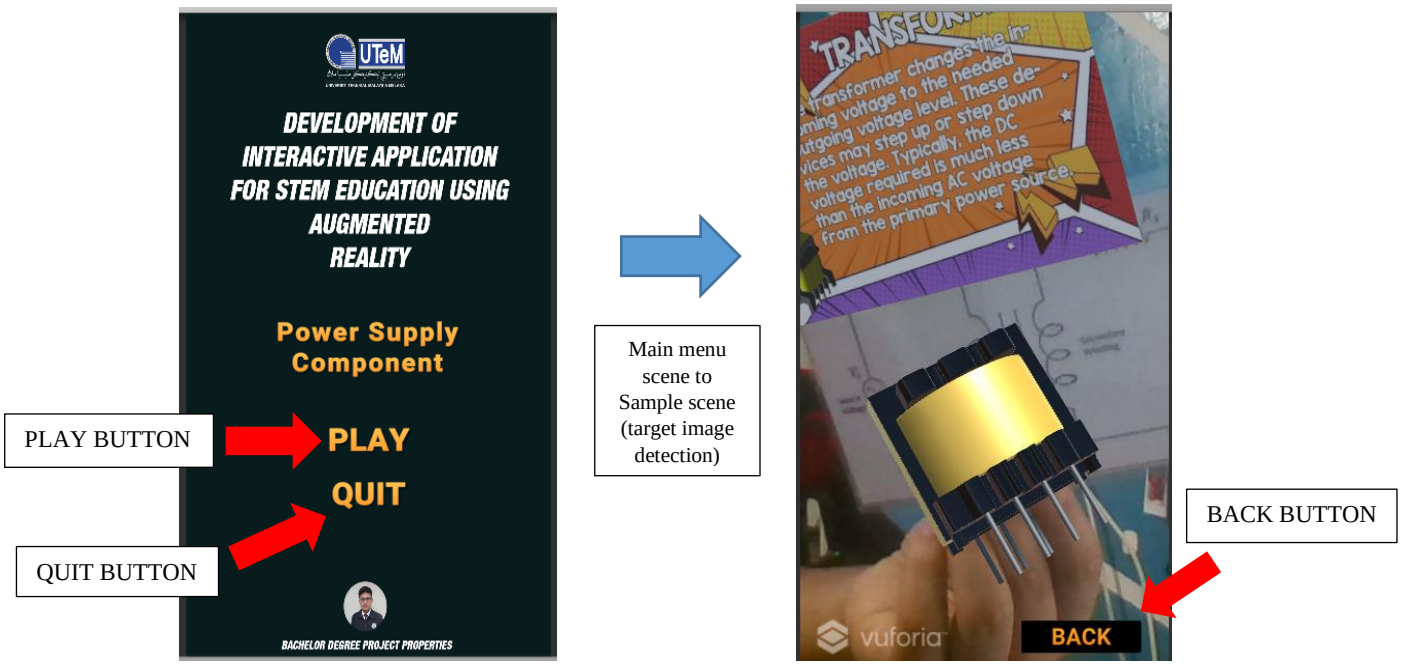


Figure 4.12: Main menu scene to Sample scene

Figure 4.13: Sample scene to Main menu scene

4.8 Response Survey

A survey was conducted to gather information about people's behaviours, needs, and opinions. The survey was done through distributing questionnaire to target users, in this case is the engineering students. It can be used to determine attitudes and reactions, to assess client satisfaction, to gauge opinions on a variety of issues, and to add credibility to the research. The survey was responded by 49 students of Faculty Technology of Electrical and Electronic Engineering. The survey was constructed to gather the input thar containing the understanding, knowledge and technical review about the components and augmented reality in this application, by the respondents. The result of the survey as in the pie chart below:

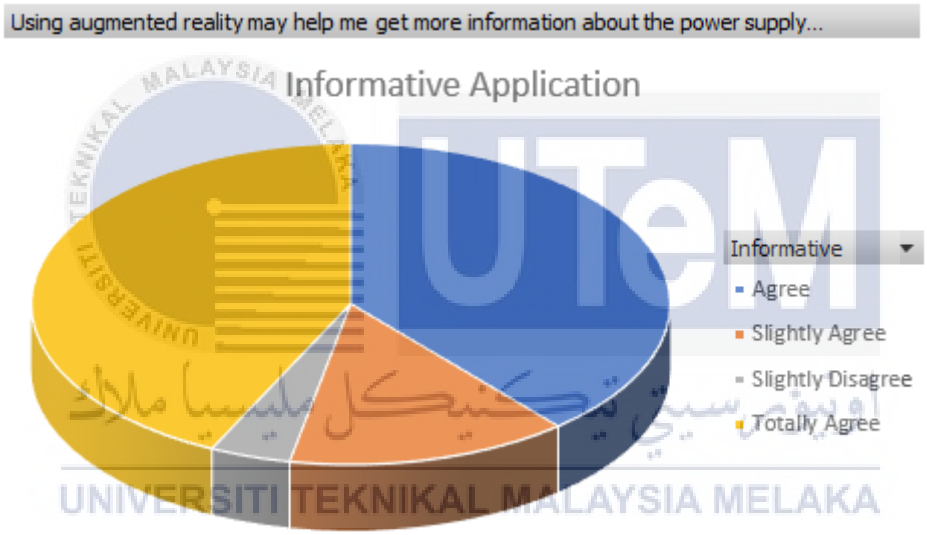


Figure 4.14: Informative application pie chart result

From the pie chart above, 21 students totally agree, 19 students agree and 7 students slightly agree in term of this application is informative application to be used in learning process.

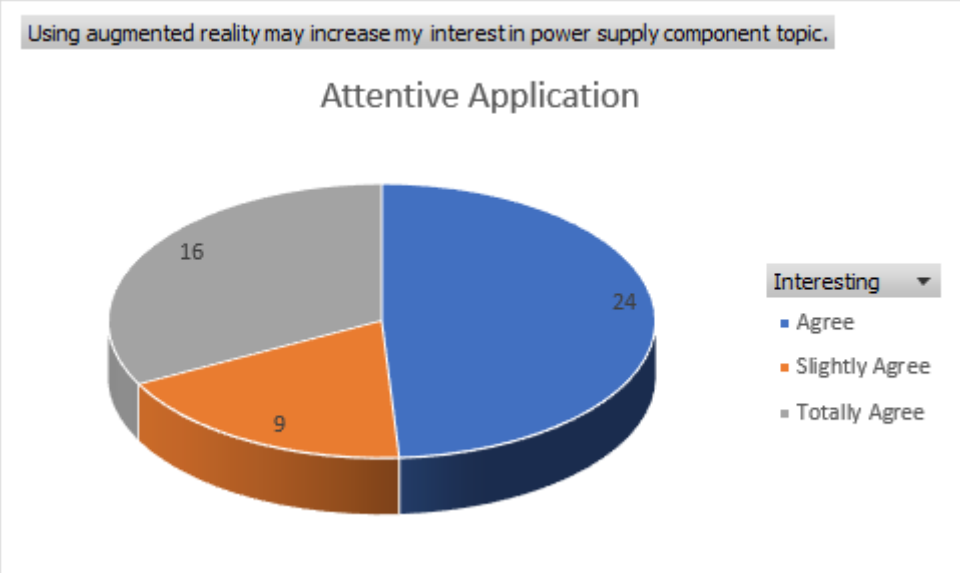


Figure 4.15: Attentive application pie chart result

From the pie chart above, 16 students totally agree, 24 students agree and 9 students slightly agree that this project is an attentive application which increases user interest about power supply components.

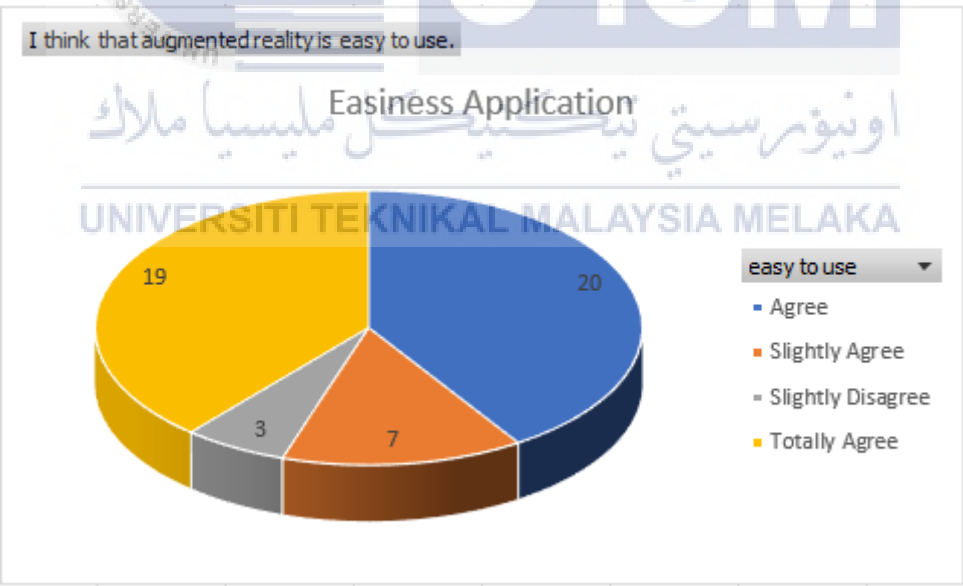


Figure 4.16: Easiness application result

From the pie chart in Figure 4.16, 19 students totally agree, 20 students agree and 7 students slightly agree that this AR application is user-friendly in terms of interface layout and output result. The straight-forward application makes the user easily utilised it without any hiccup and confusion.

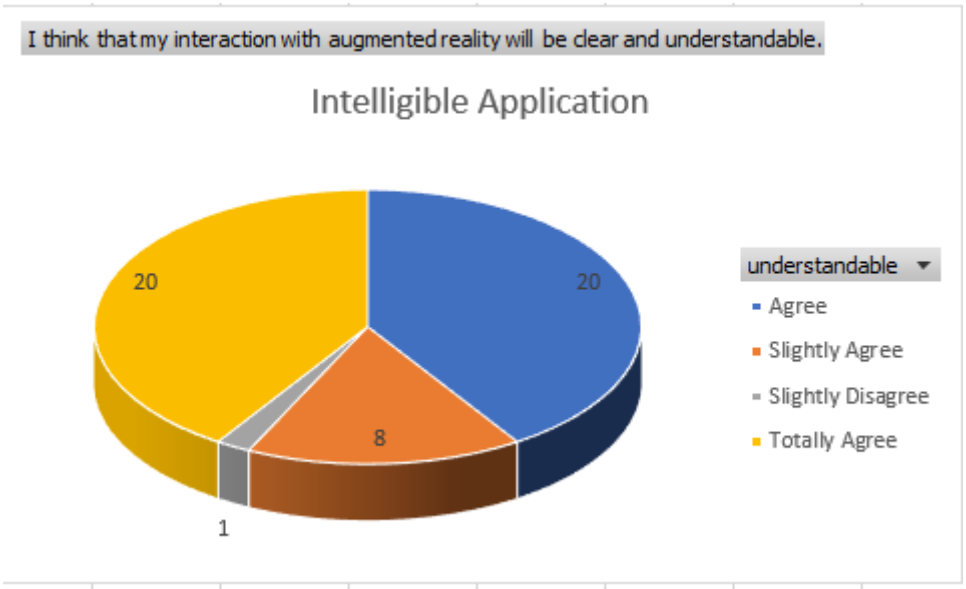


Figure 4.17: Intelligible application result

According to the pie chart above, 20 students totally agree, 20 students agree, and 8 students slightly agree in term of this application is intelligible application to be use in topic power supply. It presents the content is understandable by the user.

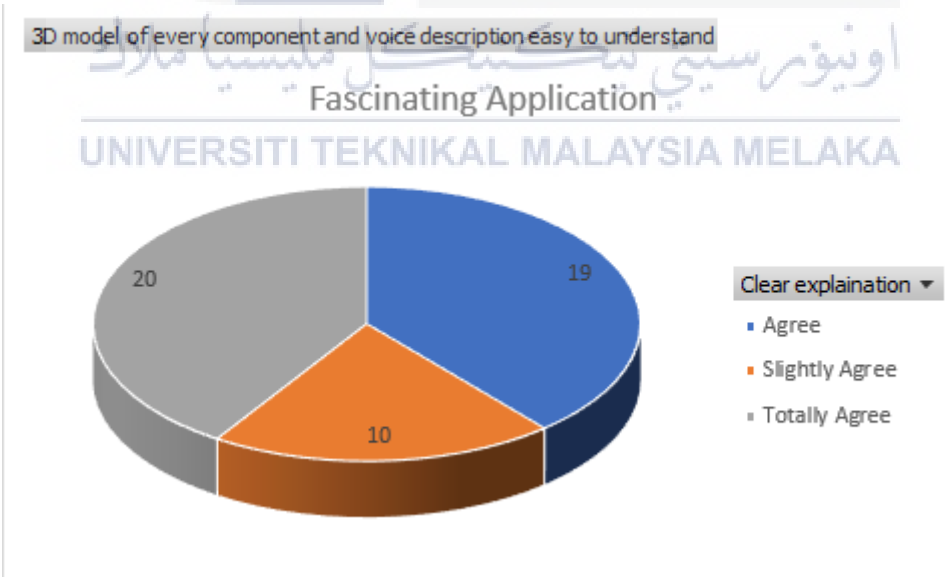


Figure 4.18: Fascinating application pie chart result

Figure 4.18 shows a pie chart which is 20 students totally agree, 19 students agree and 10 students slightly agree in term of this application is fascinating application which is have clear explanation about particular component in this project. It uses the

3D graphical method to motivate users to continue learning on the power supply and its components.

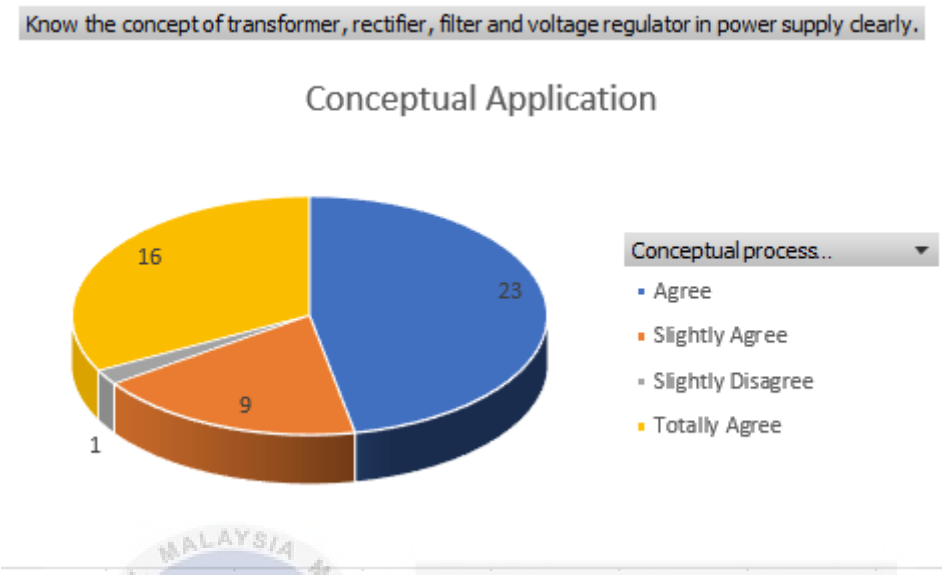


Figure 4.19: Conceptual application pie chart result

Pie chart in Figure 4.19 commit with 16 students totally agree, 23 students agree and 9 students slightly agree in term of this application is conceptual application. This project highlights on the concept of stages in the power supply. It explained and emphasized on each processes of transformer, rectifier, filter and regulator that constructed the power supply. By having this, user can understand better on how the functionality a power supply.

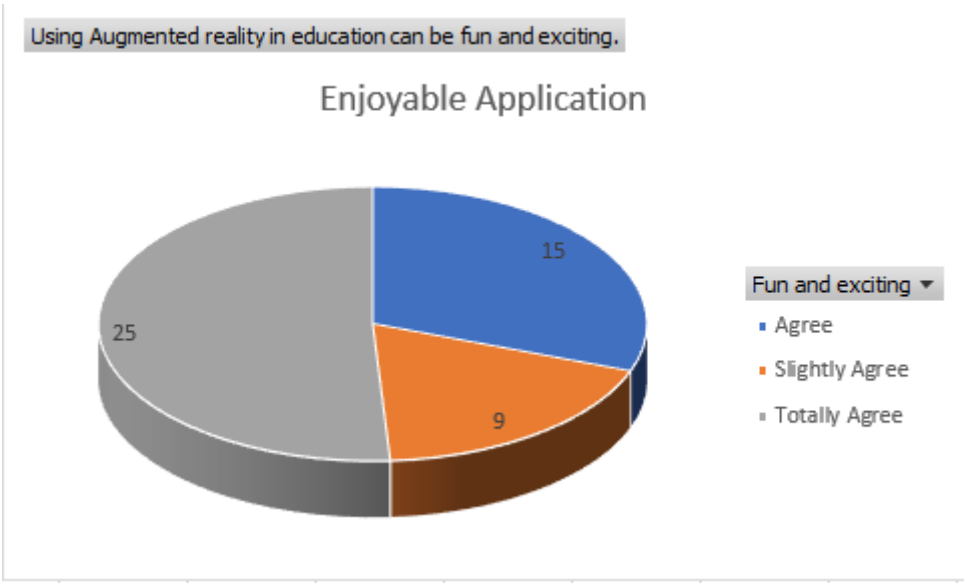


Figure 4.20: Enjoyable application pie chart result

Based on the pie chart, 25 students totally agree, 15 students agree and 9 students slightly agree in term of this application is enjoyable since a lot of features such as 3D model, descriptions and voice over. These features embedded into the learning method and creates more sustainable engagement between contents and user.

In conclusion, the survey prove that the augmented reality offered more informative, interesting, intelligible, fascinating, attentive and conceptual approach towards their user in STEM learning, in this case focusing on the power supply. AR application provides a lot of benefits to their user especially in the field of education.

4.9 Summary

This chapter concluded the outcomes of the project on the "Development of Interactive Application for STEM Education using Augmented Reality". The result shows the final design of components that constructed a power supply by using Blender software, and the assembling process involving Unity 3D software. The result also presents the final outcomes after items were configured using C# script for features such as moving scene, back scene, audio source button sound and rotate animator. The 3D modelling of a transformer, a rectifier, a filter and a voltage regulator have been done by using Blender software.

These models are assembled by using the C# script, description and voice over. A survey was conducted through questionnaire and the result observed that augmented reality application provided their users with more informative, interesting, intelligible, fascinating, attentive, and conceptual content. AR applications provide numerous benefits to their users, particularly in the educational field.

CHAPTER 5

CONCLUSION

5.1 Conclusion

In the conclusion, a study of the use of augmented reality technology in many fields of education is carried out. This project demonstrates how AR may be used to make the educational process more engaging for students. AR benefits both students and educators. It assists instructors in explaining complex subjects in an interactive learning environment while allowing students to understand concepts quickly. The potential of augmented reality in the field of education will continue to grow. As technology improves, it is obvious that augmented reality-based education will be adopted worldwide, making traditional teaching methodologies obsolete. For the long term, motivational element associated with these interfaces has been confirmed to be a valuable asset for education in the future[20]. The students had the opportunity to investigate one of the application's advantages, which is that it is a tool that promotes self-directed learning. Students will also be able to download and utilise the application from the comfort of their own homes, reducing the necessity to visit a laboratory to complete an electrical circuit work. Students' desire for an application, to utilise it for learning, and to recommend it to others for study demonstrates to them.

Therefore, this study had focused on development of AR application of a power supply. The application provides a learning method on a power supply and components that constructs it. Hence, the function of electronic components in the power supply for the design was identified prior to prepare the content of the AR apps. Next, an AR application for STEM learning specifically on the power supply was designed. Finally, the effect of AR in learning on the scope developed was measured through questionnaire to improvement or drawback of the AR in learning.

The impact of augmented reality on engineering education has been revolutionary. Exploring the applications of augmented reality in many engineering fields is necessary and will improve teaching methods. When it comes to the application of augmented reality in electronics education, there is a lot of room for innovation and new learning methodologies. Thus, this project is hoped may contribute to the pool of knowledge in AR with regards to engineering studies.

5.2 Future Works

The development of interactive application for STEM education using Augmented Reality can be improved by doing additional elements for the image target and 3D model of components. This project can be expanded for various electrical engineering contents to produce a more compact and informative AR dictionary on electrical components and items. With the addition on gamification, users can also evaluate the understanding after going through the AR learning. Rewards can be included such as points whenever the user successfully achieved or scored certain level, to provide engagement and excite the user to use the application.

5.3 Project Potential

The current project has a potential of commercialization with more feature added, also with gamification and rewards included. Besides, the application of AR is proven which can be used in different scenarios or fields such as in medical, manufacturing, architecture, design, business and many more. It is to understand the project's 3D models can be thought of as product-focused augmented reality (AR) experiences that are not triggered by physical attributes. A 3D virtual model, which is activated by the smartphone's rear camera, lets you explore a product in more detail or see how it might appear in real life.

Furniture, for example, is a product category that frequently makes use of these experiences to allow potential customers to see how a piece of furniture will look in their home. Another industry where these types of ads have seen significant adoption in recent years is automotive, with brands replacing traditional car-yard visits with virtual alternatives enabled by AR.

Furthermore, by using AR system can develop a proper application for better experience in medical. Medical students can use augmented reality technologies to visualise and practise theories. Scenario such as using augmented reality apps, students can examine the overlay anatomy data on a 3D human skeleton. The visualisation would assist them in better understanding how the human body works.

Last but not least, this application AR can be extremely beneficial in guiding new employees through the necessary procedures, protocols, and equipment. Compromise on these factors will result in workplace safety issues. New personnel can be trained through all critical procedures using AR devices and apps, resulting in safer workplace conditions.

To sum up, AR implementation can be applied in various application not only limited to engineering. Thus, it has a broad potential in commercialization.

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APPENDICES

Appendix A

C# code in Visual Studio

Assembly-CSharp — MainMenu

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

Unity Script (1 asset reference) | 0 references
public class MainMenu : MonoBehaviour
{
    0 references
    public void PlayGame ()
    {
        SceneManager.LoadScene(SceneManager.GetActiveScene().buildIndex + 1);
    }

    0 references
    public void QuitGame ()
    {
        Debug.Log("QUIT!");
        Application.Quit();
    }
```

Assembly-CSharp — LevelManager

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

Unity Script (1 asset reference) | 0 references
public class LevelManager : MonoBehaviour
{
    0 references
    public void LoadToScene(string sceneName)
    {
        SceneManager.LoadScene(sceneName);
    }
}
```

Assembly-CSharp | Trackable

```
1   using System.Collections;
2   using System.Collections.Generic;
3   using UnityEngine ;
4
    Unity Script (6 asset references) | 0 references
5   public class Trackable : DefaultTrackableEventHandler
6   {
7       public AudioSource suara;
        Unity Message | 0 references
8       void Awake()
9       {
10          suara = GetComponent<AudioSource>();
11      }
        0 references
12      protected override void OnTrackingFound()
13      {
14          base.OnTrackingFound();
15          suara.Play();
16      }
        0 references
17      protected override void OnTrackingLost()
18      {
19          base.OnTrackingLost();
20          suara.Stop();
21      }
22  }
23
```


Assembly-CSharp | Rotate

```
1   using System.Collections;
2   using System.Collections.Generic;
3   using UnityEngine;
4
    Unity Script (1 asset reference) | 0 references
5   public class Rotate : MonoBehaviour
6   {
7
        Unity Message | 0 references
8       void Update()
9       {
10          transform.Rotate(new Vector3(0f, 1f, 0f));
11      }
12  }
13
```