



Faculty of Electrical and Electronic Engineering Technology

**DEVELOPMENT OF INTERACTIVE APPLICATION FOR STEM EDUCATION
USING AUGMENTED REALITY**



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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

2022

**BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II**

Tajuk Projek : DEVELOPMENT OF INTERACTIVE APPLICATION FOR STEM EDUCATION
USING AUGMENTED REALITY

Sesi Pengajian : SEMESTER 1 SESI 22/23

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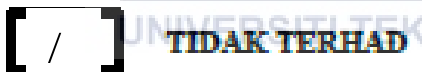
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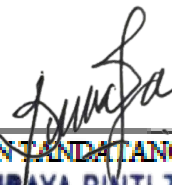


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I declare this project report entitled “Development of Interactive Application for STEM Education using Augmented Reality” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and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

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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

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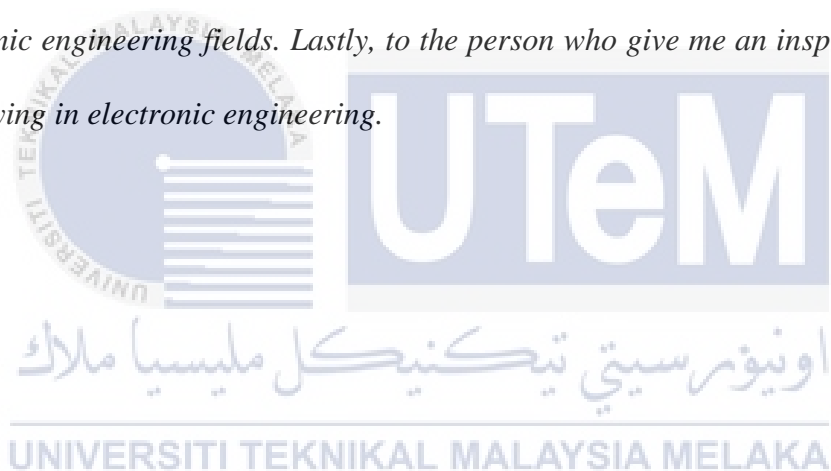
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DEDICATION

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.

Last but not least, I would like to thank all the students at the fellow colleagues and classmates, faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

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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 concepts 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	<ul style="list-style-type: none"> ➤ 3D model software ➤ ARCore software ➤ Sceneform software ➤ SDK software 	<ul style="list-style-type: none"> ➤ 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	-	<ul style="list-style-type: none"> ➤ Students 	The implementing STEM initiative into the American education system
3.	Haghanikar, Mojgan Matloob	Cyberlearning and augmented reality in STEM education	2019	<ul style="list-style-type: none"> ➤ 3D software 	<ul style="list-style-type: none"> ➤ 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	-	<ul style="list-style-type: none"> ➤ 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. Faropo, 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	<ul style="list-style-type: none"> ➤ Unity 3D software ➤ Vuforia software ➤ SDK software 	➤ Students	Augmented reality as an interactive app to improve academic performance in electronic circuit.