Faculty of Electronics and Computer Technology and Engineering

Development Of An Augmented Reality For Microelectronic Fabrication Process As Study Aids

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Development Of An Augmented Reality For Microelectronic Fabrication Process As Study Aids

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DEDICATION

this report is dedicated to my family, to my peers and friends.This journey has been memorable and enjoyable. To Dr Haslinah Binti Mohd Nasir, your advice has been a beacon of hope. This dedication is an authentic acknowledgement of the collaborative spirit that has driven the creation of this report.

ABSTRACT

Microelectronic fabrication process is a difficult process that necessitates a thorough grasp of the underlying physics and chemistry. It required extra effort to be understand because student cannot visualize the process. Augmented Reality (AR) technology has emerged as a possible answer to these difficulties, giving real-time visual guidance and interactive support during the creation process. The objective of this research is to study the prospective uses of augmented reality as a study aid and develop the system. The research begins by evaluating the existing microelectronic manufacturing learning methods, emphasising the complexities involved as well as become a guiding tools. The design of augmented reality and determining the process in fabrication for the augmented application are included in this project. First, the project will use the TinkerCAD software to model each fabrication process in three dimensions. Unity offers a 3D platform for game developers to produce visual platforms. With markerless AR, virtual objects are accurately registered in real-time using sophisticated computer vision algorithms and sensor data, as opposed to traditional AR systems that rely on predefined markers for tracking. The Unity software is used to create an AR plane which the 3D object is put for display. Markerless AR require object recognition, depth sensing, and simultaneous localization and mapping (SLAM) methods.This augmented reality application offers a way to learn about fabrication process and the design for each step in the process. Lastly, a questionnaire was used to gauge the impact of augmented reality (AR) on learning in terms of its benefits and drawbacks.

ABSTRAK

Proses fabrikasi mikroelektronik adalah proses yang sukar yang memerlukan pemahaman menyeluruh tentang fizik dan kimia asas. Ia memerlukan usaha tambahan untuk memahami kerana pelajar tidak dapat membayangkan proses tersebut. Teknologi Augmented Reality (AR) telah muncul sebagai jawapan yang mungkin membantu memudahkan kesukaran ini, memberikan bimbingan visual masa nyata dan sokongan interaktif semasa proses penciptaan. Objektif penyelidikan ini adalah untuk mengkaji prospektif penggunaan realiti tambahan sebagai bantuan kajian dan membangunkan sistem. Penyelidikan dimulakan dengan menilai kaedah pembelajaran pembuatan mikroelektronik sedia ada, menekankan kerumitan yang terlibat serta menjadi alat panduan. Reka bentuk AR dan menentukan proses dalam fabrikasi untuk aplikasi AR disertakan dalam projek ini. Pertama, projek ini akan menggunakan perisian TinkerCAD untuk memodelkan setiap proses fabrikasi dalam tiga dimensi. Unity menawarkan platform 3D untuk pembangun permainan menghasilkan platform visual. Dengan menggunakan markerless AR, objek maya didaftarkan dengan tepat dalam masa nyata menggunakan algoritma penglihatan komputer dan data penderia yang canggih, berbanding sistem AR tradisional yang bergantung pada penanda yang telah ditetapkan untuk penjejakan. Perisian Unity digunakan untuk mencipta satah AR yang objek 3D diletakkan untuk paparan. Markerless AR memerlukan pengecaman objek, pengesanan kedalaman dan kaedah penyetempatan dan pemetaan (SLAM) serentak. Aplikasi AR ini menawarkan cara untuk mempelajari proses fabrikasi dan reka bentuk untuk setiap langkah dalam proses tersebut. Akhir sekali, soal selidik telah digunakan untuk mengukur kesan (AR) terhadap pembelajaran dari segi faedah dan kelemahannya.

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AR	-	Augmented Reality
VR	-	Virtual Reality
AI	-	Artificial Intelligence

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CHAPTER 1

INTRODUCTION

1.1 Background

The microelectronics sector is one of the most significant in the modern world since it underlies many of the technological breakthroughs that was taken for granted in our everyday lives. The microelectronic fabrication process, which is used to manufacture the intricate patterns and structures that make up microelectronic devices, is at the core of this sector.

Microelectronic fabrication process is a difficult process that necessitates a thorough grasp of the underlying physics and chemistry. It might be difficult for pupils learning about this process to visualise and comprehend the various procedures involved. Augmented Reality (AR) is a technology that has the potential to transform how student learn about difficult operations such as fabrication. AR makes learning more dynamic and engaging by superimposing virtual images and animations on top of a real-world perspective.

In this regard, an augmented reality system for the microelectronic fabrication courses as a study aid has the potential to improve students' learning experiences. The system can assist students comprehend the phases involved in the basic knowledge of microelectronic fabrication which enhance their abilities by offering a visual picture of the microelectronic process.

The potential benefits of an AR system for microelectronic fabrication process as a study tool, and how it may enhance the learning experience for students. This project also goes into the technical obstacles of creating such a system, as well as the possible influence it may have on the microelectronics industry as a whole.

1.2 Problem Statement

Microelectronic process is a vital process in the modern era industry, and students studying it must have a thorough grasp of the underlying physics and chemistry involved. Traditional means of learning, such as textbooks and lectures, can make it difficult for pupils to see and comprehend the complicated stages needed [1].

To overcome this issue, a more dynamic and interesting manner for students to learn about the microelectronic fabrication process is required. Augmented Reality (AR) technology has the ability to transform the way student learn by visualising difficult processes such as microelectronic fabrication. As a result, this project which develop an markerless augmented reality system that allows students to learn about the microelectronic process in an interactive and engaging way, allowing student to better comprehend the complicated stages involved and enhance their skills.

The markerless AR system must give real-time feedback and direction by superimposing virtual images and animations onto a real-world view of a fabrication system. It must also be user-friendly, accessible, and adaptable to diverse learning styles and knowledge levels. The technological obstacles of constructing such a system, such as merging AR technology with the microelectronic process, must be addressed as well. The general results of the study showed that markerless augmented reality technology was effective in supporting the learning of students with a specific learning difficulty and these students were willing to use augmented reality technology, finding it attractive [2].

1.3 Project Objective

The major goal of building an Augmented Reality (AR) system for the microelectronic fabrication process as a study aid is to improve students' learning experiences by offering an interactive and engaging approach to learn about the etching process. The AR system's specific goals are as follows:

a) To study the current technology to adapt augmented reality into microelectronic courses for interactive education.

b) To design an interactive interface of an AR system for microelectronic course with visual image and animation over a real world.

c) To integrate the microelectronic syllabus into AR interfaces.

1.4 Scope of Project

The scope of this project are as follows:

a) Development of the markerless AR system: The project will involve the creation of an AR system that will allow students to learn about the basic knowledge of microelectronic and fabrication in an interactive and engaging manner. This will include creating and building the AR software, integrating it with the microelectronic fabrication process, and testing the system to assure its usability and effectiveness.

b) The project will focus on the construction of virtual images and animations that can be superimposed over a real-world view of a microelectronic fabrication process to create a visual depiction of the process. These images and animations must appropriately reflect the intricate processes based on the syllabus that be created. By creating markerless AR, it require object recognition, depth sensing, and simultaneous localization and mapping (SLAM) methods.

c) Integration with the microelectronic fabrication process: To guarantee the AR system is accurate and successful, extensive coordination with professionals in the microelectronic sector will be required.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the crucial facts and details discovered by various studies and research from prior studies. As a result, the chapter opens with an explanation about different way of education being conduct based on different era. This research is important because it is our main goal. Then, this chapter is continuing with augmented reality and its notions. It is critical to conduct study on these principles because they are the chosen way to complete this project. This chapter also discuss the application of augmented reality in multiple fields. This is used as a comparison and reference for the system that is develop in this project.

2.2 Education

Education is the process of learning information, skills, values, and attitudes through various formal and informal ways. It is a lifetime journey in which individuals acquire cognitive, social, and emotional talents. Individuals and societies are shaped by education, which provides them with the tools and resources they need to comprehend the world, engage in economic and social activities, and contribute to the advancement of themselves and their communities.

Formal education is often provided at schools, colleges, and universities, where students participate in structured learning under the supervision of professors or instructors. It often follows a set curriculum and leads to the awarding of degrees, diplomas, or certificates.

Informal education takes place via ordinary encounters and self-directed learning. It can happen at home, in communities, at work, or via internet platforms. Informal education includes a variety of activities such as reading books, participating in debates, attending seminars, pursuing hobbies, and even viewing instructive films [3].

Education has several aims, some of which are learning. Education seeks to convey factual information, ideas, concepts, and principles in a variety of subjects such as mathematics, science, humanities, and the arts. Education can also assist individuals in acquiring and improving practical skills such as critical thinking, problem solving, communication, teamwork, creativity, and technical talents [4]. This can be seen in figure 2.1 which a student learn the correct way to do the experiment.

Figure 2.1 student doing experiment

Personal development can be promoted through education by instilling values, attitudes, ethical principles, and social responsibilities. It seeks to foster attributes such as empathy, resilience, curiosity, and a passion of lifelong learning. Education is also critical in developing knowledgeable and engaged individuals capable of actively participating in democratic processes, contributing to social justice, promoting equality, and working for the good of society.

Education has provided individuals with the information and skills needed to pursue professional choices, engage in productive work, and contribute to economic growth and innovation. Overall, education is a dynamic and transforming process that empowers people, broadens their views, and helps them to live meaningful lives while positively benefiting their communities [5].

2.2.1 Type of Education

There are diverse approaches to education because education is impacted by a variety of variables such as societal changes, technological improvements, educational research, and growing pedagogical philosophies. There are variety of educational approaches based on requirement needed.

2.2.1.1 Conventional Education

The traditional style of classroom-based learning within official educational institutions such as schools, colleges, and universities is generally referred to as the conventional mode of education. Traditional education occurs in physical classrooms, lecture halls, libraries, and labs. Students attend classes in person and engage with lecturers and classmates face to face. Traditional schooling frequently emphasizes discipline and respect to rules and regulations. Students are expected to adhere to a strict timetable, wear uniforms, and respect institutional norms.

A planned curriculum is followed, outlining the disciplines, themes, and learning objectives to be covered during a certain time period. Curriculum is often set by educational authorities or institutions and provided via textbooks, lectures, and other instructional materials [6].

The instructor is fundamental to this method in transmitting information and promoting learning. They give lectures, explain topics, give advice, and assess students' progress through assignments, quizzes, and exams. Students often progress through grade levels or stages based on their age or academic performance. Standardized tests, quizzes, and exams are frequently used to assess students' grasp and knowledge of the subject matter [7]. These tests are frequently used to determine a student's grade or academic success as in Figure 2.2.

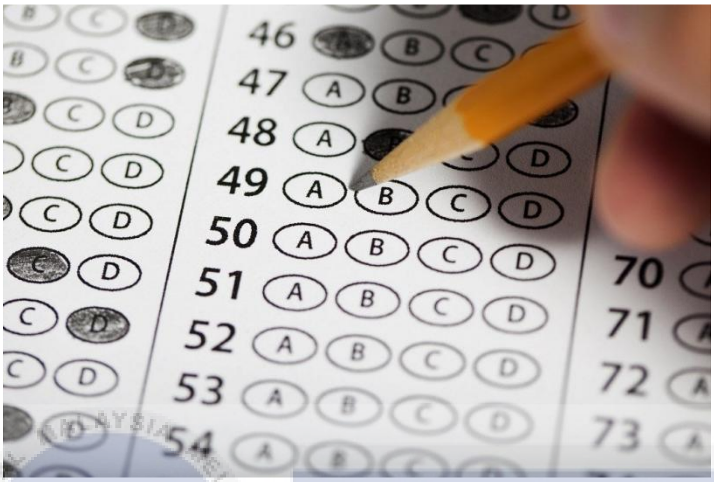

Figure 2.2 standardized test in school.

Traditional education tends to be less flexible in terms of learning pace, subject options, and individual learning styles. Curriculum and teaching techniques are frequently standardized for all students in a certain grade or course. Traditional education may have access constraints, particularly for people living in distant locations, those with physical impairments, or those suffering economic difficulties. While traditional education has long been the main type of education, it is vital to recognize that educational techniques have evolved to include more student-centered and participatory methods. With technological improvements, there has been an increase in online learning, blended learning models, and other novel techniques aimed at improving access, flexibility, and individualized learning experiences.

2.2.1.2 Current Technology Education

The current educational system incorporates a variety of techniques and trends that have arisen in reaction to societal changes, technology advances, and growing educational ideologies [8]. Technology has transformed education by introducing new tools and platforms that improve teaching, learning, collaboration, and resource access. Here are some of the most recent educational technologies.

Blackboard, Canvas, and Moodle in Figure 2.3 are examples of learning management systems that provide a centralized platform for managing educational content, organizing courses, providing online assessments, and enabling communication between professors and students [9].

Figure 2.3 Moodle website.

OER are online educational resources that are publicly accessible and openly licensed. Textbooks, films, interactive modules, and lesson plans are among the tools available. OER allows educators to have access to high-quality materials and modify them to match their own teaching requirements.

Interactive whiteboards combine a traditional whiteboard with computer technology, enabling teachers to present and interact with digital information. They allow for dynamic and compelling presentations, interactive activities, and the incorporation of multimedia. Real-time collaboration, document sharing, video conferencing, and virtual classrooms are all possible with tools like Google Workspace, Microsoft 365, and Zoom. These technologies improve communication and collaboration between professors and students, as well as among students. These tools enable instructors to digitally generate and deliver quizzes, examinations, and assignments. These systems give real-time feedback, automatic grading, and data analysis to help teachers make better decisions and track students' development.

There are several educational applications and software available for a variety of subjects and grade levels. These applications feature fascinating and interactive learning experiences, practice tasks, simulations, and instructional games. Online learning sites, such as Coursera, Udemy, and Khan Academy, provide a diverse selection of online courses and materials. Learners may access lectures, quizzes, and assignments, communicate with instructors and fellow students, and earn certificates at the end [10].

coursera

Figure 2.4 Coursera logo.

Mobile learning has grown in popularity as smartphones and tablets have become more widely available. Educational applications, mobile-friendly websites, and mobile-based learning platforms allow learners to access educational information at any time and from any location, allowing for personalized and on-the-go learning. The growth of smartphones, tablets, and other mobile devices has created new learning opportunities. Learning applications, mobile-friendly websites, and digital textbooks enable students to access educational resources at any time and from any location, fostering personalized and on-the-go learning.

2.2.1.3 Modern Technology Education

Modern technology has had a huge influence on education, revolutionizing the methods of teaching and learning. Here are some instances of how modern technology is being used in education:

Artificial Intelligence (AI) technologies are increasingly being applied in the classroom. Chatbots powered by AI give personalized help, virtual instructors provide adaptive learning experiences, and AI-based language processing technologies aid in language acquisition and evaluation. Adaptive learning platforms personalize the learning experience via the use of algorithms and artificial intelligence [11]. These technologies analyses student data, tailor material to individual preferences, and offer personalized feedback and suggestions. The process of AI can be observed in Figure 2.5.

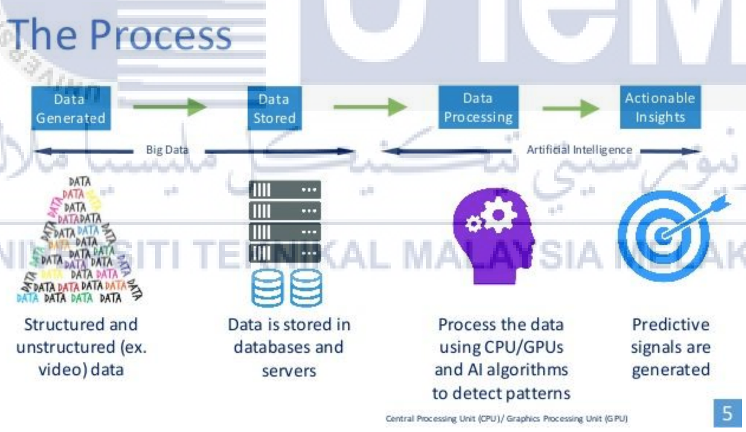

Figure 2.5 Process of AI.

Virtual Reality (VR) technologies provide immersive learning experiences. Students can use virtual reality to explore virtual worlds, visit historical locations, and participate in simulations [12]. The process of VR system is shown as in Figure 2.6. Virtual Learning Environments (VLEs) are online venues where students and teachers may connect, collaborate, and access educational resources [13]. Discussion boards, file sharing, and online evaluation tools are frequently included in these settings.

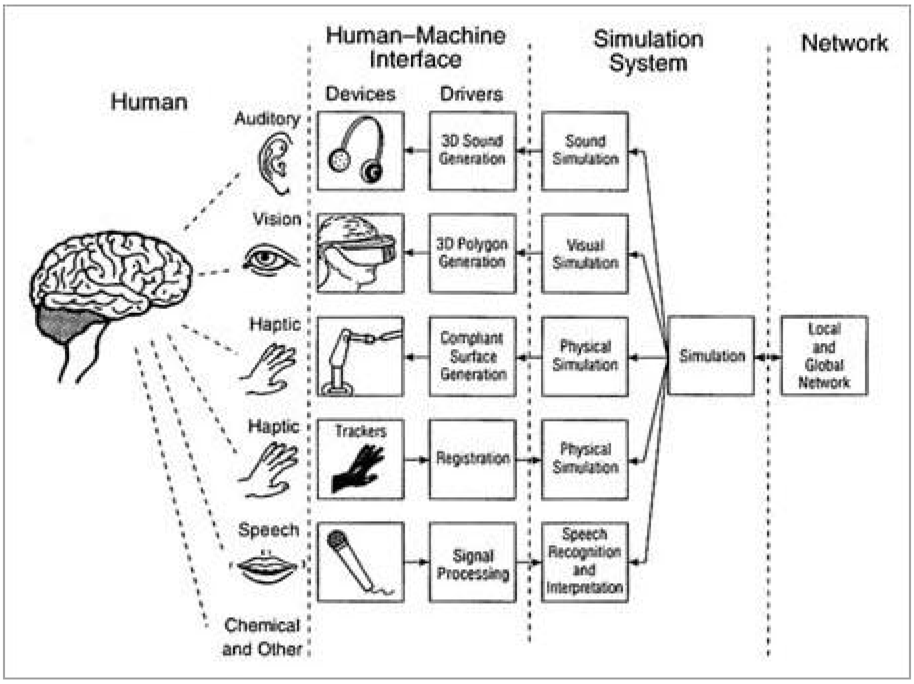

Figure 2.6 Process of VR.

Augmented reality(AR) superimposes digital data on the actual environment, enhancing learning by offering interactive and contextual data. AR allows students to participate in virtual simulations and experiments that bring abstract concepts to life [14]. In science lessons, for example, students can utilize augmented reality to examine the human body, watch chemical processes, or conduct physics experiments in a virtual setting. The example of learning process using AR can be observed in Figure 2.7.

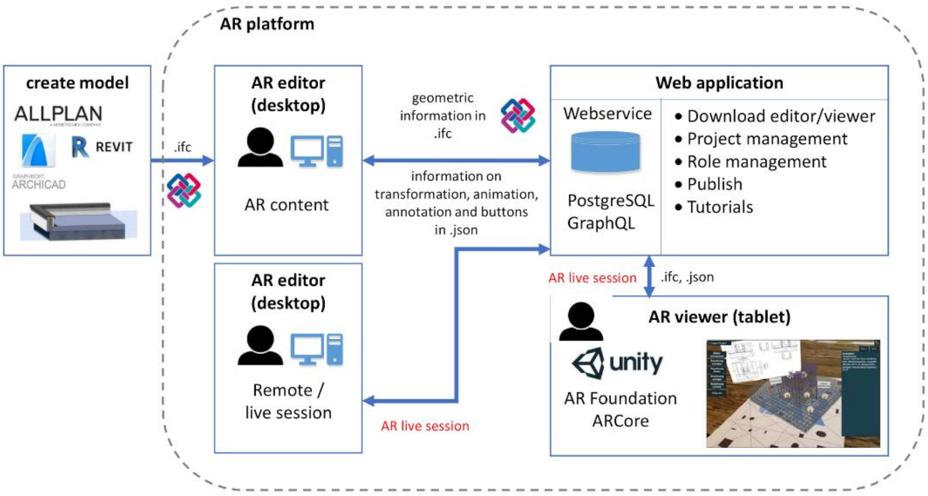

Figure 2.7 Process of AR.

AR supplements traditional learning methods like textbooks and flashcards by superimposing digital content on real items. Students can use a mobile device to scan photos or text to gain access to more material, videos, or interactive aspects, making the learning experience more engaging and dynamic.

AR technology has the potential to improve educational accessibility by offering visual and interactive support for students with diverse learning styles or special needs. To suit varied learners, it may include audio descriptions, text-to-speech capabilities, and customizable features. From figure 2.8 show what AR is consist and its characterisitic.

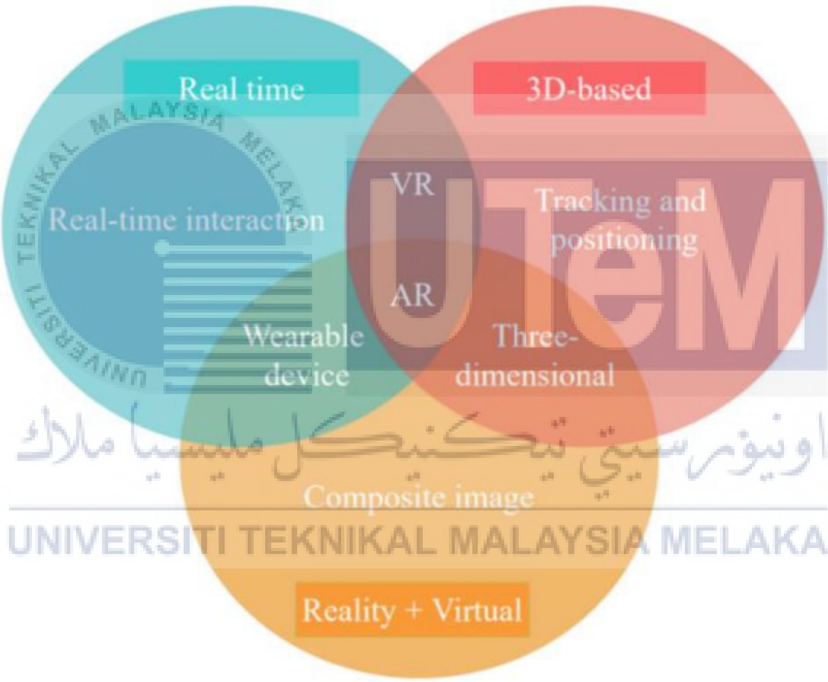

Figure 2.8 AR Characteristic.

2.3 Different type of technology

There are 3 type of technology that can be used for education in this era. Each has their own requirement and advantages. From Table 2.1, it describes a few characteristic for each technology based on different research result.

Table 2.1 Comparison of different technology.

METHOD	RESULT	CITE
AI	-Used to track and detect object. -Focus more on to solve human problem as an assisting technology. - It also can be used to be as a human replacing technology.	[11]
VR	-Required a headset device. -Only create virtual environment. -Allow interaction with the virtual object. -Has a more degree of freedom to be integrated.	[12], [13]
AR	-Can be access through phone and laptop. -Integrate virtual element into real world environment. - Can choose the best value from both world. - Allow student to visualize the process much easier.	[14], [15]

2.4 Augmented reality

Augmented Reality (AR) is a technology that overlays digital information and virtual objects onto the real world, creating an enhanced and interactive user experience. AR combines the real-time camera feed of a device, such as a smartphone or a head-mounted display, with computer-generated graphics, sounds, and other sensory inputs which allows one to view the real world with the addition of external information intended to provide a new understanding of what is being seen [15]. This system is similar with Figure 2.9.

AR technology allows users to interact with digital content in a more immersive and contextual manner. Implementation of Augmented Reality in learning material gives more information about the object being studied, information about on shapes, textures, and provide more visualization for the object. AR applications can range from entertainment and gaming to education, healthcare, retail, industrial training, and many other fields. Thus Augmented Reality (AR) is one solution to fix the problem of science learning in the industrial revolution era 4.0 that is able to accommodate science learning [16].

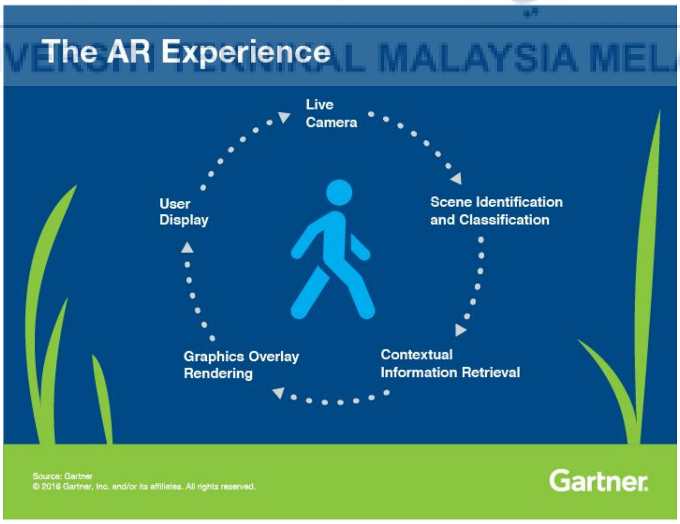

Figure 2.9 AR System In General.

The key components and techniques used in AR include:

Sensors: AR relies on various sensors, such as cameras, gyroscopes, accelerometers, and GPS, to track the user's position, orientation, and movement. These sensors provide real-time data to determine the user's viewpoint and enable accurate alignment of virtual content with the real world.

Computer Vision: Computer vision algorithms analyze the camera feed and extract information about the surrounding environment. This includes object recognition, scene understanding, and tracking of physical features. Computer vision helps in identifying and mapping real-world objects and surfaces where virtual content can be placed.

Display Systems: AR content is typically presented through displays that allow users to see both the real world and the virtual elements simultaneously. This can include smartphone screens, head-mounted displays (HMDs), smart glasses, or even projection-based systems. The display system should provide a seamless integration of the virtual and real-world views.

Tracking and Registration: AR systems need to accurately track the user's position and movement in real time. This involves matching the camera feed with known reference points or features in the environment. Registration algorithms align the virtual content with the real-world coordinates, ensuring proper spatial consistency and overlay of the virtual objects.

Content Rendering: Virtual objects or information are generated and rendered in real time to create the augmented experience. This includes 3D models, images, videos, animations, and text overlays. The rendering process considers the lighting conditions, shadows, and occlusion from real objects to make the virtual content blend seamlessly with the real environment.

Interaction: AR enables user interaction with virtual objects or information. This can involve gestures, voice commands, touch input, or even haptic feedback. Interaction techniques vary depending on the device being used and the specific application requirements.

AR technology has seen significant advancements in recent years which can be seen on Figure 2.10, driven by improvements in hardware capabilities, computer vision algorithms, and mobile computing power. Popular examples of AR include mobile applications like Pokémon Go, which overlays virtual creatures on the real world, and furniture shopping apps that allow users to visualize how furniture will look in their homes.

Figure 2.10 Development Of AR

AR has the potential to revolutionize various industries by providing innovative and immersive experiences. It can be used for training simulations, architectural visualization, medical education, navigation assistance, remote collaboration, and more. As technology continues to advance, AR is expected to play an increasingly prominent role in people daily lives, transforming how people perceive and interact with the world.

2.4.1 Type of AR

Augmented Reality, or AR, is a technology that superimposes digital information or virtual objects on the actual environment. By mixing computer -generated features with the physical world, it improves a user's impression of realism. AR is classified into several sorts or categories based on how it is perceived or the equipment used.

2.4.1.1 MARKER-LESS AR

Markerless AR, also known as location-based or position-based AR, does not use markers. It instead makes use of the device's sensors (GPS, accelerometer, and compass) to detect the user's position and orientation. Based on these characteristics, the virtual material is subsequently superimposed into the real-world surroundings. Markerless AR is used in applications like Pokémon Go, which superimpose virtual animals onto the actual world. It also used in home design as in Figure 2.11.

Figure 2.11 markerless AR used in home design

Markerless AR employs a variety of approaches to comprehend the user's surroundings and match virtual material with the actual world. Markerless AR methods that are often used include:

1. Simultaneous Localization and Mapping (SLAM): SLAM is a technology that allows a device to construct a map of its surroundings while also tracking its own location within that map. SLAM allows markerless AR apps to comprehend the user's surroundings and properly overlay virtual objects by analysing visual characteristics and sensor data [17].

2. Object Recognition and Tracking: Using computer vision techniques, markerless AR can recognise and track certain things in the actual world. The system can recognise items and link virtual material to them by analysing visual cues like as forms, textures, or colours [18]. This enables interactive experiences such as virtual object placement on table tops and virtual apparel and accessory try-ons.

3. Environmental Mapping: Markerless AR applications can align virtual information with pre-existing maps or digital representations of the actual environment. This method can be observed in Figure 2.12. Computer simulations indicate that the proposed augmented reality-based vision-aid indoor navigation system can provide precise simultaneous localization and mapping in a GPS-denied environment [19].

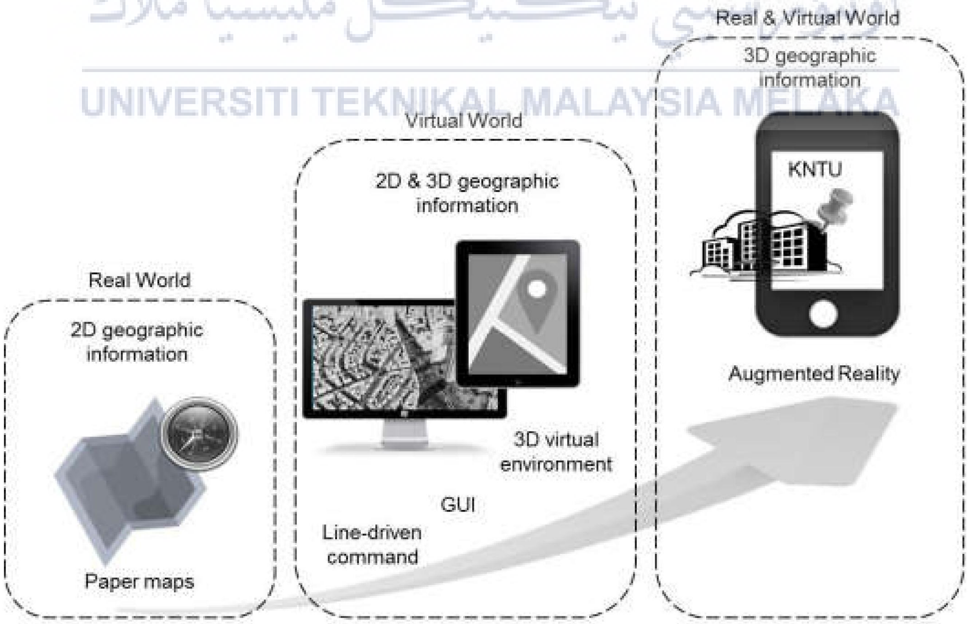

Figure 2.12 markerless AR in mapping system

2.4.1.2 MARKER AR

Marker based AR can be activate by involving the usage of markers or certain visual patterns. When the device's camera identifies the marking, it overlays the related virtual content. Scanning QR codes or aiming the camera onto printed markers to reveal 3D models are two common examples.

These markers are generally 2D pictures or patterns with distinguishing characteristics that an AR system can readily recognise and track. The following are the essential features and components of marker-based AR:

1. Markers: Markers are visual patterns or pictures that serve as triggers for the augmented reality system. They can be projected on displays, printed on paper, or embedded in actual things. Markers are meant to have distinguishing characteristics, such as black-and-white squares, QR codes, or custom-made patterns, that allow the AR system to detect and track them. Marker is used to estimation by using multiple keypoints that exist in the marker based on cells [20].

2. Recognition and tracking: The AR system recognises and tracks markers in real time using computer vision techniques. The system recognises the markers' distinctive properties and determines their location and orientation relative to the camera's perspective by analysing the camera feed or input from a device's camera. Robust tracking was obtained by combining corner and texture information. Experiment result shows the marker system and the tracking algorithm are stable and effective [21].

3. Augmentation: After recognising and tracking the markers, the AR system overlays virtual material onto the markers' real-world placements. This virtual material can take the form of 3D models, photos, films, animations, or interactive features that appear to be attached to or tied to the markers.

4.Interactivity: AR experiences built on markers can be interactive, allowing users to engage with virtual material. Users can interact with the virtual objects connected with the markers by touching, rotating, or manipulating them, triggering further actions or animations. augmented reality (AR) contributes to interactivity and facilitates co-creation [22].

Marker-based augmented reality has several uses in domains such as education, gaming, marketing, and entertainment. It is often employed in interactive children's novels, gaming experiences in which virtual characters appear on printed cards, product packaging with AR-enabled features, museum exhibitions and landmark as in Figure 2.13 that deliver additional information through markers.

Figure 2.13 marker AR used for tourism

Binary markers, QR codes, natural feature markers, and custom-designed markers are some of the markers used in marker-based AR. Binary markers are made up of black-and-white squares that are organised in a precise pattern, allowing for easy identification and tracking. QR codes as in Figure 2.14 , which are a sort of two-dimensional barcode, may also be used as markers. Natural feature markers use distinguishing characteristics of the environment, such as corners or edges, to attach virtual information. Markers with various forms or patterns may be made to fit certain AR applications. A planar marker for estimating the direction of a light source using a structural color[23].

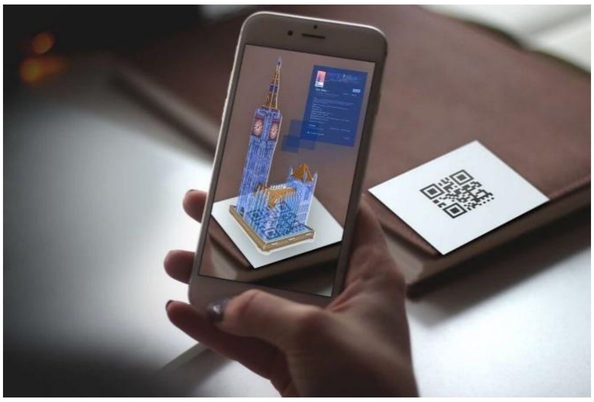

Figure 2.14 QR code for marker AR system

Markers provide a dependable and exact method of triggering and aligning virtual material in augmented reality encounters. However, the existence of the physical marker is required for the AR system to operate properly. Because of its versatility and ease of deployment, marker-based AR has been extensively embraced.

2.4.2 APPLICATION OF AR

There are multiples application of AR that has been used in this modern world. For example, AR Technology have a great potential to be utilized efficiently inside the fashion market as it will meritoriously improve the shopping experience of consumers across multiple fashion related industry channels [24]. When consumers feel satisfaction and pleasure in experience realms of augmented fashion reality applications, they are more likely to reuse of an augmented reality fashion application, and to purchase the products consumers were implementing an augmented reality fashion application for [25].

By applying Augmented Reality technology to interior design work, a user can view virtual furniture and communicate with 3D virtual furniture data using a dynamic and flexible user interface[26]. Augmented Reality can help to create and simulate buying furniture an online experience and enhancing customer experience provided uniqueness and mobility with the help of a mobile application [27].

AR is uses in gaming and entertainment, where virtual items, characters, or effects are superimposed on the actual world. This enables interactive games, treasure hunts, and immersive storytelling experiences that merge virtual aspects with the user's environment. With the rise of augmented reality technology, it is possible to bring the 3D objects in the real world [28]. Augmented reality technology is able to make the game more interesting [29]. The best example of AR usage in gaming is Pokemon Go in Figure 2.15.

Figure 2.15 Pokemon Go

AR can provide travellers with new and engaging experiences. The intelligent augmented reality tourist guide application is very helpful for tourists, particularly enhancing self-guided tours and improving tourists' experience in their touring [30]. Visitors to museums or art galleries can utilise augmented reality to watch supplementary exhibit information or animations. AR may also be used to make tourism more enjoyable by allowing users to solve puzzles and accomplish tasks.or participate in virtual scavenger hunts[31].

AR can be beneficial for planning vacations or reserving lodgings since users may virtually "walk" around hotel rooms, visit tourist destinations, and visualise various travel possibilities. Augmented reality applications, playing a major role in the travels of tourists, make consumers feel safer while making the travels easier [32].

AR projection mapping is becoming increasingly popular in live events, concerts, and stage plays This enables dynamic and adaptable stage designs that may accommodate diverse acts or themes. The system has a higher degree of freedom in practical applications, which can present an interactive spatial augmented reality effect, and therefore provide new possibilities for the application of spatial augmented reality in the stage performance [33].

AR projection mapping can be used to visualise ideas, concepts, or future developments in architecture and urban planning. The prototype system demonstrated a new application of augmented reality architecture and an accessible way for members of the public to participate in urban planning projects [34]. Most current architecture use Stambol software as in Figure 2.16 which allow a much more realistic immersive experiences for customer to view the property.

Figure 2.16 Stambol, AR for architecture

AR also can be used to help learners through specific tasks or activities in training or educational settings. AR may give visual signals and instructions to aid learners in performing activities or understanding complicated ideas by underlining essential processes or areas of interest. Augmented reality technology application for project activity has positive impact on learning outcomes and competitiveness of the national workforce; it will enhance the country's position in the global economic space [35]. The students found the use of augmented reality applications in education useful in terms of making the lesson fun, providing permanence in learning, and improving creativity skills [36].

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, it presents the approach and techniques employed in the development of an augmented reality for microelectronic fabrication courses as study aids. This chapter provides an overview of the project flowchart, block diagram, parameters, and testing methods used to visualize, process and integrated the augmented reality with microelectronic fabrication courses as study aids.

3.2 Project Overview

A mixed-method project design for this project entails combining qualitative and quantitative research methods to acquire a thorough knowledge of the effectiveness, user experiences, and possible advantages of AR study aids.

The aim of this project is to develop microelectronic fabrication courses as a study aid by using augmented reality technology. This project use markerless AR which did not require physical marker. Markerless AR needs advanced computer vision algorithms in order to comprehend and interpret the user's surroundings in the absence of preset markers. This require for increasingly intricate tracking, feature recognition, and scene comprehension.The whole process of this project is as in Figure 3.1.

The first step that been done is create virtual object based on the microelectronic fabrication process. Then, The AR system will be constructed through Unity. Unity is used to create 3D animation for this project. The system is tested to see its functionality.

During the testing phase, this application is performed on mobile phones running the Android operating system. If there is error, the system will be render again to check the problem. If the system can operate accordingly, the project will be summarized as successful.

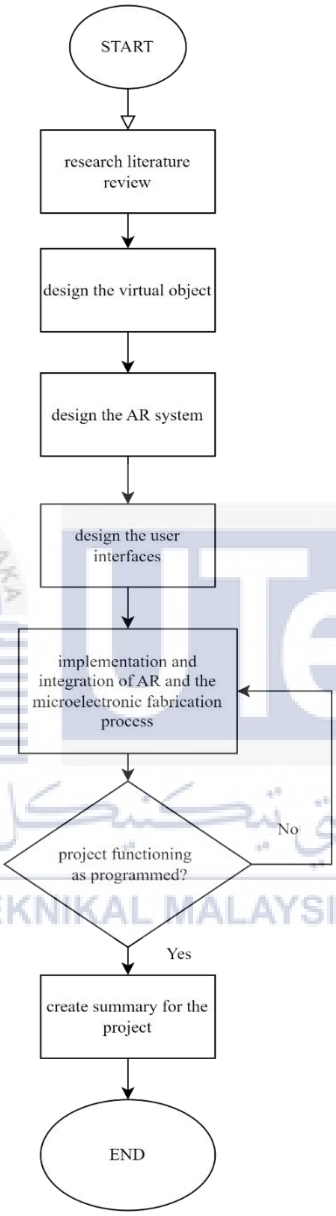

Figure 3.1 Project flow chart

This virtual object is created in Tinkercad and Unity. The phone application is important to act as an interface for the system. It will be created by using Unity. The AR system is the main part of this project. This AR system will be constructed through Unity. Each part of the AR system can be observed in Figure 3.3.

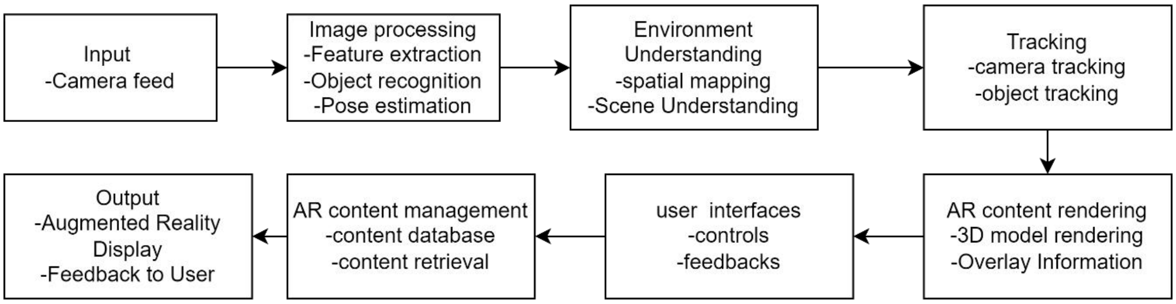

Figure 3.2 Block Diagram for the AR system

3.3 Project flowchart

The focus for this project is to build the AR system. The AR system is based on flowchart at Figure 3.3. This step is done by converting design concept into a functioning application.

This project consists of four software programs which is TinkerCAD, Microsoft Visual Studio, Unity and mobile Application. Each software has a different purpose to make the project function well. Table 3.1 shows the software that is used in this project and its function for the project.

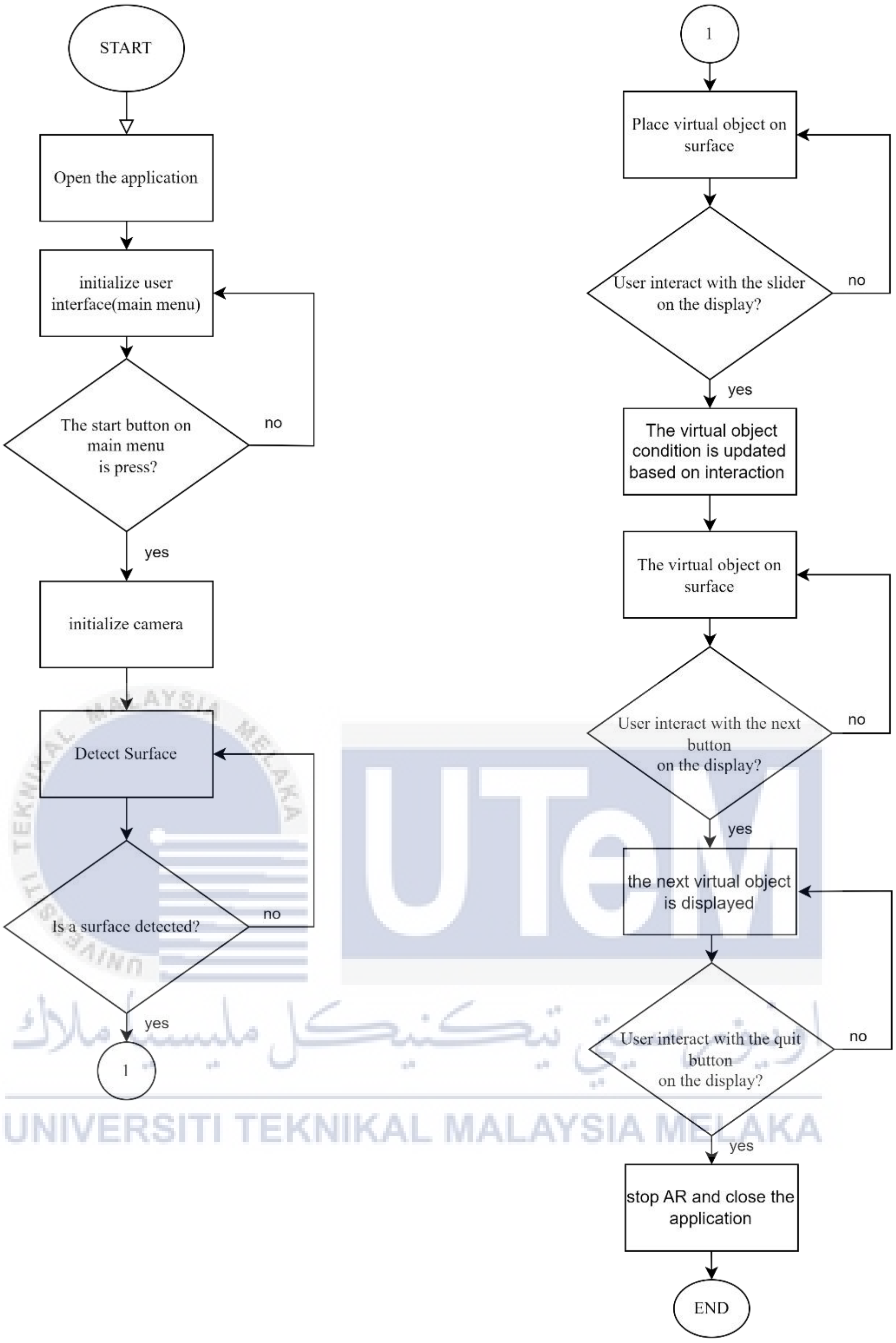

Figure 3.3 AR system flow chart

Table 3.1 Function of each software used.

Software	Description
TinkerCAD	The goal of this software is to model the process flow of fabrication process. This will enable more dynamic design manipulation and a better finish when exporting the object to Unity.
Microsoft Visual Studio	The goal of this software is to facilitate the writing of scripts, or code, that control the graphical user interface (GUI) and its interactions. It also reduces development time because of it is easier to be integrated to Unity.
Unity	The goal of this software is connecting the objects produced by the different IDEs (Integrated Development Environments). This software makes it possible to enhance and fix problems with texture and animation. Achieving a degree of coherence in quality that guarantees the generated program's compatibility across multiple platforms.
Mobile Application	The goal of this software is to download the Application Server application (APK) for mobile devices.

3.4 Project Development

For this project, there are 4 stages that have been followed to make sure the project is develop successfully. The first stage is to create a virtual object for the fabrication process. The second stage is to build the AR system in Unity. The third stage is to create the application's code by using C# in Visual Studio. The last stage is to build an APK file to be used on the mobile.

The first stage is creating the virtual object for the microelectronic fabrication process. In first stage, it is required to identify each shape of the process involve in augmented reality. The shape of the process will be used as the virtual object in the AR. This design is created in 3D modelling software known as TinkerCAD. The object that has been created is in Figure 3.4.

Before transitioning from the 3D modeling phase to the assembly phase, all components are formatted as .obj files for Unity software. This approach integrates augmented reality into the learning process. This will determine the subjects, concepts, and skills with which students will interact with AR.

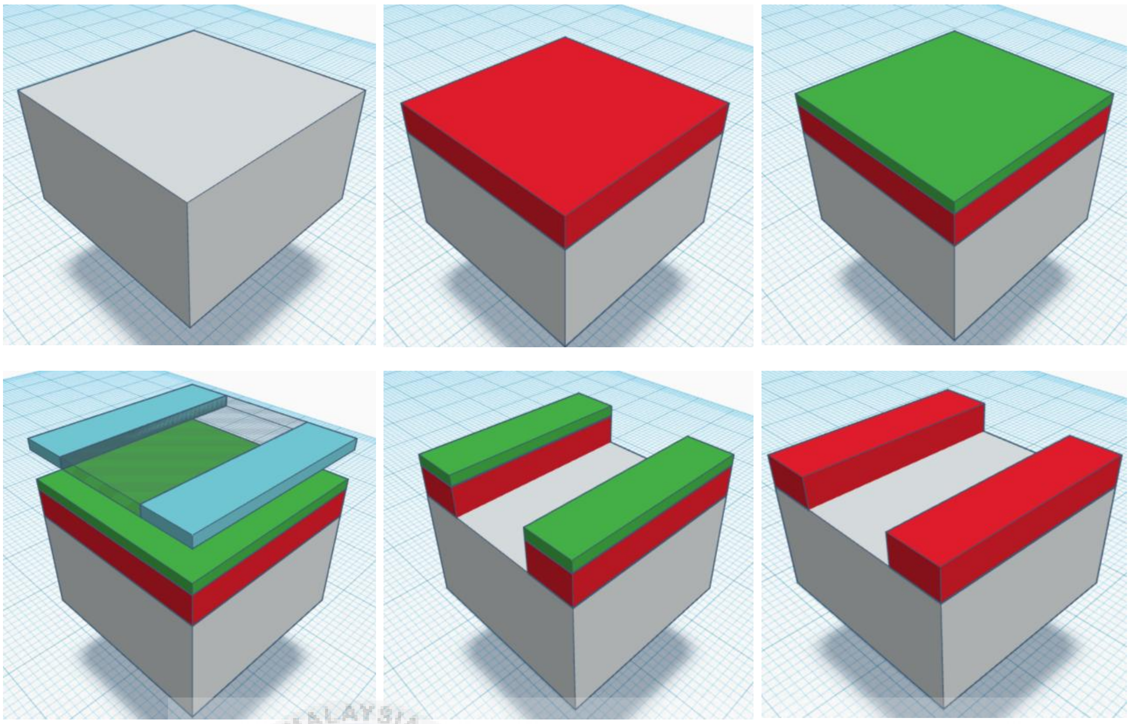

Figure 3.4 etching process virtual object.

The second stage is to build the AR system. This step is done by converting design concept into a functioning application. This stage is done by using Unity software. This stage required to create an idea about how to use augmented reality efficiently. There will be a list of prospective features, interactions, and visualisations that are related to the learning objectives to be put in the AR. There are a few displays, motions, and information will be displaying that users will interact with. Figure 3.5 show the main menu for the AR application.

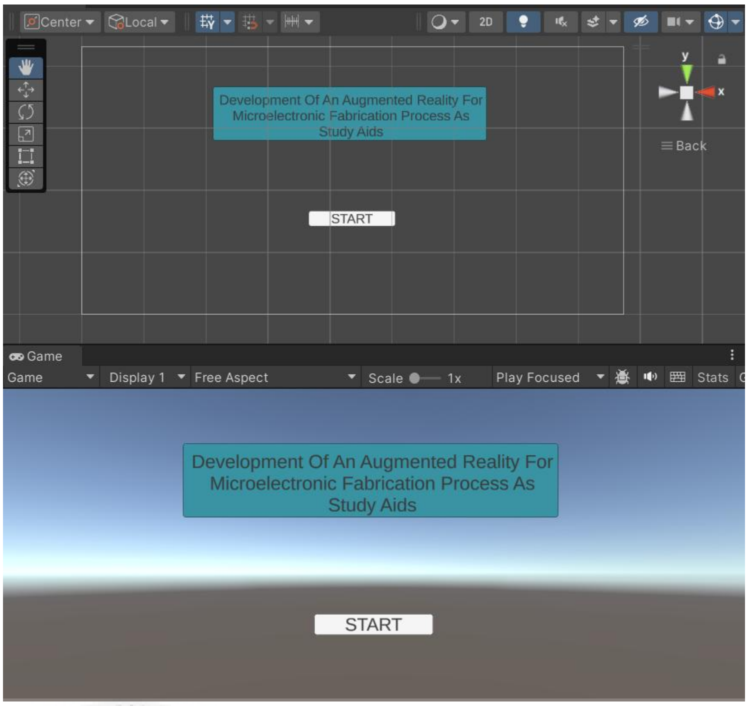

Figure 3.5 Main Menu Page

Besides, in the second stage also involves the practical implementation and develop microelectronic fabrication courses as a study aid by using augmented reality technology. It consists of assembling the system together. The unity is used to create 3D animation for each process. The AR application is created by using the right development tools and platforms. This may entail coding, integrating AR framework, which is ARCore, and implementing capabilities such as object detection, tracking, and interaction.

An asset is anything that is use in the Unity project to create the application. 3D models, textures, and sprites are examples of the visual object of the project that assets can represent. In addition, assets can represent more abstract objects like colour gradients and animation masks, as well as more arbitrary text or numeric data for any purpose. An asset could originate from a 3D model or image made outside of Unity which in this project cases is from Tinker CAD.

Additionally, The virtual object can be controlled in Unity such as in Figure 3.6. It can be rotate to view from many angles. This part is also used to make the size of the object become bigger or smaller using scale. The position of the object is determined by axis-x, axis-y and axis-z. The setting for the position of the object is in Figure 3.7.

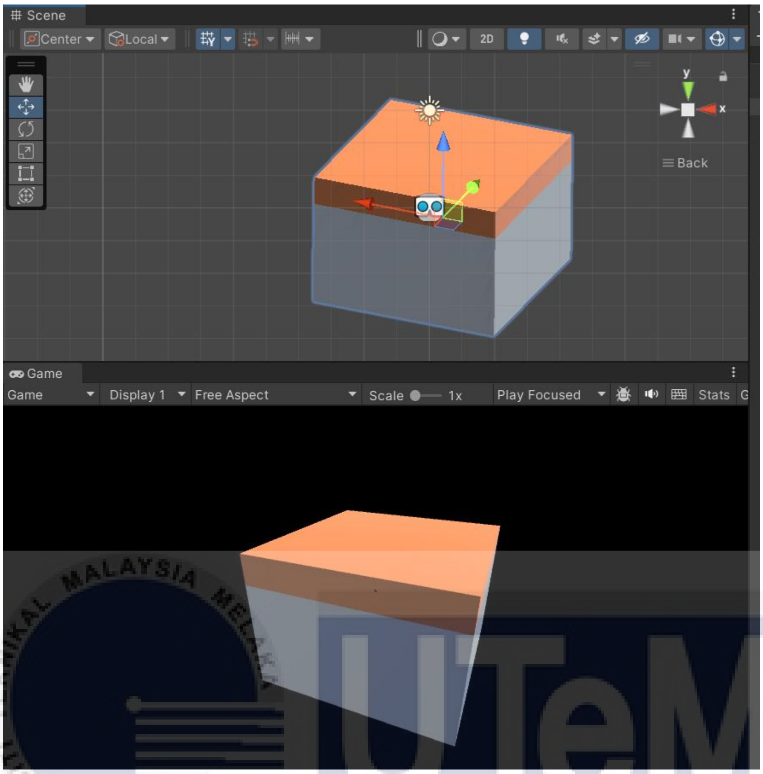

Figure 3.6 Unity scene and game panel

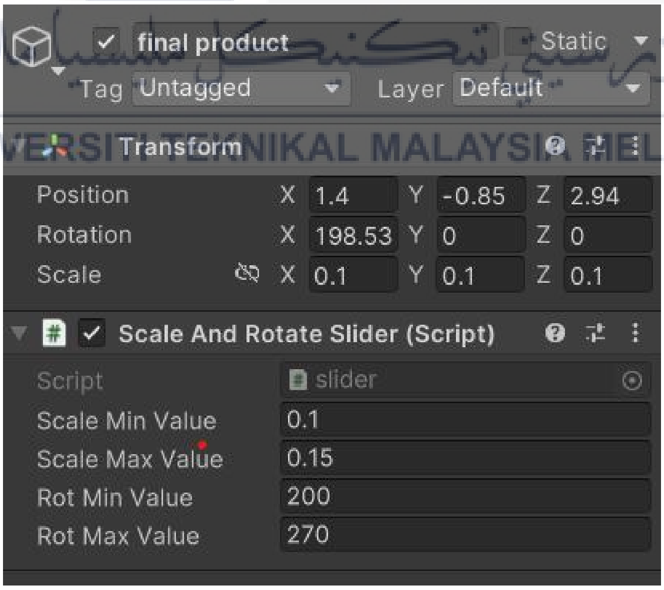

Figure 3.7 Setting for the position, rotation, and size of the object.

The third stage is the application's code, using C# in Visual Studio because the compatibility with the Unity platform. It involves creating functions for interface execution and object movement within the scene. As in Figure 3.8, the script is for the main menu. The code controls the start button on the main menu to go to the next scene. For Figure 3.9, It involves in the setting for the AR controller which is slider. This coding will adjust the position of the object based on the user desired.

main menu.cs

C: > Users > Hp > My project (1) > Assets > script > main menu.cs

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

public class MainMenu : MonoBehaviour
{
    // Start is called before the first frame update
    public void PlayGame()
    {

   SceneManager.LoadSceneAsync(1);

    }
}
```

Figure 3.8 example of main menu script

```
C: > Users > Hp > My project (1) > Assets > script > slider.cs > ...
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
using UnityEngine.UI;

0 references
public class ScaleAndRotateSlider : MonoBehaviour
{
    // we need two sliders
    // we need min and max values of each

    4 references
    private Slider scaleSlider;
    4 references
    private Slider rotateSlider;
    1 reference
    public float scaleMinValue;
    1 reference
    public float scaleMaxValue;
    1 reference
    public float rotMinValue;
    1 reference
    public float rotMaxValue;



    }

    1 reference
    void ScaleSliderUpdate(float value)
    {
        transform.localScale = new Vector3(value, value, value);
    }

    0 references
    void RotateSliderUpdate(float value)
    {
        transform.localEulerAngles = new Vector3( value, transform.rotation.y, trar
    }
}
```


Figure 3.9 example of slider script

In coding, functions denoted by uppercase letters, encapsulate script fragments handling and comparing variables. This arrangement fosters code reuse across the program, ensuring flexibility and efficiency. Additionally, classes are employed to organize variables and functions, enabling the creation of templates defining object attributes. This modular structure enhances maintainability and facilitates the efficient management of code in diverse program sections.

The last stage is to build an APK file to be used on the mobile. The Android platform can also be selected in the build setting to generate the apk.file. This setting is as in Figure 3.10. APK file device setting and scene arrangement. To set the target API level to 24, which is compatible with Android version 7, open another setting. This API setting can be configured in Figure 3.11.

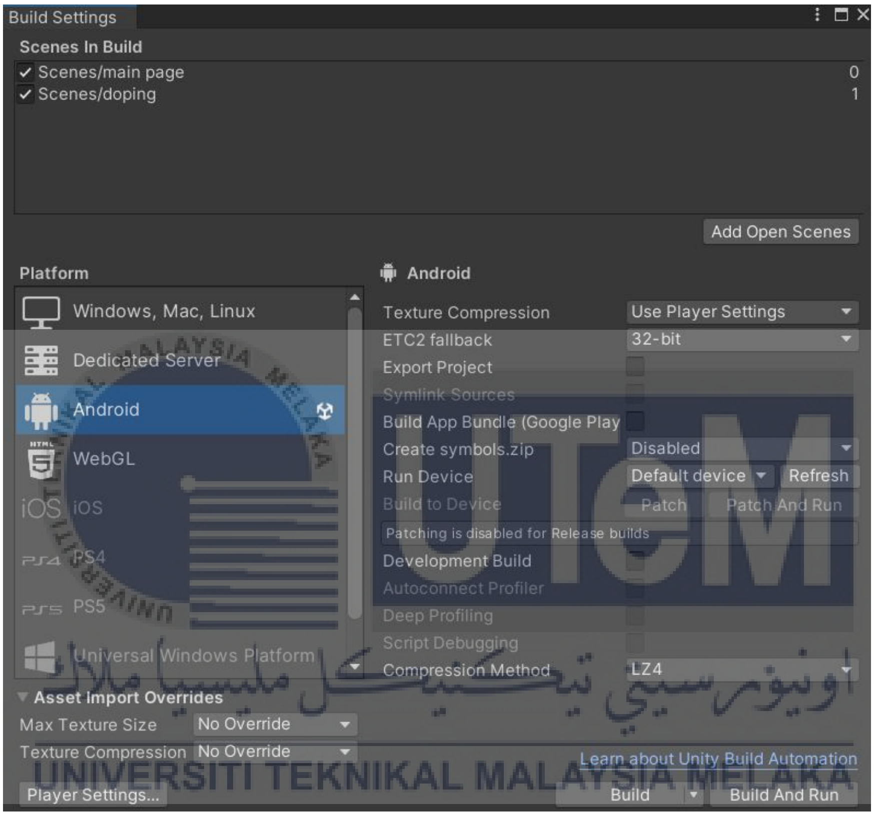

Figure 3.10 APK file device setting and scene arrangement.

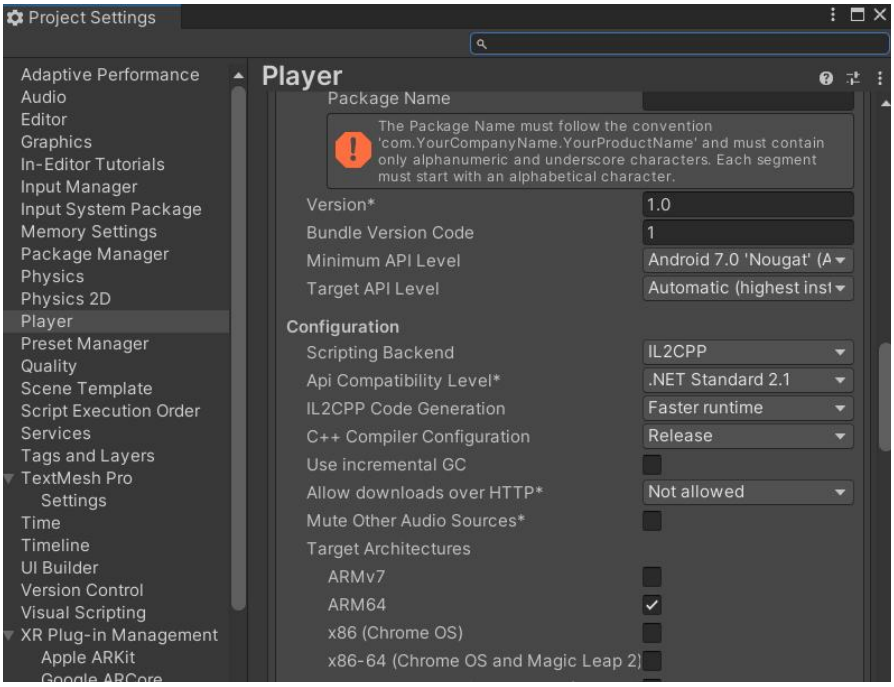

Figure 3.11 APK file API setting

The interface of both stage is check for functionality and make sure the AR elements are in line with the learning objectives. There will also has a graphic depiction of the user interface and interactions of the AR system. The last stage is to integrate all previous stage in one. To build a seamless AR study aid experience, it will be combined with the produced software, content materials, and user interface. This last stage is also created with an innovative and user-friendly interface for the augmented reality application. Visual clarity, navigation ease, and the proper usage is considered for the AR features.

3.5 Parameter

In the context of microelectronic fabrication courses as a study aid by using augmented reality technology project, the parameter can be categorizing into fixed and variable parameters. Fixed parameters refer to the characteristics or settings of the system that remain constant throughout the monitoring process. These predetermined parameters include camera specifications, lighting conditions, background environment, and system calibration.

They do not change during data collection and analysis. Variable parameters are factors that can be manipulated or vary during the monitoring process. These parameters include algorithm settings, data pre-processing techniques, and marker point. They can be adjusted to optimize the performance of the system.

3.6 Selecting and Evaluating Tools for a Sustainable Development (SDG)

This AR system as a study aids project aligns with several Sustainable Development Goals. Firstly, the system relates with SDG 4: Quality Education by creating an interactive learning method for student. Besides, this project also relates to SDG 9: Industry, Innovation, and Infrastructure by utilizing advanced technologies such as augmented reality and visual studio, showcasing innovation in education and microelectronic industry sector. Lastly, SDG 11: Sustainable Cities and Communities also relate with this project. This is related to higher level of interactive education can make a much more develop communities.

3.7 Summary

To summarize this chapter, this project is based on mixed research design which combining qualitative and quantitative research methods to acquire a thorough knowledge of the effectiveness, user experiences, and possible advantages of AR study aids. The project flowchart depicts the progression of the project's, including research, development, and data collection. The flowchart and block diagram effectively show the hardware and software flow for this project.

CHAPTER 4

RESULT

4.1 Introduction

In this chapter, it shows the result obtained for the development of an augmented reality for microelectronic fabrication process used as a study aids. This chapter also explains the process for this project to be developed, tested, animated, and troubleshoot. This chapter is crucial for demonstrating whether the objectives outlined in the first chapter have been met. The functionality of the project and the efficiency of the Unity software assembly procedure are also determined in this chapter. To export as an Android Package Kit (APK) file, Unity will be used to create all the necessary objects, including the database, image target, 3D models of the fabrication process, scenes and coding. This chapter discusses how using augmented reality technologies enhances learning environments by enabling students to attain a higher level of technical knowledge and proficiency.

4.2 Result

This project object in the " Development Of An Augmented Reality For Microelectronic Fabrication Process As Study Aids" is design in TinkerCAD software. This project is based on markerless AR which require an advanced computer vision algorithms for feature detection. This allows the project to identifies and tracks features in the real world without markers.

This project is using TinkerCAD software as design software for the 3D modelling object for fabrication process. The objects created for this project are as in Figure 4.1. The objects with numbers assigned are the process to be displayed and controlled in Unity. While the object with title is the description for each process.

Figure 4.1 Objects for the fabrication process

Each object is assigned to a different scene based on suitable arrangement. This is important to make sure the object is in the right order to make sure the user understands the step-by-step process of fabrication. The list of scenes is in Figure 4.2. A "scene" is a basic unit of organization in which game or application developers divide and organize various sections. Scenes serve as holding areas for all the components unique to a given part of the project, including assets, lights, cameras, and objects.

With Unity's Scene View and Hierarchy Panel, developers can efficiently arrange and manipulate game objects by seeing visual and hierarchical representations of the scenes. Furthermore, by defining the application's flow and enabling developers to switch between scenes based on user interactions or predefined events, scenes are essential for producing a seamless user experience. For each game object in a scene, the Inspector Panel provides extensive details and customization choices.

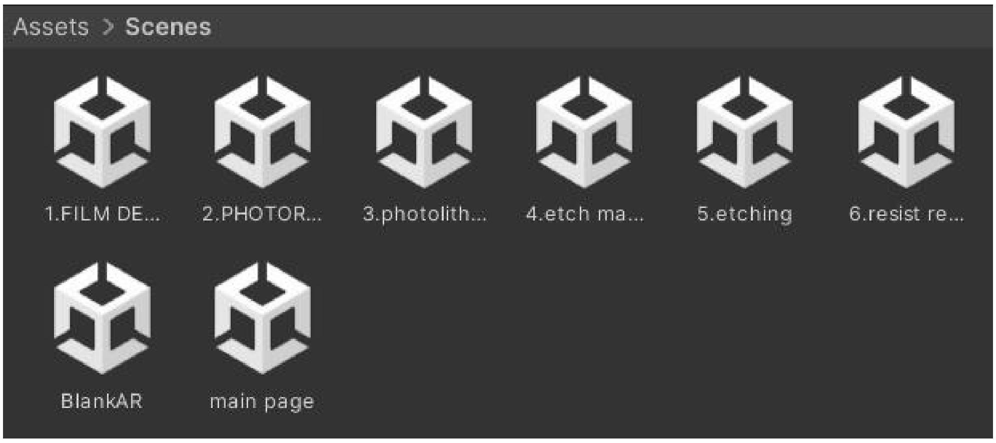

Figure 4.2 Scene for the fabrication process

This script section contains all the code that controls the flow of the project. The main menu script is to control the button that is assigned on the main menu scene. In Unity, scripting is an essential part of game development. The primary scripting language used by Unity is C#, which offers developers a strong and adaptable environment for creating and modifying GameObjects. The list of script that is used for this project is in Figure 4.3. In the script, there is code to change scenes in Unity requires a few crucial steps. To begin with, scenes must be made in the Unity Editor, each of which represents a distinct area of the game or application. The Scene Management library can be accessed through UnityEngine inclusion.SceneManagement; offers all the features required for scene-related tasks.

Developers can use SceneManager to load a new scene.LoadScene and pass in the target scene's name or index. The SceneManager can also be used to manage scene transitions with parameters.sceneLoaded event, allowing for specific actions to be performed upon loading a new scene. Additive scene loading is supported by Unity, allowing scenes to be loaded on top of pre-existing content while keeping the current scene in its current state. On the other hand, SceneManager can be used to unload scenes.UnloadScene: helpful for releasing memory or switching between sections of the program.

For scenes to be accessible through code, they must be added to the build settings. Lastly, to preserve clarity and modularity in the overall project structure, that scene management code need to be arranged according to best practices in a specific script or manager.

Figure 4.3 Script for transition and control using Visual Studio

This script has given characteristics that improve object manipulation in a markerless setting, greatly enhancing the augmented reality experience's potential. The ability to dynamically instantiate virtual objects is made possible by the addition of variables. With this feature, users can choose and use different objects, giving the AR learning scenario more adaptability and customization and increasing its suitability for a range of educational contexts.

Additionally, the script includes optional object rotation features. Adding the capability to rotate virtual objects around the X-axis at a predetermined speed makes augmented reality (AR) more visually captivating and interactive for users. This rotating feature gives the learning environment a dynamic touch and makes interacting with instructional content more engaging and immersive for users.

Apart from rotation, the script adds an optional scaling function that lets users use slider to dynamically change the virtual object's size. By enabling users to customize their interactions with virtual content according to their preferences, this functionality gives the AR learning experience a more tactile and intuitive element.

In Unity, designing the user interface (UI) for a markerless augmented reality application is a methodical procedure. To start, create a canvas, which is a container for user interface elements. Then, add components to the canvas, such as text, buttons, and images, according to the needs of the application. After these UI elements are added, carefully use the RectTransform component to modify their size, position, and style so that they match the intended look and feel.

Incorporate a text component, to guide users through the experience by giving them immediate feedback on their augmented reality interactions. There is buttons for switching between scenes. To define the specific functions of these buttons and enable the smooth integration of user input into the augmented reality environment, attach scripts to them.

Next, The APK file is created and installed on an Android device by the Unity software after the assembly process is finished. The mobile application's journey began on the Main menu scene. The user can view the process scene by clicking the start button.

After clicked the start button, the component's 3D model will show up on the screen and can be controlled to rotate and increase in size by using slider. There will be a description for each object that describes what process it resembles in the fabrication process. This transition can be seen in Figure 4.4. To go to the next scene, press the next button. It will display the next process of fabrication and its description. All the component 3D model can be controlled by using slider as in Figure 4.5. To close the application, click the button on the last scene.

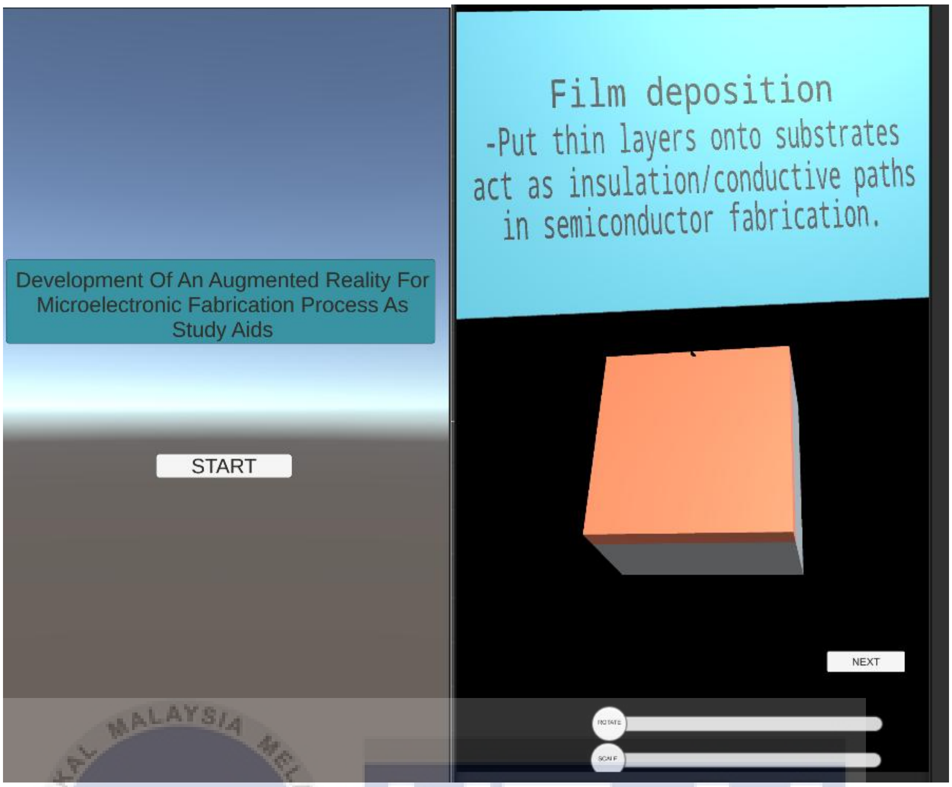

Figure 4.4 Main menu scene and sample scene

Figure 4.5 Control panel for the transition and animation

4.3 Analysis

A survey was conducted to gain insights into the needs, opinions, and behaviors of engineering students. Questionnaires were distributed to the target users, specifically 18 students from the Faculty of Technology of Electrical and Electronic Engineering. The amount of student that take microelectronic course is 15 student and only 3 that did not take the microelectronic courses. The survey aimed to explore attitudes and responses, evaluate client satisfaction, gather opinions on various topics, and establish the legitimacy of the research.

The purpose of the survey was to collect responses from participants regarding their understanding, technical review, and knowledge of augmented reality and its components in a specific application. The survey results were represented in a pie chart, illustrating the distribution of responses among the participants. Figure 4.6 show that 77.8% of respondents agree and 22.2% of student slightly agree that the application help them to get more information about fabrication process.

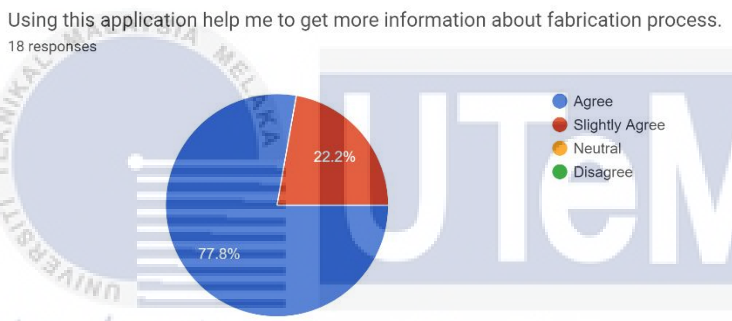

Figure 4.6 Pie Chart about this application effectiveness to deliver information.

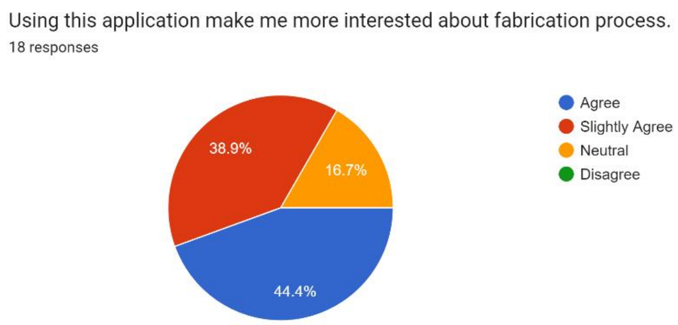

Figure 4.7 Pie Chart about interesting level of student toward the application.

From Figure 4.7, 44.4% student agree, 38.9% slightly agree and 16.7% student respond neutral. This show that the application make them more interested in the fabrication process.

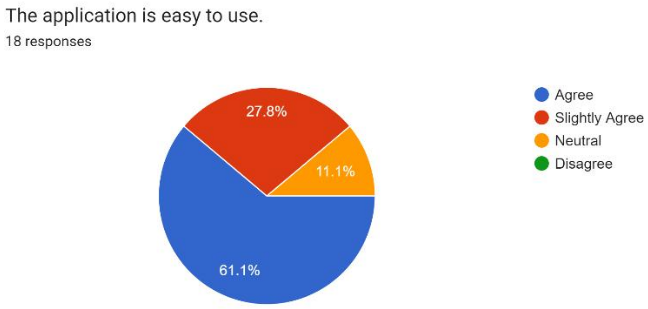

Figure 4.8 Pie Chart about the easiness level in using the application.

From Figure 4.8, 61.1% student agree, 27.8% slightly agree and 11.1% student respond neutral. This indicate that the application is easy to use.

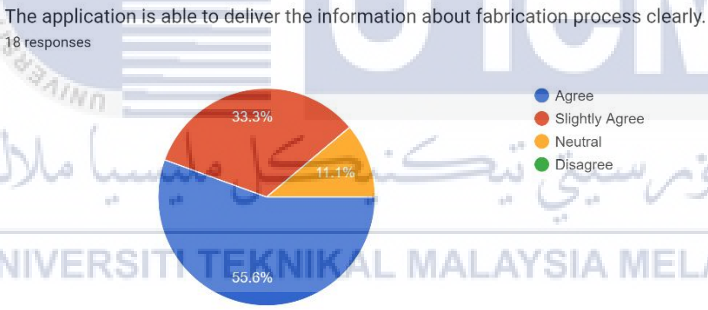

Figure 4.9 Pie Chart about the application ability to deliver the information.

From Figure 4.9, 55.6% student agree, 33.3% slightly agree and 11.1% student respond neutral. This indicate that the application can deliver the information about fabrication process.

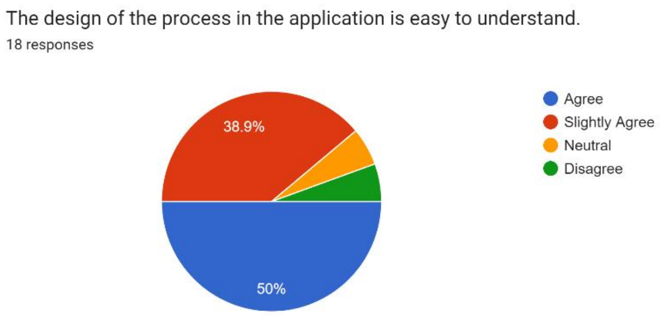

Figure 4.10 Pie Chart about the 3D design of the application.

From Figure 4.10, 50.1% student agree, 38.9% slightly agree, 5.5% student respond neutral, and 5.5% student respond disagree. This indicate that the 3D design is good but there can be a few improvements to be made.

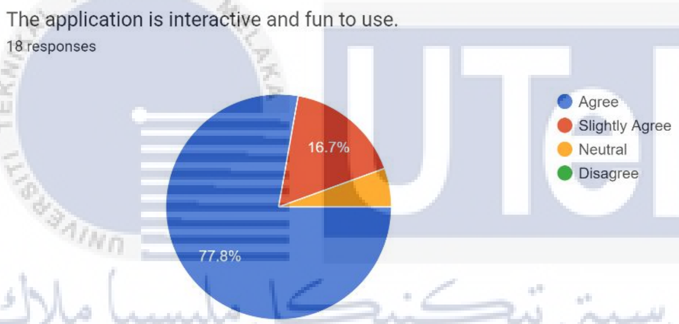

Figure 4.11 Pie Chart about the feature design of the application.

From Figure 4.11, 77.8% student agree, 16.7% slightly agree and 5.5% student respond neutral. This indicate that the feature design is good overall and interactive to use by students.

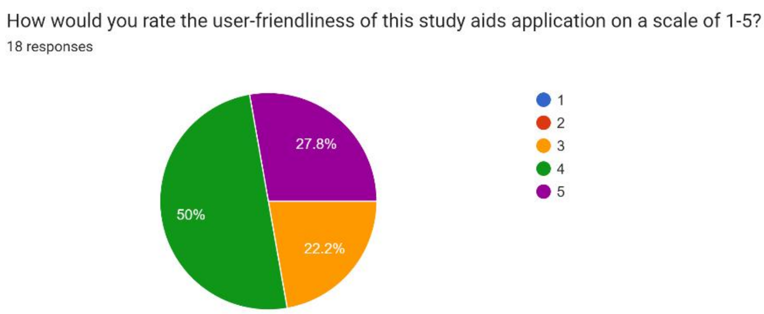

Figure 4.12 Pie Chart about the user friendliness of the application.

From Figure 4.12, 50% student give 5, 27.8% give 4 and 22.2% student respond 3 points. This indicate that the application is user friendly.

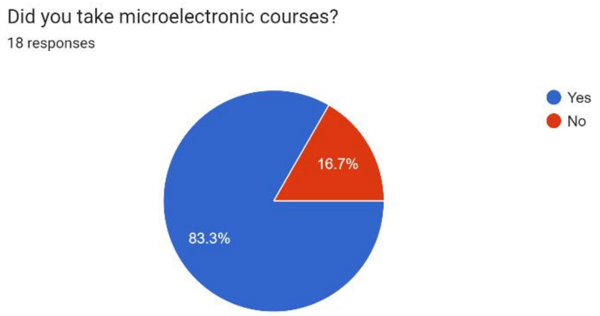

Figure 4.13 Pie Chart about the amount of student that take microelectronic course.

From Figure 4.13, 83.3% student say yes and 16.7% say no. This indicate that the questionnaire also be answer by student that did not take microelectronic courses. This helps to observe whether the application can help student that did not take microelectronic courses to understand the fabrication process.

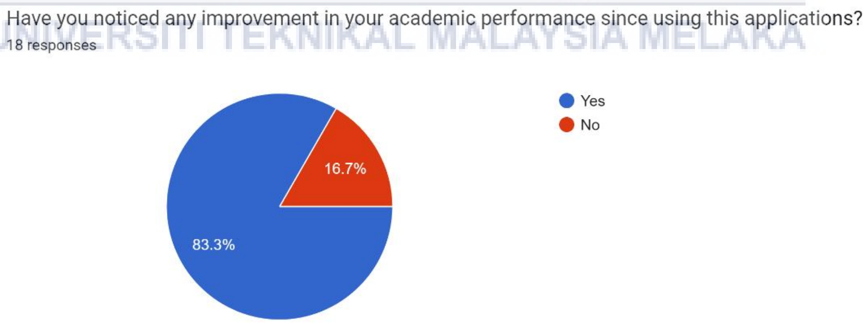

Figure 4.14 Pie Chart about the improvement in academic performance.

From Figure 4.14, 83.3% student say yes and 16.7% say no. This indicate that this application has improve majority of student academic performance.

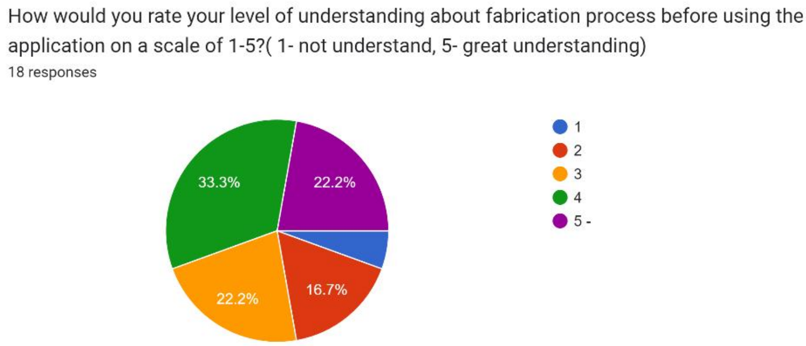

Figure 4.15 Pie Chart about level of understanding before using the application.

From Figure 4.15, majority of student choose 3 to 5 as their level of understanding for fabrication process which is 77.7%. This indicate that most students have a strong foundation about fabrication process.

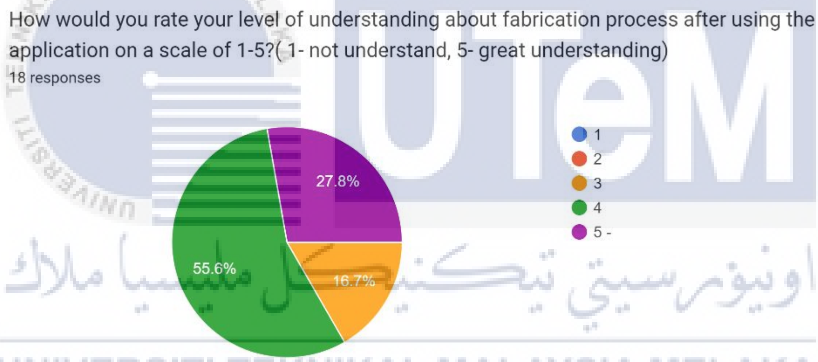

Figure 4.16 Pie Chart about level of understanding after using the application.

From Figure 4.16, all students choose 3 to 5 as their level of understanding for fabrication process which is 100%. This indicate that students have gain more knowledge about fabrication process.

4.4 Summary

The project's outcomes were wrapped up in this chapter. The outcome displays the final TinkerCAD component design and the Unity 3D software assembly process for the creation of fabrication process design. TinkerCAD software has been used for 3D modeling. The result also shows the finished products following the configuration of elements for features like rotation and scale slider, next scene, and moving scene using C# script. TinkerCAD software has been used for 3D modeling. The description, and C# script are used to put these models together.

A questionnaire-based survey was used to gather data, and the findings showed that augmented reality applications gave their users access to more conceptual, fascinating, intelligible, and informative content. Users of AR applications benefit greatly from them, especially in the field of education.

CHAPTER 5

CONCLUSION

5.1 Conclusion

As a conclusion, this AR for microelectronic fabrication process as study aids is developed in this project. One of the objective is to study the current technology to adapt augmented reality into microelectronic courses for interactive education. This project shows how augmented reality (AR) can be used to increase student engagement in the learning process. Teachers and students both gain from AR. It helps teachers clarify difficult concepts in an engaging classroom setting while enabling students to pick up concepts quickly. The field of education will see continued growth in the potential of augmented reality. It is clear that augmented reality-based education will become widely used as technology advances, rendering conventional teaching approaches obsolete. It has been established that these interfaces' motivational component will be a beneficial long-term asset for education.

One benefit of the application that the students could explore was that it is a tool that encourages self-directed learning. Additionally, students won't need to travel to a lab to create the design for the fabrication process because they can download and use the application from the comfort of their own homes. Students' desire for an application, to utilise it for learning, and to recommend it to others for study demonstrates to them.

The main objective is to design an interactive interface of an AR system for microelectronic course with visual image and animation over a real world. This project is a good solution to make learning experience become more interactive and enjoyable for student. This system will describe and display the process in a much more detail information. It can provide a better simulation and demonstration for the student usage during study compare to traditional method which is through textbook and journal.

As a result, the development of an AR fabrication process application was the main focus of this study. The application has integrate the microelectronic syllabus into AR interfaces. The application offers a way to learn about fabrication process and the step-by-step process to get the final design. Therefore, before creating the content for the AR apps, the structure for each step in the process was determined. Next, a specialized augmented reality application for fabrication process was created. Lastly, a survey was used to gauge the impact of augmented reality (AR) on learning in terms of its benefits and drawbacks.

5.2 Future Improvement

The development of AR applications for microelectronic fabrication processes can be improved by doing a few additional elements such as adding an audio with the explanation for the process. Another improvement is to put the animation for the 3D model to make it more attractive. This application can also be improved by adding another fabrication process to be displayed. This allows students to get more information about the fabrication process.

5.3 Commercialization Potential

This augmented reality (AR) project has a lot of potential applications in different fields. Its potential in the education sector is to modernize microelectronics courses taught in schools, providing a stimulating and innovative learning environment that will probably draw students. Additionally, the project's flexibility extends to training facilities, offering professionals in the microelectronics industry beneficial opportunities for hands-on learning that improve their practical skills.

This project opens doors to profitable tech partnerships, not just for educational institutions. Opportunities for cooperation with tech firms looking to develop cutting-edge teaching resources offer a way to incorporate augmented reality (AR) into training curricula, enhancing the immersive and productive learning environment. A wider audience is also ensured by the project's application to online learning environments, providing high-quality microelectronics education to a worldwide audience. Additionally, the opportunity for joint research on microelectronics and augmented reality projects can stimulate additional growth, improving our knowledge of and ability to use these technologies in both academic and professional contexts.

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APPENDICES

Appendix A