OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment

By

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

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It is hereby certified that ***Wong Kai Jie*** (ID No: ***1903336 ID***) has completed this final year project entitled "*An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment*" under the supervision of Dr Manoranjitham a/p Muniandy (Supervisor) from the Department of Computer Science, Faculty of Information and Communication Technology, and Ts Dr Khor Siak Wang (Co-Supervisor)* from the Department of Information Systems, Faculty of Information and Communication Technology.

I understand that University will upload softcopy of my final year project in pdf format into UTAR Institutional Repository, which may be made accessible to UTAR community and public.

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In addition, I want to thank my friends that had given me encouragement during hard times. Finally, I must say thanks to my parents and my family for always being by my side and giving me their love and support.

ABSTRACT

Interior design of an office can be impactful towards the atmosphere of the office. A well-designed office indoor environment can bring positive effects on the office workers' work efficiency and always keeping their mood up. However, hiring an expertise to carry out the task can be very costly. OfficeIT is a mobile application that helps user on designing an office indoor environment using augmented reality technology. The main functionalities of this application are viewing furniture scaled according to estimated room area, providing sound cue for object interactions and provide custom model selection to user. The application uses the Android OS platform and therefore could only be used on Android devices. The application requires Android 7 or above to be able to use the augmented reality features. The main objective of this project is to create an augmented reality application that is easy to use and able to efficiently help the user on designing an office indoor environment. To achieve the objective of this project, the Software Development Life Cycle is implemented throughout the model planning and development stages to maintain an organized project. Android Studio Chipmunk will be used as the integrated development environment along with Java as the programming language to develop this application. Google ARCore API and Sceneform plugins will be applied to provide augmented reality capabilities to the application. Firebase will also be used as the database to store all the 3D Models. UML Diagrams are used during planning phase to visualize the application workflows.

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LIST OF ABBREVIATIONS

AR	Augmented Reality
SDLC	Software Development Life Cycle
IDE	Integrated Development Environment
SDK	Software Development Kit
OS	Operating System
2D	2-Dimensional
3D	3-Dimensional

Chapter 1 Introduction

1.1 Problem Statement and Motivation

The current existing interior design applications are created by furniture retailer companies, which are targeted mainly to increase the sales of their product rather than a generalized application that is fully intended to aid users on designing the interior of a property. In example, Houzz, IKEA Place, and Room Planner are all commercialized interior design applications with the purpose of selling their product instead of designing an interior environment of a room. In these interior design applications, users can browse and try out furniture that are included in the market. However, they are unable to try out own customized furniture. This often frustrate users since the retailer does not always provide suitable furniture or products that suit the user preference and when the user finds a product that is preferred on the internet, there is no way for the user to try out or view the product in the room. Besides that, the designing layout provided in the interior design applications on the market are more applicable for home interior design rather than an office interior design. This has caused an issue where the items in the applications are often shown a bit larger than they actually are (Bradford, 2018). This problem is crucial to be fixed because an unoptimized layout might cause miscalculation in the room area for the augmented reality and cause discrepancy between the simulated design and the end design.

Another issue of the interior design applications is the lack of haptic interaction implemented in the system. One big influencer of how a person experience a room is the weight of the objects in the room. The weight of an object can be used to ensure work efficiency in accessing public use resource and safety of the environment as well as providing a general sense of the intensity of noise the object could produce. A room can be very noisy without any auditory treatment such as softer flooring or soundproof panels in the wall, does not matter if is it for commercial or domestic (Westbury Garden Room, 2020). Without the consideration of sound and sense of touch of the object, the current system might not be complete and effective in achieving its designing goal. When designing an indoor office environment, there are more factors that need to be considered by the designer. For office interior design, the chosen product needs to be practical, meaning it should provide ease of access while effectively carry out its task without causing disturbance. This is especially important to keep the office workers focused on their tasks.

The existing systems are unable to accurately fit the furniture into the room. Even though the dimensions of the augmented reality objects are provided, the application is unable to scale and fit the objects into the room accurately. This is because the applications are unable to estimate the room space to accurately scale the object. Precision is an important factor when designing furniture to be tested out in the application. Therefore, the application should be able to scale the objects according to the height, length and width of the space available in the room so that a more thorough planning can be carried out accurately.

1. **Users are confined to choose the products available in the application.**
2. **Existing systems are not optimized to design an office indoor environment.**
3. **Lack of auditory and haptic interactions between users and system.**
4. **Lack of precision in the existing systems for area calculation.**

1.2 Project Scope

The purpose of this project is to create a mobile application with augmented reality technology which the user can utilise it to design the interior environment of an office. The application will allow user to try out furniture and layout design which are not confined to what is available in the application. The application will have functions to allow user to view own customized furniture, which can be uploaded to the system from the mobile phone to be viewed in the application. Moreover, the application will be intended and optimized to be used in designing an office environment. However, the application can still be used for other room environment such as home environment and school environment. Besides that, the application can be used to aid user is designing an indoor environment. However, the application might not be as efficient, or might not work at all if being used in an outdoor environment. Furthermore, the application will be able to have auditory interactions with the user. This auditory effect is to let user better identify the suitable furniture to be used in an indoor office environment, where sound made by the surroundings might affect the work efficiency of the office workers. Therefore, the sound and touch feedback when placing the furniture in the application will be able to reflect how the furniture would sound in the reality. In this case, the application will produce sound cues when the user interacts with the object that are provided by the retailers or users. Next, the application will be able to scale the augmented reality objects to fit in the environment provided that a flat surface is available.

1.3 Project Objectives

Since the targeted users are not experts in interior design, the application shall allow users to visualize the objects in real-world environment and viewed from any angle without having to move the object. The application should also provide basic calculations to prevent any errors from occurring during the design. For this, area calculation feature is required so that the system can scale the object according to the room area using the ratio of the object dimensions against the plane area so that user can view the actual size of the object matched to the office interior measurement.

The objectives of this project are as follow:

1. To create a new interior design application optimized for designing an office indoor environment using markerless augmented reality.

2. To implement a new auditory system with haptic feedbacks that is able to interact with the user to produce an interactive experience between the system and the user.

3. To implement area detection and calculation system to scale the objects according to the measurements of the surface area.

4. To increase the usability of the application by allowing user to add in own custom design of furniture and accessories for wider designing options.

1.4 Impact, Significance and Contribution

OfficeIT is an interior design application for office environment using augmented reality technology. It is proposed with the purpose to solve the problems found in the existing interior design application. The target audience of this application is business owners to help save cost on hiring professional designers. By having this application installed the user’s mobile phone, user would be able to create interesting and innovative office interior designs according to personal likings. Instead of hiring a professional designer and hope that the end result is desirable, users can put it in their own hands to determine the outcome of the design by using OfficeIT. Besides that, users can prevent unnecessary cost of buying products that does not fit in the office, either the size does not fit, or the product does not fit the atmosphere or theme of the office. This is achieved by allowing users to place virtual objects in the office to see if the objects fit their preference before buying the product. Furthermore, when an object is placed in the office using Markerless Augmented Reality, users can get a 360-degree view of the product in the office environment. Moreover, users can also determine the suitability of the objects in the real-world office environment through auditory interactions such as haptic feedbacks when interacting with the augmented reality objects in the application. Finally, with the added sense of sound and touch of the object, users can quickly understand the weight of the object and how the object affects its surroundings. With this, users can create a design plan based on what they need, such that a heavy object that is a common shared resource in the office should be placed in a location where the object is easy to access since it is hard to move around. On the other hand, a heavy object that is not necessary in the daily work routine of the office employees should generally be avoided or place in a location where it will not easily fall and people would not have to interact with it. This is to avoid accidents from happening in the office and ensure the safety of the environment.

1.5 Project Background

According to the Cambridge Advanced Learner's Dictionary & Thesaurus, the word "augment" means to add something to another thing to increase the size or value of it (dictionary.cambridge.org, n.d.), while the word "reality" means the things in the states as they are, rather than they are being imagined (Cambridge Dictionary, 2020). Therefore, the phrase "augmented reality" can be understood as to add something to the reality, this can be achieved by applying images produced by computers to the real world to be viewed together.

The history of augmented reality date back to the year of 1968, which was the year when Ivan Sutherland developed the first head-mounted display system and named it "The Sword of Damocles". It was used to enhance the user's sensory perception of the world by letting them experience computer-generated graphics. However, although it was the same technology as the augmented reality that are often seen now, the term "augmented reality" was not used back in the day. In fact, the term only started being used in the year 1990 after being invented by Boeing researcher Tim Caudell (Poetker, 2019).

In the year 1992, a researcher in the USAF Armstrong's Research Lab named Louis Rosenburg created one of the first fully functional augmented reality systems which is called "Virtual Fixtures" to aid military training. During that time, air force trainings were considered very expensive and highly dangerous due to potential incidents happening during the flight. Therefore, Virtual Fixtures was invented to curb this problem by allowing air force trainings to be carried out virtually by military personnel and on a safer environment (Poetker, 2019).

Over the past 50 years, augmented reality has evolved from being used in the military to our daily lives. The technology becomes more and more common in the recent years and is expected to be developed even further in the future. Recently, the traces of augmented reality can be seen in business applications, entertainment industries, sports competitions and even automobile industries. When it comes to augmented reality, one of the areas the requires the implementation of this technology the most is in the property industry. In this project, the technology will be targeted to be implemented for interior design.

Throughout the recent years, interior design of a property becomes increasingly more important in the eyes of the consumers. This is because a property, for example a home, is where a person spends most of his time at. Therefore, it is an absolute requirement for that environment to be comfortable for the person living in it. However, one big issue when it comes to interior design is that hiring a professional can be costly, and inappropriate for minor changes for the house, which is why many consumers prefer doing everything by themselves. In this case, estimation errors such as miscalculation of available space in the room, colour misfit and awkward design compared to the theme of the room might happen. Often times the selected furniture turn out to be much larger or smaller than what the consumers expected because they are unable to "try out" the furniture to see if the chosen furniture fits well into the layout of the room.

In order to curb the aforementioned issues, furniture retailer company IKEA have released a mobile application called IKEA Place with integrated augmented reality to aid consumers on selecting the right furniture for their properties. Following that, multiple mobile applications with augmented reality feature such as Houzz, Measure and Homestyler are released by various companies to aid consumers on interior design of their houses.

However, all the mentioned applications have their own strength and weaknesses, which can be problematic for the consumers choose which application is suitable for their needs. Another major issue of the current interior design applications is that they are mostly targeted at home design, which will not be as efficient when are used to design the interior layout of an office due to the lack of required features for the task. Therefore, the aim of this project is to utilize the benefits brought upon by augmented reality to create an application which the user can use it to design an office layout.

1.6 Report Organization

This report is organized into 7 different chapters which are Introduction, Literature Review, System Approach, System Design, System Implementation, System Evaluation and Discussion and Conclusion. In Chapter 1 which is the introduction, of the project, the problem statement, project scope, objectives, contributions, project background and report organization are included. Next, in Chapter 2 which is literature review, several existing augmented reality systems will be studied to identify the strength and weaknesses of each system. Then, in Chapter 3 which is the system approach, the methodology used to develop the system will be explained. Here, a general approach to visualize the system is included such as system architecture diagram, use case diagram and activity diagram. Furthermore, in Chapter 4 which is the system design, the overall flow of the system will be explained using system block diagram, system flowchart and the wireframe user interface design. The chapter will also explain how each component in the system interacts with each other. Besides that, in Chapter 5 which is the system implementation, the hardware and software setup to develop and run the system will be included along with the required setting and configuration. The chapter will then show and explain the system outcome and implementation issue will be stated and concluded. Moreover, in Chapter 6 which is the system evaluation and discussion, desired results from system testing will be stated and result of test cases will be included. The chapter will then include the challenges faced in the project and evaluate the system to the objectives of the project and a short conclusion will be made. Finally, in Chapter 7 which is the conclusion and recommendation, the project will be concluded and state the possible future improvements for the system.

Chapter 2 Literature Review

A total of four existing interior design applications with augmented reality were being reviewed, which are Houzz, Homestyler and Measure.

2.1 Houzz

Figure 2.1.1: Houzz Mobile Application

2.1.1 Introduction to Houzz

Figure 2.1.1 shows the first interior design application reviewed, which is Houzz by Houzz Inc. In this application, the users can click on the “Products” button to browse the products sold. These products are sorted into multiple categories which are “Kitchen & Dining”, “Bath”, “Bedroom”, “Living”, “Furniture”, “Home Decor”, “Home Improvement”, “Outdoor”, “Storage & Organization”, “Holiday Decor” and “SALE”. After selecting a category, various products of the selected category will be shown to the user. User can then view the details of the product. From here, user can choose to view the selected product in the user’s room through augmented reality. Some selected products can be viewed in 2D while some can be viewed in 3D. If the selected product can only be viewed in 2D, user can enlarge or reduce the size, tilt, or move the product into desired position while being viewed in the user’s room. If the selected product can be viewed in 3D, user can move or rotate the product to fit in the room.

Figure 2.1.2: Augmented Reality Feature in Houzz

2.1.2 Strengths and Weaknesses of Houzz

User can choose to move the furniture anywhere in the room to be viewed. This allows the user to fit the product into a room with limited space which may restrict the movement of the user to test the product out on the spot. Besides that, user can also view multiple products in the user's room through augmented reality at once.

As shown in Figure 2.1.2, the products are unable to be fixed in place, meaning the background environment that the products are being viewed in need to be in a static state. To achieve this, user needs to either view the product in a picture taken through the phone's or hold the phone in place so that the products can be viewed correctly. The product viewed in this application might not be accurate in size because the application does not do the calculation for the user. In this case, the user needs to manually move the product into the correct position and viewpoint to show the accurate product size. Besides that, the augmented reality objects do not interact with each other nor the user.

2.2 Measure

Figure 2.2.1: Measure Mobile Application

2.2.1 Introduction to Measure

Figure 2.2.1 shows the second interior design application reviewed, which is Measure by Google LLC. This application is mainly aimed at design professionals. It allows the user to measure and map the interior design spaces. Unlike other interior design applications that are reviewed, rather than letting the user try out furniture in the real-world environment, Measure uses low-level augmented reality technology to aid user in measuring the spaces in the room (Iflexion, 2020). This application is used more towards designing the floor plan and layout of the room than to design the look of the room. Multiple measuring tools are available in this application to be utilized by the user to carry out the measurements through augmented reality.

2.2.2 Strengths and Weaknesses of Measure

User can utilize the application to carry out analytics of the space inside the room. These analytics can aid user in designing the layout of the room. Although this application works differently than other interior design applications, planning out the layout and floor plan of the room is a very important preliminary requirement prior to designing the interior of the room.

The user needs to manually carry out the measuring of the space in the room. When used by individuals that are not professional in this area, errors can easily occur. This can turn out to be a serious issue because any miscalculation and estimation in the planning of the layout of the room can lead to further errors. Besides that, the application only aids the user in obtaining the measurement of the room but user still needs to find a furniture that fits in that space. In this case, the user might be susceptible to errors when choosing a furniture since there are no means to view the object to see how it fits in the room.

2.3 Homestyler

Figure 2.3.1: Homestyler Mobile Application

2.3.1 Introduction to Homestyler

Figure 2.3.1 shows the icon of the third interior design application reviewed, which is Homestyler by Topping Homestyler(Shanghai) Technology Co., Ltd. To use this application, user can choose between 3 different sources for the interior design planning, which are taking a new photo, selecting a photo previously taken in the gallery, or selecting a layout provided by the application as a starting point. After selecting the environment to design, the application will then detect the corners of the room. If the corners are not detected by the system, it will prompt the user to set the corners of the room manually through a detection feature. Next, the user can then start designing the room with the available tools or view selected furniture.

2.3.2 Strengths and Weaknesses of Homestyler

The application will automatically detect for corners in the room and estimates the height and width of the room. Similar to the Houzz mobile application, this application allows user to view furniture in the selected environment. The user can also move and rotate the furniture to a desired position. User can also view multiple furniture through augmented reality at once using this application.

The application can only work on static images, meaning a live camera will not be able to function in this application. Moreover, this application is unable to work properly in a room with objects. The objects in the room will obstruct the system from correctly detecting the corners of the room. In this case, the user needs to manually set the corners and height of the room which may cause errors to occur.

2.4 Summary of Literature Review

After reviewing the existing interior design applications with augmented reality, a few crucial features had been identified. These features include analytics of the space available in the room to aid user on designing and selecting the furniture of suitable size to prevent occurrence of discrepancy between the simulated design and the reality. Furthermore, the furniture to be viewed in the application needs to reflect the actual size of the furniture in reality. To achieve this, the application needs to calculate the size of the furniture and the room and able to match both. To curb the problem of having to move the furniture to a certain spot to correctly view its size, the furniture can be made to be fixed on the spot after the user chose the spot to place the furniture. The view of the furniture will then change according to the place where the user views the furniture from. Besides that, all the reviewed applications do not have auditory interaction implemented in the system. This can be an issue because different materials of the furniture can produce different sound when interaction occurs in the real environment. To achieve this result, auditory interactions will be implemented in this project to fully reflect how the furniture interacts in the real environment so that the users can select furniture with materials most suitable to be used in an office which would not produce loud or irritating sound when being moved around or interacting with the user.

Reviewed Systems	Proposed System
Systems do not provide any auditory and haptic interactions between users and the AR object for better understanding of the product.	Implements haptic feedbacks to provide interaction between system and users to simulate real-world environment.
AR object needs to be placed in the position manually which might not accurately reflect the actual view.	AR object will be placed and stay in position using plane detection. User can walk around to view the object from any angle.
Size of the AR object often does not reflect the actual product.	AR object will be scaled using measurements of the room to minimize sizing error.
A static image is preferred over live camera due to AR object not fixed in one position.	Live camera can be used for the application so that the user can view the AR object in 360-degree.

Table 2.4.1: Comparison of Existing Systems and Proposed System

Chapter 3 System Approach

3.1 Methodology

To carry out this project, a complete flow of the development process is required to make sure that the development of the project is smooth. By planning out the development process before developing the project, it is easier to identify any errors in a software before they are discovered with higher cost required to neutralize the error (Robert, 2019). To plan out the development process, the Software Development Life Cycle (SDLC) methodology will be used as a guide. Various stages are involved in the SDLC process, which are requirement gathering and analysis, designing, implementation, testing, deployment, and maintenance. The purpose of SDLC is to deliver a product that is according to the customer's requirement and of high-quality (Softwaretestinghelp.com, 2019).

Figure 3.1.1: Software Development Life Cycle

The development of this project will be started on the requirement gathering and analysis stage. In this stage, all information that is related to the project is collected through various ways. In this case, the information required are gathered from reviewed the current existing systems that are similar to the proposed system. Therefore, multiple augmented reality applications for interior design are reviewed. Once the gathered information is sufficient, an analysis will be carried out to analyse the feasibility of the proposed system. More information is required if any ambiguity is found when analysing the system. The project will go into designing stage once the analysis of the product is done and no ambiguity is found. In this stage, the information gathered will be used to design the augmented reality application. Any important features, user interface and improvements are being added into the design of the system according to the requirements and analysis. The designing stage is completed when all the requirements and analysed improvements to the reviewed systems is added into the design of the proposed system and is able to achieve the objectives of the project. After that, stage 3 of the SDLC will start, which is the implementation stage. All the components in the designing stage are implemented into the proposed system as source code. Next, the testing stage will start where the modules released from the designing stage will be tested thoroughly by the developer. Any defects or errors found in this stage will be fixed. Multiple tests will be carried out on the application until no defects are found and that the system can work as intended. In this stage, the system will be constantly revised so that it matches the requirements and design from the previous stages, while also delivers the objectives of the project.

3.2 Architecture Diagram

Architecture Diagram is used to visualize the general structure of the application and how the frontend and backend of the application are related in the application. It also provides a general idea of how the frontend should be portrayed to carry out each function in the application.

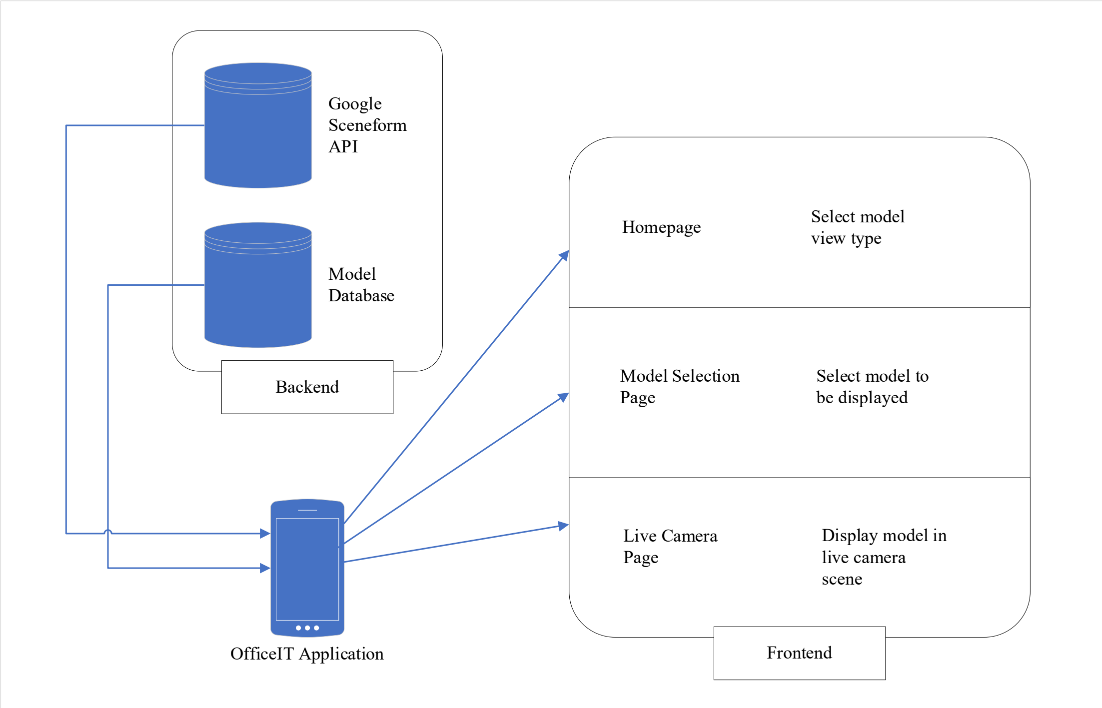

Figure 3.2.1: Architecture Diagram of OfficeIT Application

Figure 3.2.1 shows the Architecture Diagram of the proposed application. The application will consist of 2 backend components which are the Google Sceneform API and the Model Database, and 3 frontend components which are the Homepage, Model Selection Page, and the Live Camera Page. The Google Sceneform API is used to render the model in the application while the Model Database will be used to store the 3D model data such as the images, 3D object files, categories and weights. For frontend, the Homepage will display buttons for user to select how and where the model should be obtained while the Model Selection Page will show the model images for user to select. Finally, the Live Camera Page is used to display the selected model in the live camera scene of the user's device.

3.3 Use Case Diagram

Use Case Diagram is used to visualize the overall flow of the application and provide a clear view of how the application should work in terms of functionalities. The diagram indicates how an actor interacts with the application.

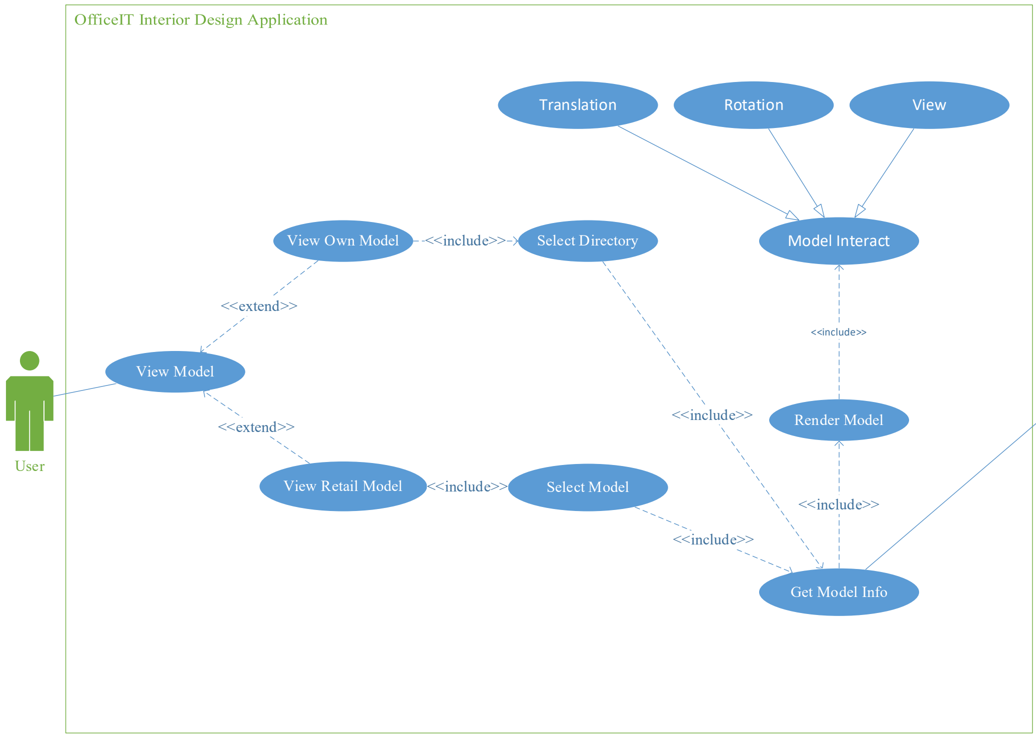

Figure 3.3.1: Use Case Diagram

Figure 3.3.1 shows the Use Case Diagram of the proposed application. On application launch, the user is met with the initial page of the application to choose between viewing own model or viewing retail models. If the user chooses to view own 3D model, the user is required to provide the model directory by locating the 3D model in the device. The model will then be displayed as an AR object through the mobile device's live camera. Besides that, the user can view retailed 3D model provided in the application. These 3d models will be stored in the Model Database. Here, user can choose between multiple selection of 3D models provided by the application. The application will get the model info from the Model Database. After selecting a 3D model through either method, the application will then render the model. The user can then display the selected model on the mobile device's live camera and interact with it.

3.4 Activity Diagram

Activity Diagrams are used to visualize a detailed view of how each function in the application is performed and display the flow of the function.

View Own Model

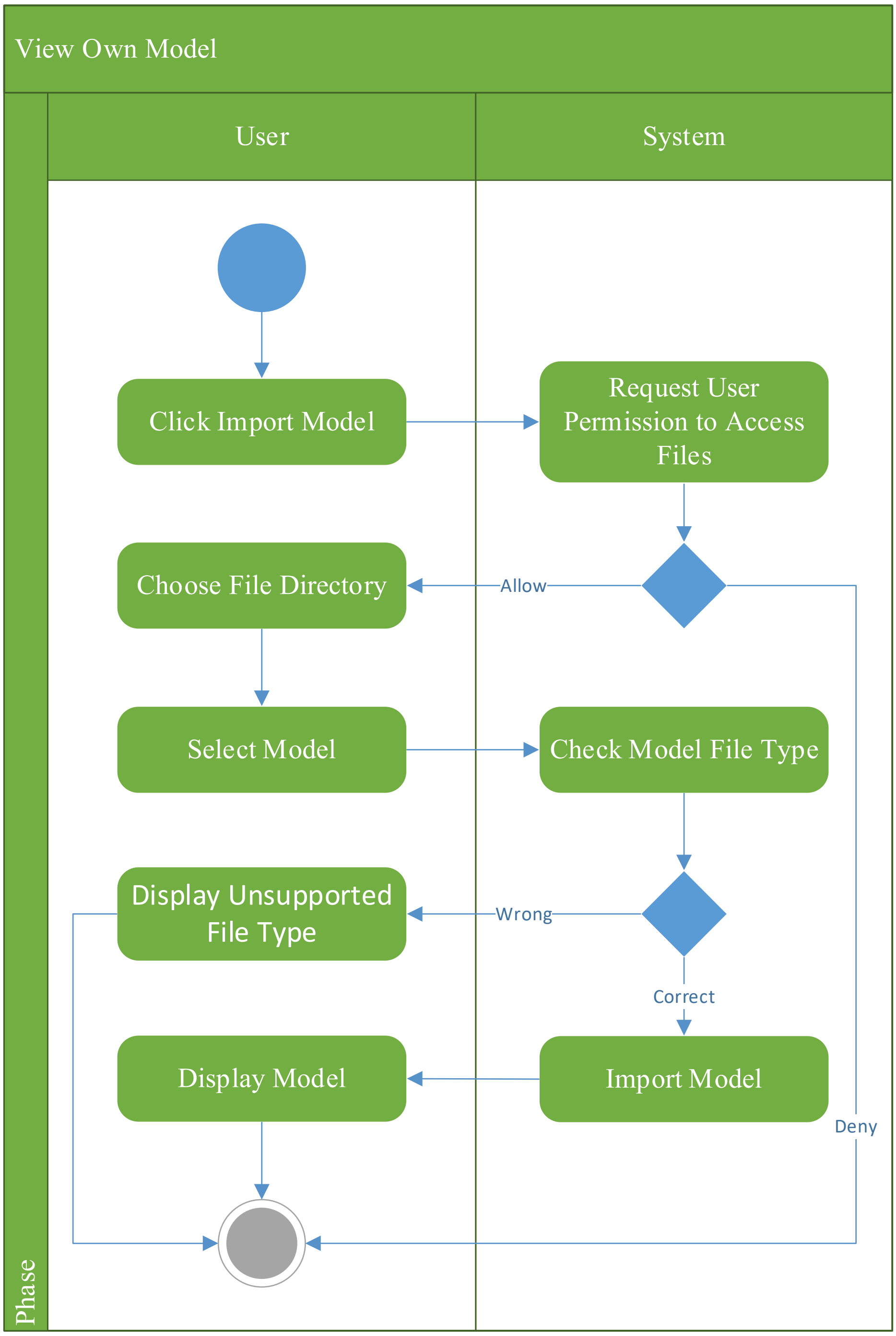

Figure 3.4.1: View Own Model Activity Diagram

Figure 3.4.1 shows the flow of the view own model function. This function allows user to import local 3D models of .glb file type from the mobile device to the application and display as augmented reality object on live camera. First, the system will prompt a request for permission to access the device's camera. If the permission is denied, the function cannot proceed. After granting the permission, system will prompt message to request user permission for the application to access files in the mobile device. If the user denies the permission, the function will end since the application cannot import any 3d models from the device. If permission is granted, user will be prompted to find the file directory and select the 3D model to be used. Next, the system will check the file type and display error message if file type is unsupported. If the file type is correct, the system will import the selected 3D model, scale it according to the plane area measurements and display on the user device's live camera.

View Retailed Model

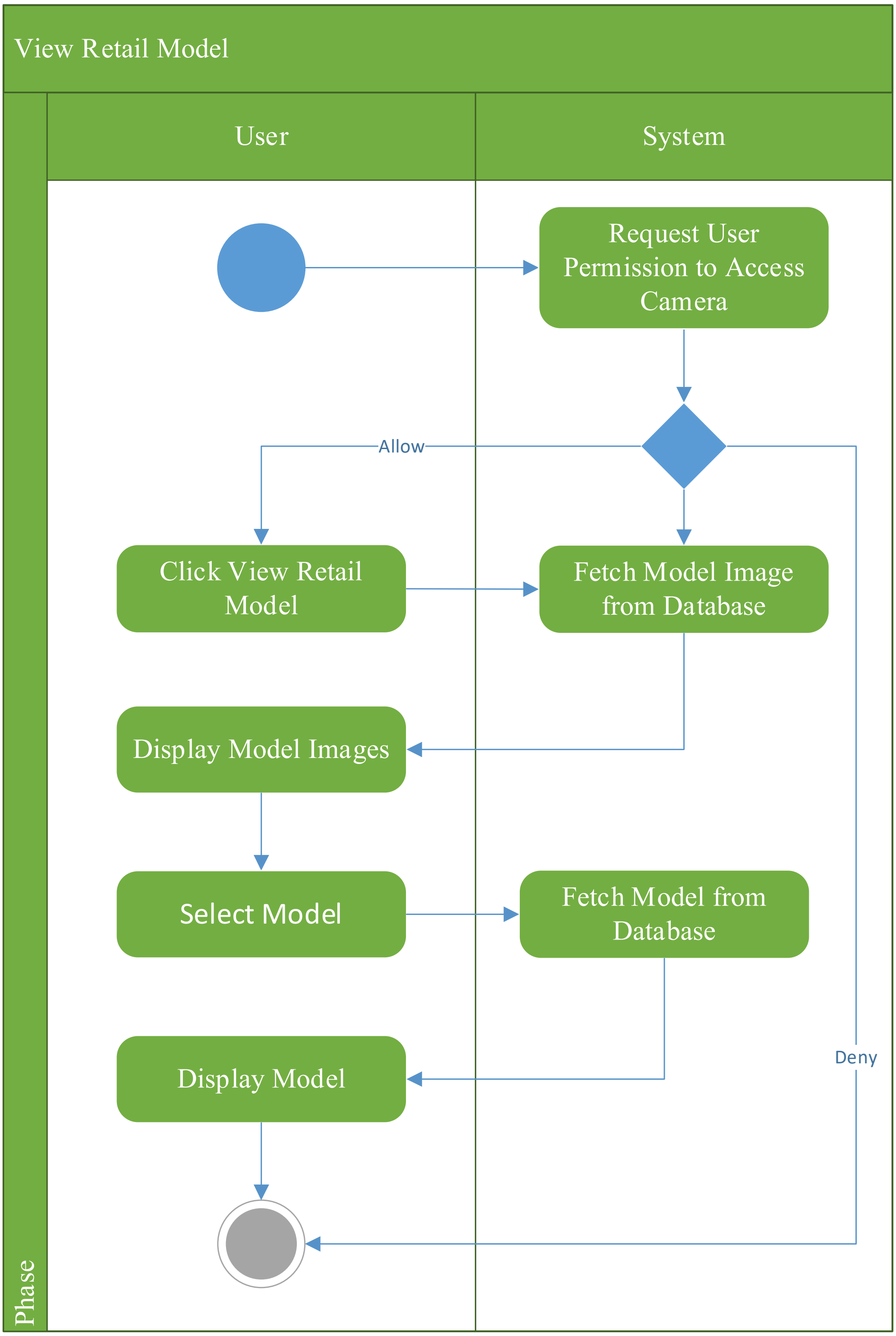

Figure 3.4.2: View Retail Model Activity Diagram

Figure 3.4.2 shows the flow of the view retail model function. This function allows user to view 3D models provided in the application and display as augmented reality object on live camera. To access the function, the system will prompt a request for permission to access the device's camera. If the permission is denied, the function cannot proceed. After granting the permission, the system will fetch model information such as images from the database and display on the user side to let user have a clear view of the objects. User can then select a model to be displayed. Then, the system will fetch the model from the database. The system will then import the selected 3D model, scale it according to the provided plane area measurements and display on the user device's live camera.

3.5 Timeline

Gantt chart is used in the planning of this project to provide an organized schedule and identify milestones of the project.

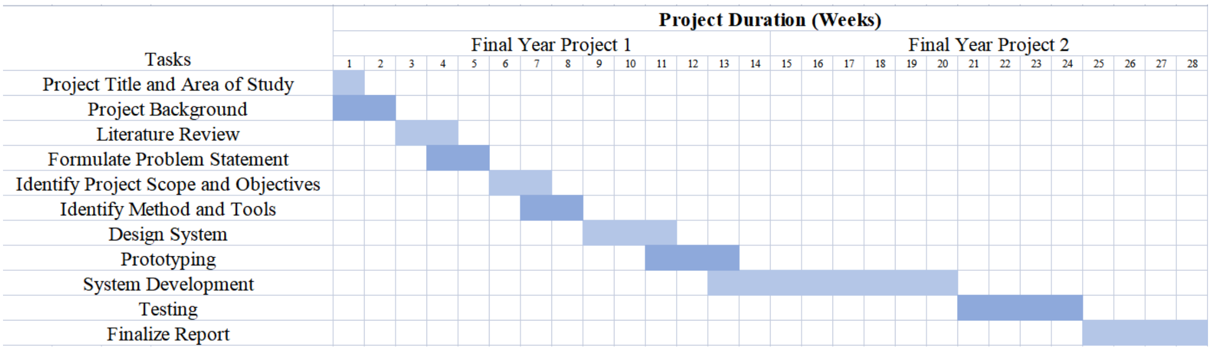

Figure 3.5.1: Gantt Chart

Figure 3.5.1 shows the overall duration planning of the project.

Chapter 4 System Design

4.1 System Block Diagram

System Block Diagram is used to visualise the interrelationship between the components in the application.

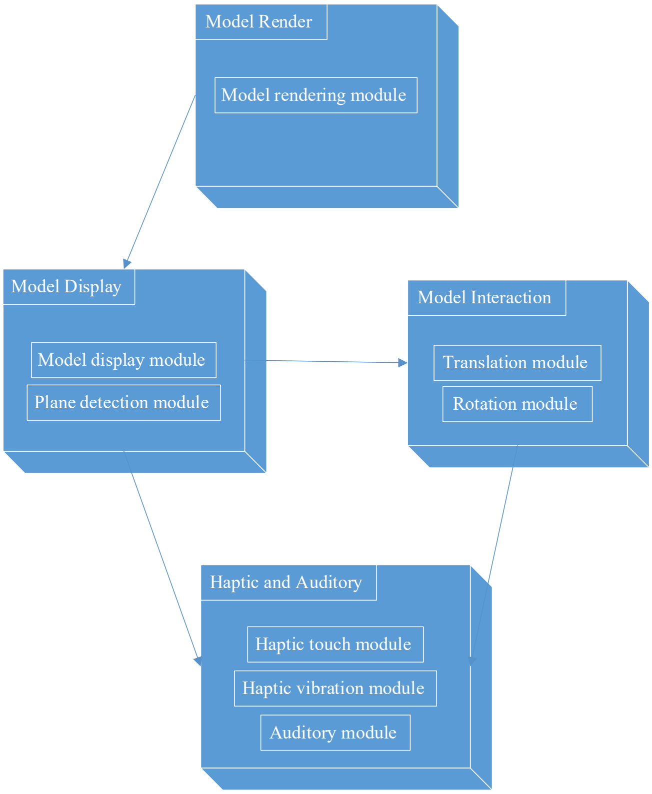

Figure 4.1.1

Figure 4.1.1 shows the system block diagram for the proposed application. The application will consist of 4 major components which are Model Render, Model Display, Model Interaction and Haptic and Auditory components. Model Render component consists of the model rendering module which will process and render the selected model. The Model Display component is dependent on the Model Render component and consists of the model display module and the plane detection module to identify a flat surface to display the 3D model. Next, the Model Interaction component consists of the translation module and the rotation module to allow user to perform actions on the displayed model. Finally, the Haptic and Auditory component is dependent on the Model Display and Model Interaction components and consists of the haptic touch module, haptic vibration module and the auditory module to improve interaction between user and the 3D model.

4.2 System Components Specifications

4.2.1 Model Render Component

The model render component will consist of the model rendering module. In the model rendering module, the application will be able to import the user selected 3D model. In this module, the application will be able to render the model to its shape, texture, colour and shadow. This is important as the first module to be accessed by the application since any other components in the application and actions to be performed by the user will first require the 3D model to be rendered. This component will be crucial to allow the application to display the 3D model onto the device live camera scene.

4.2.2 Model Display Component

The model display component will consist of 2 modules which are the model display module and the plane detection module. The plane detection module will allow the user to use the application to identify a flat surface using the device's camera. This module will require the user to grant the application the permission to access the device camera. Using the plane detection module, the application will scan the scene using the device camera and identify a plane. Once the plane is identified, the user can then display the 3D module on the plane using the model display module. The model display module will also allow the application to use the device camera to identify the light source in the environment to apply lighting and shadow on the displayed 3D model.

4.2.3 Model Interaction Component

The model interaction component will consist of 2 modules which are the translation module and the rotation module. This component will allow user to perform actions such as moving and displaying the displayed 3D model. The translation module will be responsible to calculate and assigning the matrices when the user holds the 3D model and move around the device's screen. Next, the rotation module will be responsible to calculate and assigning the matrices when the user rotates the displayed 3D model. The user can also pinch on the 3D model displayed to scale the object into a larger or smaller size.

4.2.4 Haptic and Auditory Component

The haptic and auditory component will consist of 3 modules which are the haptic touch module, haptic vibration module and the auditory module. This component is dependent on the model display and model interaction modules and its purpose is to enhance the overall experience when user displays and interacts with the 3D model. This module will use the weight data provided with the 3D model. The haptic touch module will provide a realistic feel to the 3D model by changing the ease of moving the 3D model based on the weight. For example, a 3D model that has high weight, which can be considered heavy will be harder to move by the user, meaning the user will require more effort to move the 3D model to a desired location compared to a 3D model that has a lower weight which is considered lighter. Next, the haptic vibration module and the auditory module works in a similar fashion, and both are reliant on the weight of the 3D model. The haptic vibration module provides different intensity of vibration feedbacks when placing the 3D model to simulate the impact when placing down an object in the real-world environment whereas the auditory module uses the weight of the 3D model to produce different sound effects to simulate the sound the placing the object in the real-world environment.

4.3 System Flowchart

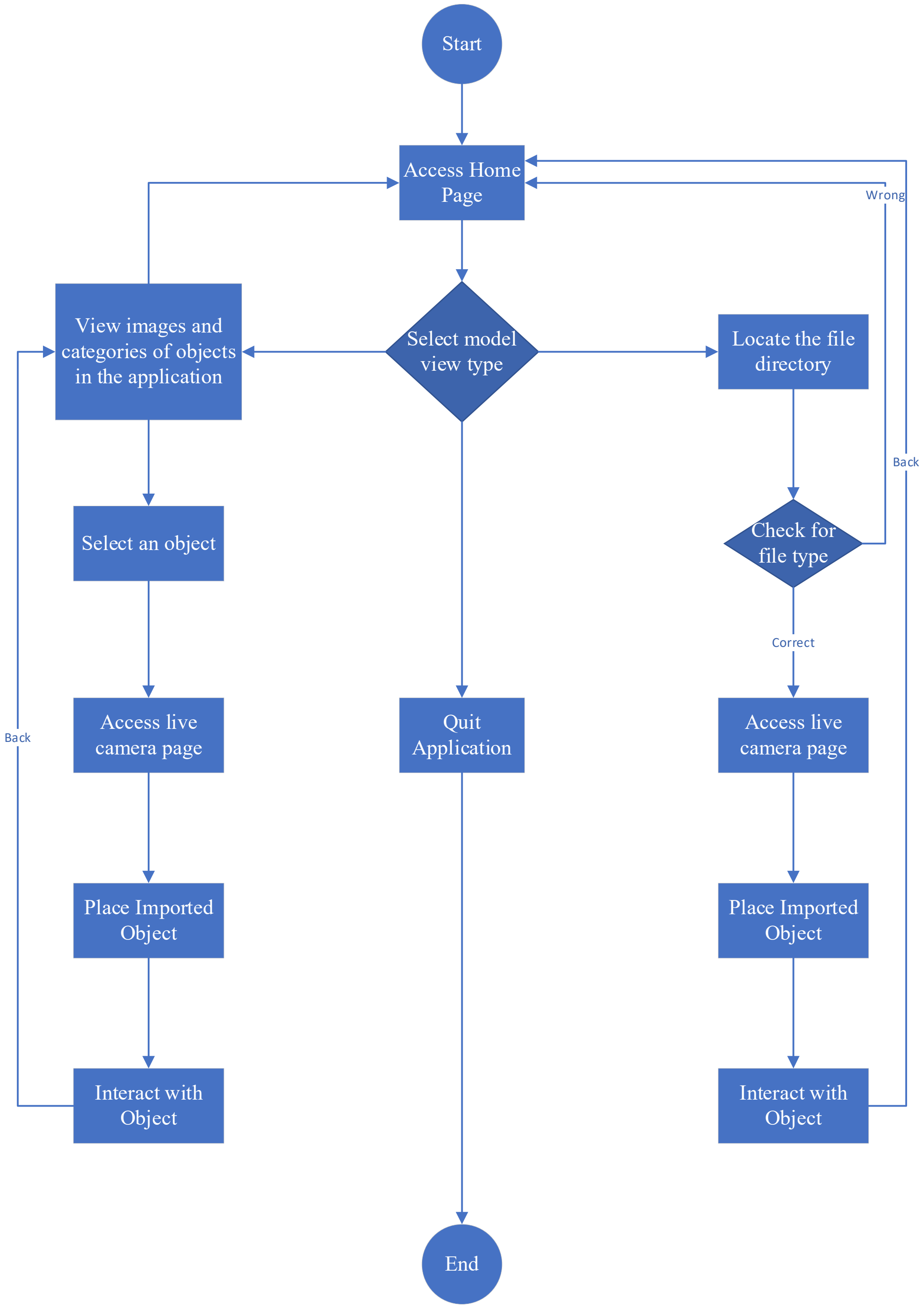

Figure 4.3.1: Flowchart of OfficeIT Application

4.4 User Interface Wireframe Design

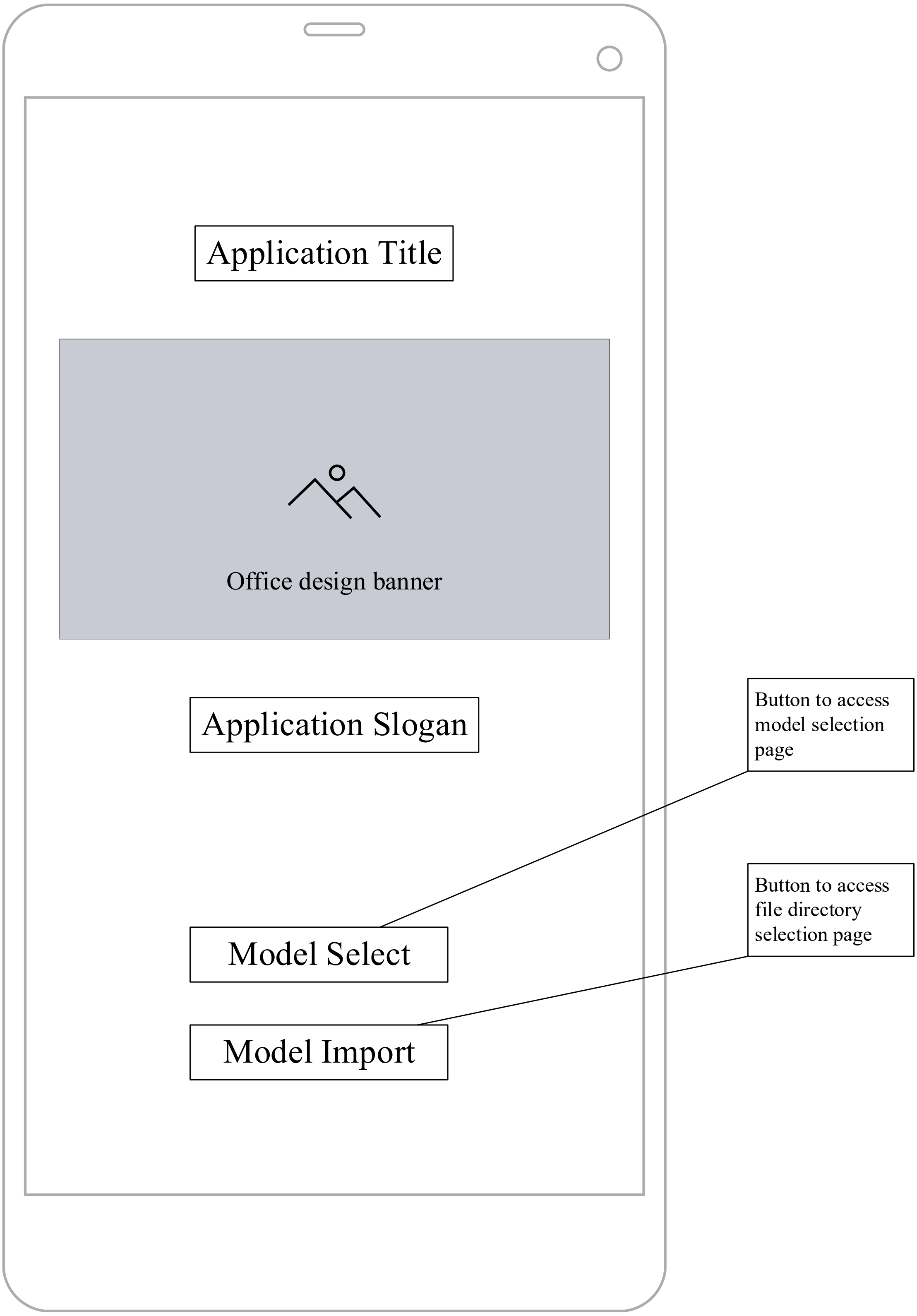

Figure 4.4.1: Home Page Design

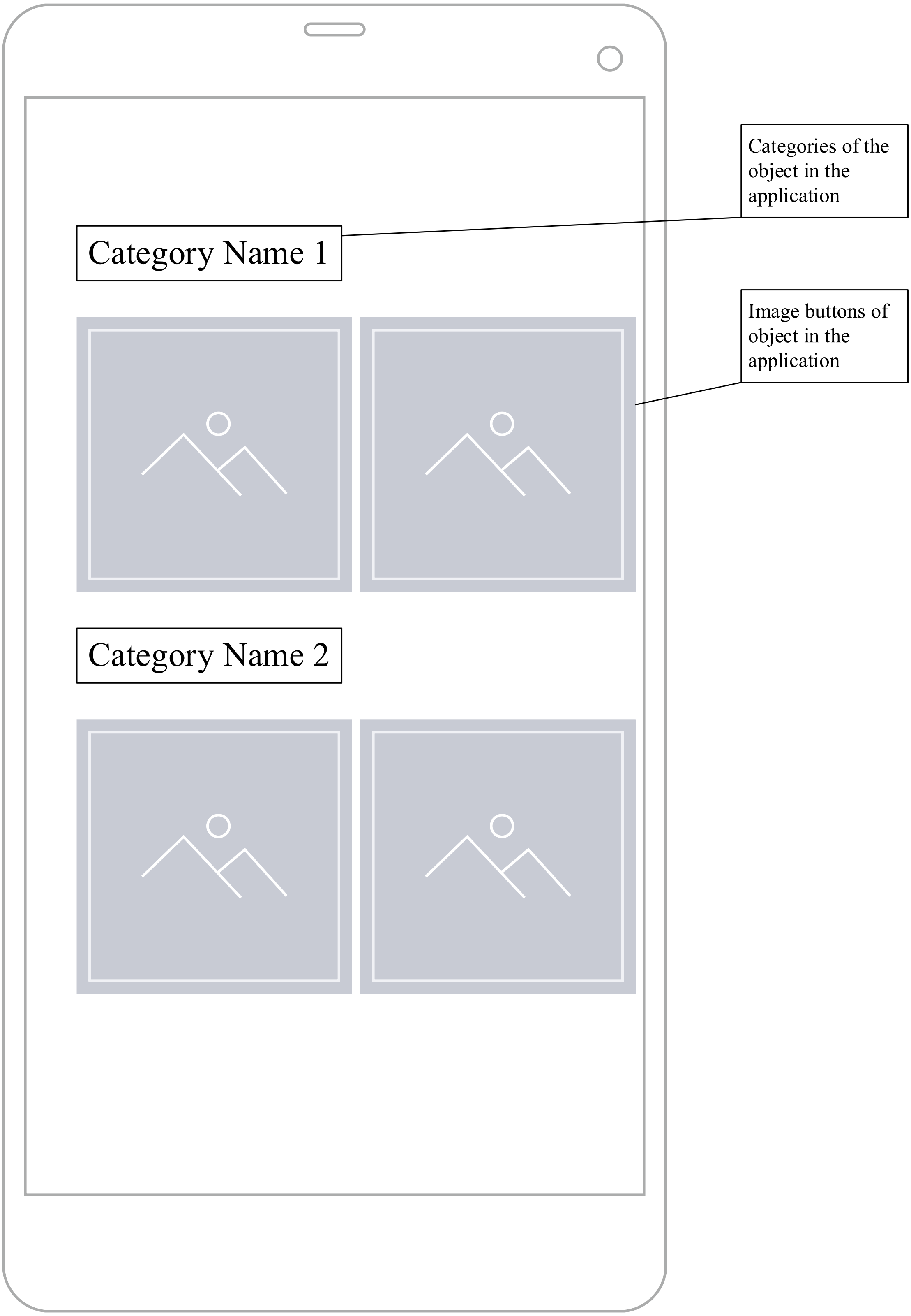

Figure 4.4.2: Model Selection Page Design

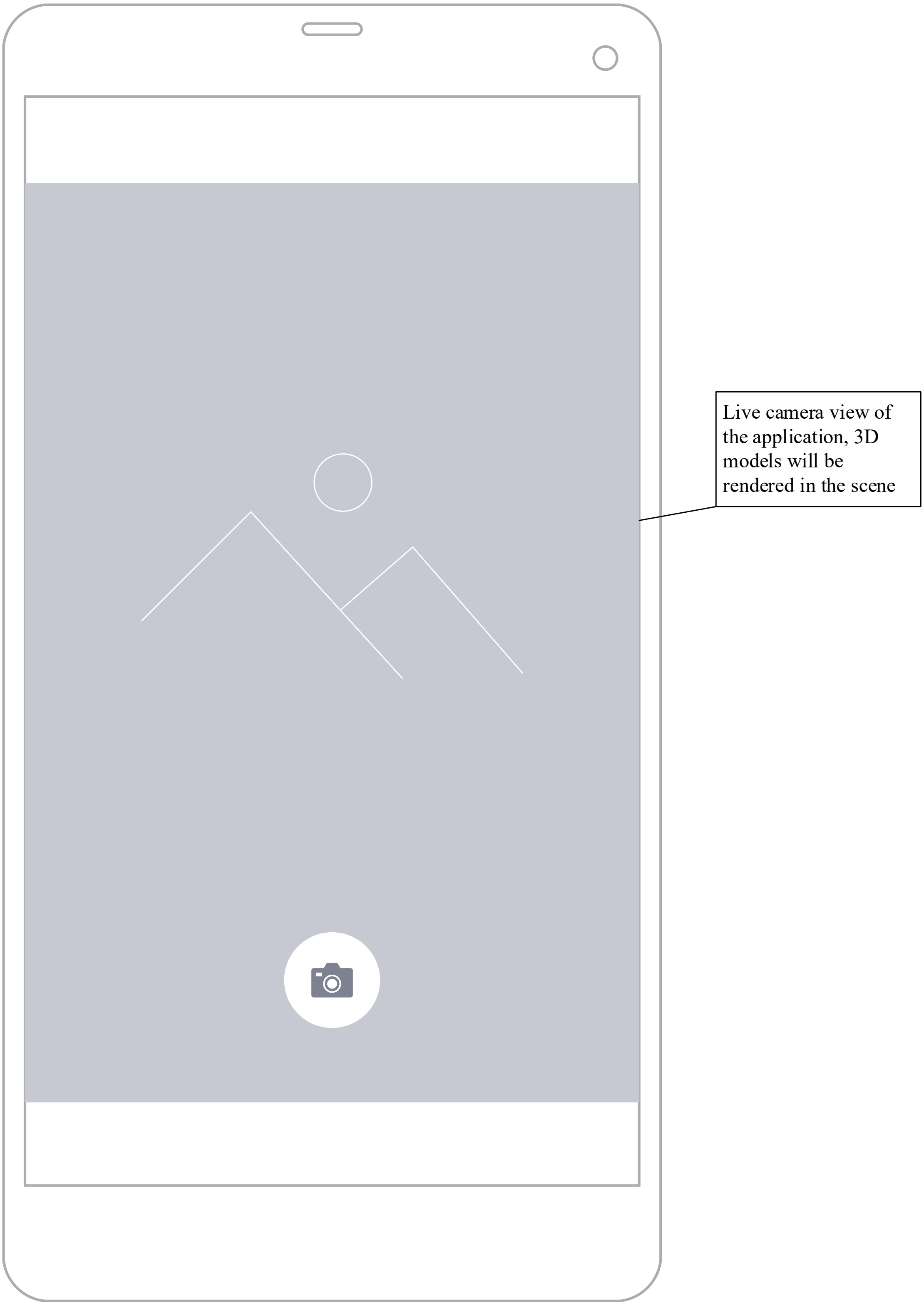

Figure 4.4.3: Live Camera View Design

Chapter 5 System Implementation

5.1 Hardware Setup

The hardware required in this application is a laptop and an android mobile device. Since this application requires access to the device camera, the android mobile device used to operate the application must have a built-in camera with augmented reality module. Although the application is developed on a laptop, an android mobile device is mandatory to run the application since this application must operate using a live camera scene.

Model	HP EliteBook 840 Notebook PC
Processor	Intel(R) Core(TM) i5-10310U CPU @ 1.70GHz 2.21 GHz
Installed RAM	16.0 GB DDR4 RAM
System type	64-bit operating system, x64-based processor
GPU	Intel Integrated Graphics Card
Memory	256GB PCIe NVMe SSD

Table 5.1.1: Laptop Specification

Table 5.1.1 shows the hardware specifications for the laptop used to develop the OfficeIT mobile application. Since the laptop is only used to develop the application source code while all processing and model rendering are done on the mobile device, the hardware requirement for the laptop is not demanding. The application can be developed without a high-performance GPU and processor.

Model	Samsung Galaxy A52
Chipset	Qualcomm SM7125 Snapdragon 720G (8 nm)
GPU	Adreno 618
Memory	256GB 8GB RAM
Main Camera	64 MP, f/1.8, 26mm (wide), 1/1.7", 0.8µm, PDAF, OIS 12 MP, f/2.2, 123˚ (ultrawide), 1.12µm 5 MP, f/2.4, (macro) 5 MP, f/2.4, (depth)
Sensors	Fingerprint, gyro, compass, accelerometer, virtual proximity sensing

Table 5.1.2: Android Mobile Device Specification

Table 5.1.2 shows the hardware specifications for the android mobile device to run the application. Since the application is an augmented reality application which uses the device camera, it is mandatory that the mobile device used should have a camera. It is also highly recommended that the mobile device has a good chipset to handle the calculations and model rendering in the application. Besides that, the mobile device must also have the gyro and accelerometer since these sensors are used in the application to obtain the device position while displaying the model. Next, although the application is currently occupying roughly 200MB worth of memory space, it is recommended that the mobile device has at least 1GB of free memory space to install the application and be able to run smoothly.

5.2 Software Setup

Android Studio Chipmunk

Figure 5.2.1: Android Studio Chipmunk

Android Studio Chipmunk is chosen as the IDE to develop this mobile application. Android Studio is chosen because it is free to access and is widely used by mobile application developers. Besides that, Android Studio is able to support multiple programming language such and Java and Kotlin. Moreover, Android Studio provides virtual emulator with Android OS meaning that the application can be tested on multiple Android devices with different versions of Android OS. Furthermore, Android Studio is able to run the developed application on a physical mobile device through USB or wifi pairing. Therefore, the developed application can also be installed on a physical device to see how the application works in the real-world environment.

Google ARCore

Figure 5.2.2: Google ARCore

Google ARCore will be used in the development this mobile application to implement augmented reality capabilities. The purpose of using Google ARCore is to help mobile devices understand the environment of the real world. Besides that, Google ARCore is constantly updated for better performance in terms of efficiency and accuracy.

Sceneform

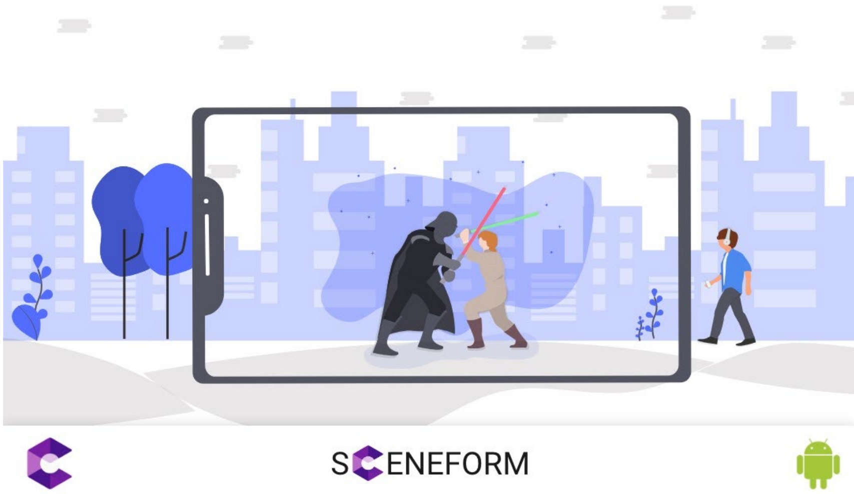

Figure 5.2.3: Sceneform

Sceneform is also used in the development of this mobile application. It is a 3D framework that is used to render 3D models for augmented reality features.

Java Programming Language

The programming language chosen for the development of this mobile application is Java. This is because Java covers a wide variety of platforms, making it easy to port the developed application to another platform.

Windows Edition	Windows 11 Pro
Version	22H2
OS Build	22621.1555

Table 5.2.1: Laptop Software Specification

The application was initially developed on Windows 10 and then upgraded to Windows 11 later. Both Windows 10 and Windows 11 are application to develop the application.

The mobile device used to develop this application runs on Android version 13 (Tiramisu). However, the minimum requirement for the Android version to run this application is Android 7 (Nougat) because Google ARCore is only available on Android 7 and above.

5.3 Setting and Configuration

The application but operate on an android mobile device. There are 2 different methods to install application in the mobile device. For development purpose, the application is installed using the USB debugging. This method is achieved by connecting the mobile device to the development laptop using a micro-USB type C to USB to connect the mobile device charging port to the laptop USB port. In order to achieve this, developer mode need to be turned on in the mobile device. Then in the developer option, turn on the USB debugging. Next, Select the Device Manager in the Android Studio and select physical device, the connected mobile device will be shown in the list of physical device. The mobile device is then selected from the list and run the application in Android Studio, the application will be installed in the connected mobile device and application will be opened once Android Studio is done executing the code. Another method to install the application on the mobile device is to create an APK file using Android Studio. For this method, select Build on the top menu of Android Studio and select Generate Signed Bundle / APK. Next, select APK and fill in the information then choose a directory. The APK file will be generated which can be distributed to users.

5.4 System Operation

After constantly revising the prototype, a finalised system prototype has been created. The finalised prototype created is able to carry out all the proposed functions in a simple and efficient flow. The user interface of the prototype is also revised to provide a better user experience and attract user while improving the ease of use of the application.

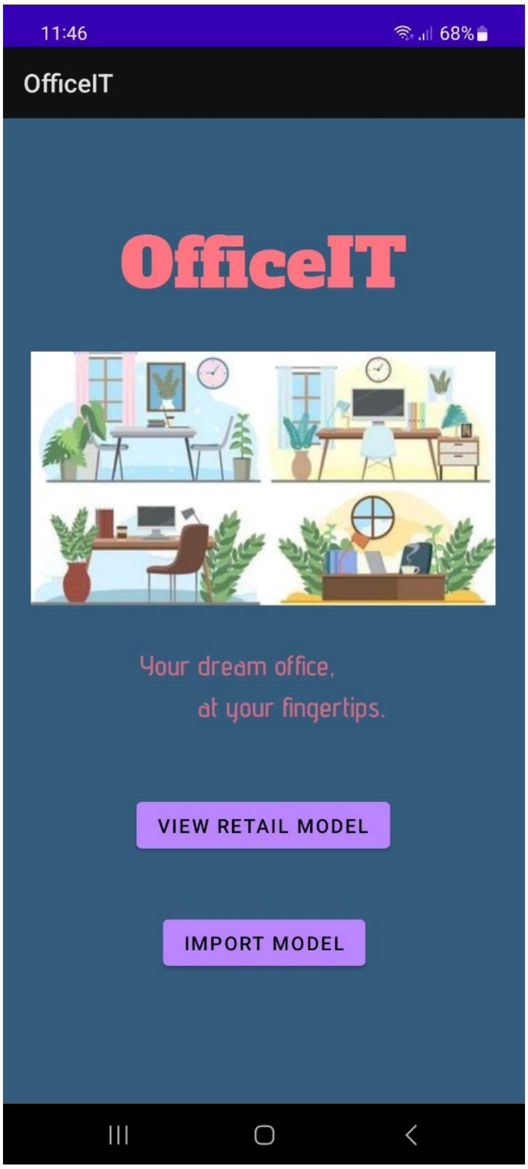

Figure 5.4.1: Home Page

Figure 5.4.2: Select Retail Model

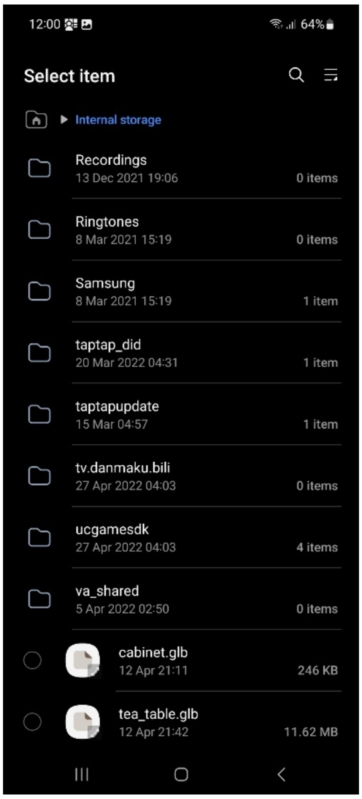

Figure 5.4.3: Import Model

Figure 5.4.4: Plane Searching

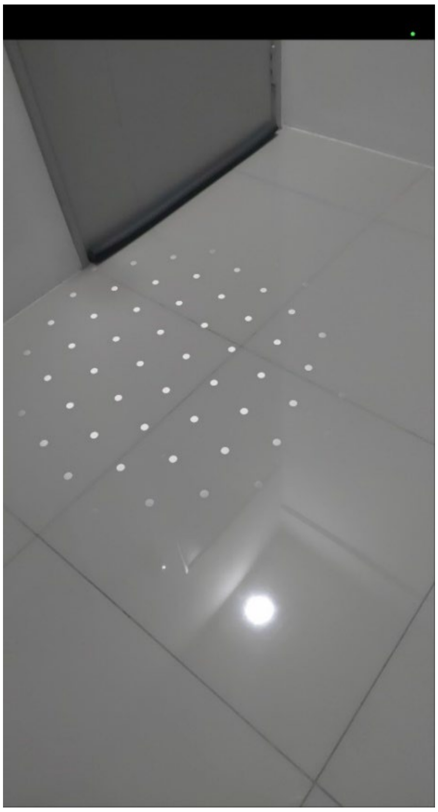

Figure 5.4.5: Plane Detection

Figure 5.4.6: Place AR Object

Figure 5.4.7: Rotate AR Object

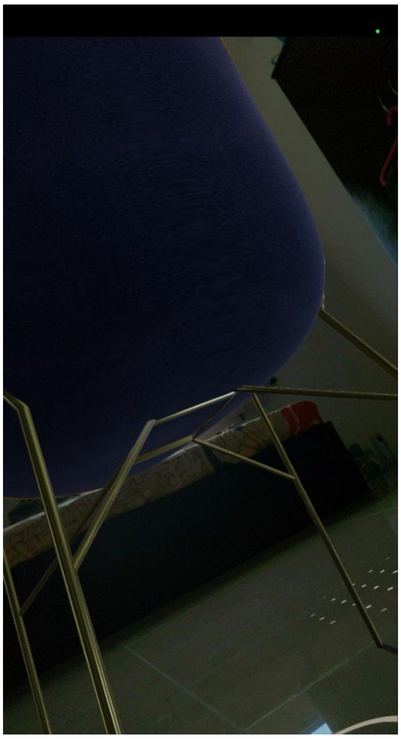

Figure 5.4.8: 360 View of AR Object

Figure 5.4.9: Wall Detection

Figure 5.4.10: Vertical Object Placement

Figure 5.4.11: Portrait View

All main features have been implemented into the prototype according to the proposed application. Android Studio is used as the development tool throughout the development of this prototype. The prototype consists of only Java programming language. In this prototype, Google ARCore and Sceneform plugin is successfully integrated.

A user interface is created as the prototype for the main function of the application as shown in Figure 5.4.1. The View Retail Model button will redirect the user to the user interface shown in Figure 5.4.2. Here, users are able to select an object they want to view as the augmented reality model. Initially, the buttons only show the object name but have been changed to display images instead so that users can preview the object during selection. This have been done with the consideration that simple word might not be able to fully convey the general sense of how the object would look when displayed. For example, user would not be able to understand how the object "chair" look without seeing the image of the object itself. Besides that, a future where multiple objects that are considered a chair might be added to the application. In this case, showing the images of the object will be a better interpretation of the object. Furthermore, each object has been separated according to the categories of the object. Currently, there are 5 different categories which are Floor, Table Top, Topshelf, Bottomshelf and Ceiling. Next, the 3D models in this application are stored separately. When the user accesses this interface, instead of getting all the 3D models, the application only displays the images from the database. The application only fetches and renders the 3D model when the user has already selected an object to view in the camera scene.

Next, the Import Model button in Figure 5.4.1 is used to for the prototyping of the import model function as proposed during the system planning. When the user clicks on the button, the application opens the file directory of the user's mobile device. Here, user can select the directory where the 3D model is stored in the device storage. To achieve this, the user needs to provide permission for the application to access the files in the device. After selecting a file, the system will check for the file type to make sure that it is a .glb file to make sure that the file type is supported by the application.

If the file type is wrong, the user will be redirected back to the Home Page in Figure 5.4.1. If the file type is correct, the system will import the file and render the 3D model.

Then, user will be redirected into the interface as shown in Figure 5.4.4. In this interface, an image of a hand holding a mobile phone is shown to indicate that the application is searching for a plane to place the 3D object. The image will be moving in a circular pattern to tell user to move the mobile device around for the application to understand the environment and identify a plane to place the object. Once the application has identified a plane, an area of white dots will be shown on the plane as shown in Figure 5.4.5 This is to tell the user that the application is ready to place the augmented reality object on the identified plane.

To place the augmented reality object, user has to simply tap on the identified plane and the object will be placed on the selected area as shown in Figure 5.4.6. After placing the object, user can interact with the object using different gestures such as moving the object around using the drag gesture which is to tap and hold the object and move around the device screen or rotating the object to the desired angle using the twist gesture, which is to tap and hold the object with one finger and move around in a circular motion with another finger. When moving the object, the application will be able to approximately calculate the view of the object from the user to the object and scale the object accordingly to match the actual size. Besides that, another action that the user can perform on the object is scaling, which is to enlarge or reduce the size of the object. This is achieved by the pinch gesture where the user place 2 fingers on the device screen and move both fingers closer to each other to reduce or away from each other to enlarge the size of the object. Once the object is the desired size, the user simply needs to let go and the scaled size will retain. However, there is a maximum and minimum scale for each object in which the object will bounce back to the minimum or maximum scale when the scale limit is exceeded. This is to prevent the user from accidentally overscale the object to a point where it is unrealistic to the actual size of the object.

Furthermore, multiple different features are also integrated into the application to improve the user experience when interacting with the object. These features use the auditory feedbacks and sense of touch to improve user understanding of the object how simulate how the object interacts with the surrounding in the real world using the weight simulation. The weight simulation utilises the weight data that is provided to identify and simulate approximately how heavy the object is in the real-world environment. When the user places the object onto the detected plane, a haptic vibration effect will be triggered. This haptic vibration varies in intensity according to the object weight in which object with more weight will produce a higher intensity vibration and vice versa. Similarly, the auditory feedbacks also vary according to the object weight, meaning different object will produce different sound when being placed on the detected plane. On the other hand, a haptic touch effect is also implemented in the prototype. The haptic touch effect is a feature that makes object that has more weight harder to move around. When user is moving a heavy object in this application, the user will notice that the object is harder to move in the sense that the object only follow partially the distant of the drag gesture performed. Here, user will understand that the object is heavy and hard to move around in the real-world environment and will be able to plan the placement of the object accordingly.

Moreover, markerless augmented reality is implemented in this application to allow user to place the model in place and move around the model to inspect how the object looks like in real world from any angle as shown in Figure 5.4.8. Furthermore, the application can detect the light source of the environment and display the lighting of the object and the shadow of the object to help user better understand how the object will look like in the real environment.

Aside from plane detection, the application can also identify limitations of the interior such as walls and obstacles as shown in Figure 5.4.9. However, the application will require more time to detect vertical plane, especially if the environment has low lighting. This is because, in the application point of view, it is easier to recognise a horizontal plane due to images usually being perceived to be 2-dimensional in general. Therefore, the application would need better lighting and time to process and calculate the presence of vertical plane. With the help of accurate vertical plane detection, user of the application will also be able to place augmented reality objects such as windows, curtains and air conditioning on vertical plane. Figure 5.4.10 shows an example of how wall detection can used to place object on the wall. Finally, since the augmented reality object can be placed on the plane instead of being reliant on user having the correct point of view, the object can be viewed in the real-world through landscape mode for a wider visualization of the room interior with the object as shown in Figure 5.4.11.

5.5 Implementation Issues and Challenges

While developing the system, it is found out that Google has stopped developing on Sceneform and has archived the Sceneform plugin. This means that the Sceneform plugin can no longer be accessed in the Android Studio importable plugins. Therefore, the Google Sceneform plugin needed to be manually imported and some complicated set up need to be done on the project gradle in order to integrate the Sceneform features into the application. In order to achieve this, the archived Sceneform files are downloaded and integrated into the OfficeIT application through the Android Studio IDE.

Besides that, another implementation issue faced while developing the application is the complication of different model names. This issue initially occurred while the model selections were displayed using model names. This has caused an issue where it is hard to identify the models to be displayed since the names hardly represent any valuable information about the object itself. For example, an office chair can also be considered as a chair even though the application already has another object identified as chair. Initially, the object can still be differentiated through different naming such as "office chair" and "chair" but in the future where more models are included in the application, it might cause further complications to occur. To solve this issue, the model names in the model selection are replaced with the model images. However, the application performance had to be compromised to achieve this goal since an image file is significantly larger than simple texts. This has caused the application to spend more time loading the page and accessing the model selection page. Although the reduce in performance is insignificant, the loading time will be longer in parallel to the number of models included in the application.

5.6 Concluding Remark

In the implementation phase of the application, all proposed functions are successfully implemented in the prototype. The user of the OfficeIT application is able to select how he wants to view a 3D model, which is to select from a list of 3D models provided in the application or to import the 3D model from external storage of the application which is from the storage memory of the user's mobile device.

Next, the user can use the camera on the mobile device to scan for planes in the surrounding. Once a plane has been identified, the selected 3D model can be displayed by tapping on the detected plane and the model will be shown on the device screen. The user can then perform multiple actions such as moving the model, rotating the model, enlarging and shrinking the model using different hand gestures.

Chapter 6 System Evaluation and Discussion

6.1 System Testing and Performance Metrics

The application is able to run in real-time with high accuracy in terms of detecting the environment.

The application is able to render augmented reality objects with high efficiency.

The application is able to react to changes quickly when interacting with the augmented reality object.

The application will be tested with different 3D models to see how the application performs with unsupported file type.

The performance of the application will be tested by placing different the augmented reality objects in terms of size to see how well the application perform in terms of efficiency and accuracy.

The object will be placed and multiple transformation actions will be performed to see how efficient the application can carry out and react to these changes.

6.2 Testing Setup and Result

Project Name	OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment				
Test Title	Application flow to render model				
Description	Ensure smooth flow and no crash when rendering model				
Module Name	Model Render			Test Priority	High
Precondition	Start testing from the Home Page				
Step	Action	Input	Expected Result	Actual Result	Status
1	Access model selection page	Click on View Retail Model button	Redirect to model selection page	Redirect to model selection page	Success
2	Scroll through objects in the same category	Scroll horizontally in Floor category	Previously unavailable objects shown	Previously unavailable objects shown	Success
3	Scroll through different categories	Scroll vertically	Previously unavailable categories shown	Previously unavailable categories shown	Success
4	Select an object to render	Click office chair image button	Redirect to live camera scene	Redirect to live camera scene	Success
5	Return to model selection page	Click on the back button	Redirect to model selection page	Redirect to model selection page	Success

6	Select another object to render	Click tea table image button	Redirect to live camera scene	Redirect to live camera scene	Success

Table 6.2.1: Model Render Test Case

Project Name	OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment				
Test Title	Application flow import model				
Description	Ensure smooth flow and no crash when importing model				
Module Name	Import Model			Test Priority	High
Precondition	Start testing from the Home Page				
Step	Action	Input	Expected Result	Actual Result	Status
1	Access model import page	Click on Import Model button	Redirect to directory selection page	Redirect to directory selection page	Success
2	Select an unsupported file type	Click on a .obj file	Prompt unsupported file type message and redirect to Home Page	Prompt unsupported file type message and redirect to Home Page	Success
3	Select a supported file type to import	Click on a .glb file	Redirect to live camera page	Redirect to live camera page	Success

4	Cancel import model action	Click back in directory selection page	Redirect to Home Page	Redirect to Home Page	Success

Table 6.2.2: Import Model Test Case

Project Name	OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment				
Test Title	Perform actions on the displayed object				
Description	Ensure smooth flow and no crash when interaction with object				
Module Name	Model Interaction			Test Priority	High
Precondition	Select tea table object in model selection page				
Step	Action	Input	Expected Result	Actual Result	Status
1	Identify horizontal planes	Point device camera at a flat surface	Dots shown on the flat surface	Dots shown on the flat surface	Success
2	Identify vertical plane	Point device camera at a vertical surface	Dots shown on the vertical surface	Dots shown on the vertical surface	Success
3	Display the object	Click on the dots on the flat surface	Tea table displayed on plane, producing a vibration and a sound effect	Tea table displayed on plane, producing a vibration and a sound effect	Success

4	Move the object	Hold the object and slide across the screen	Object move in same direction but with partial distance	Object move in same direction but with partial distance	Success
5	Rotate the object	Perform clockwise twist gesture on the object	Object rotates clockwise	Object rotates clockwise	Success
6	Scale up the object	Pinch the object and move both fingers further away	Object enlarges in size	Object enlarges in size	Success
7	Scale down the object	Pinch the object and move both fingers closer together	Object reduces in size	Object reduces in size	Success
8	Exceed the scale limit	Pinch the object and move both fingers closer together repeatedly	Object reduces in size but stop shrinking when scale limit reached	Object reduces in size but stop shrinking when scale limit reached	Success

Table 6.2.3: Model Interaction Test Case

6.3 Project Challenges

Throughout the project, multiple challenges have been faced that had to be overcome in order to produce the desired quality and result for the OfficeIT application. In the early phase of implementation, the Google Sceneform plugin was archived. In order to integrate the Sceneform API in the application, a manual set up was required. The Sceneform archived files were downloaded and integrated in the project file manually.

Then, another challenge was faced when changing the model selection button from displaying object names to images. This has caused potential performance issue. In order to solve and prevent the performance drop in the application, the object image and model were stored separately. The application only fetches and display the object images when user accesses the model selection page. This is important since the application needs to fetch all the images in the model selection page to allow user to choose. In this case, the initial system flow where all the images were fetched along with the corresponding model will cause a large performance drop since fetching all the 3D model files uses a very large amount of computing resources. In the end, the issue is eradicated by letting the application only fetching the images to let user choose the object and only then, the object fetches the corresponding 3D model file and render the object.

Next, another complicated issue was identified when developing the haptic touch effect. The application is met with performance issue when implementing the haptic touch effect due to the calculation of the vectors and the distance moved. The performance issue can be identified where there was a delay and short screen froze whenever the user releases the object after a translation action. Therefore, whenever the user moves the object, the translation of the object is instead done by constantly obtaining the pointer location, which is the location of the finger of the user on the device screen. When the model is dragged across the screen, the application will repeatedly obtain the pointer position and assign it to the object position instead of calculating all the matrices when the user releases the object. This helps in a way where the application does not need to perform heavy calculation with the drag distance and the vectors of the object.

6.4 Objectives Evaluation

After constantly revising and evaluating the OfficeIT application, it can be concluded that the application has accomplished all the proposed objectives of the project. First, the application is created using the markerless augmented reality. In this application, the user is able to place the 3D model on the selected position, on an identified plane. The user can then move around the object to view the object from any desired angle.

Next, auditory and haptic feedbacks features were implemented in the OfficeIT application. These features utilise the provided weight of the object to create a simulation where the user is able to fully feel the object how the object interacts with its surrounding without having to actually access the actual object in real life. The auditory feedbacks feature produces a sound effect when the user places an object on the detected plane which can vary depending on the weight of the object. Besides that, the haptic feedbacks feature adds another layer of immersion through the sense of touch to allow the user to fully understand the object. Using the same weight data, the haptic vibration feature produces a vibration effect which varies in terms of intensity according to the weight of the object. Combined with the haptic touch feature where the object is harder to move around based on the object weight, the application is able to create an interactive experience between the user and the system.

Then, the object is scaled to the area of the detected planes. In the plane detection module, the application uses the device camera to scan for a flat surface. After that, by using the accelerometer in the mobile device, the application is able to obtain the position of the device and estimating the distance of the device and the detected plane. From this, the application can display the object approximate to its real size and whenever the user moves around the object, the size changes to reflect the correct size of the object from every angle and any distance. For example, the object will appear larger when the user in closer to it and smaller when the user moves further away from it.

Finally, the user is able to use the import model function in the OfficeIT application to access the mobile device storage. Here, the user can select the directory of a 3d model file to import and display in the application. Hence improving the usability of the application by allowing user to use own custom model instead of being limited to choose between the options available in the application. This also provides a wider option and usage of the application since the user can use the application to display any object as long as the user has the 3D model file for that object.

6.5 Concluding Remark

After constantly and thoroughly test and evaluate the OfficeIT application, the application can now carry out all the function without problem. Besides that, the application flow has been ensured to be smooth, efficient and easy to understand by the user. From the test cases carried out on each major module in the application, it can be concluded that the application is fully working as intended. Moreover, the application has also achieved all the proposed objectives which are to create the application using markerless augmented reality, implementing auditory and haptic feedback features to enhance user experience and interaction with the system, implementing area detection and calculation feature to accurately display the object and to improve usability and range of options of the application by allowing the user to import model from the user mobile device storage.

Chapter 7 Conclusion and Recommendation

7.1 Conclusion

Throughout the recent years, interior design of an office becomes increasingly important in the eyes of business owner. This is because a well-designed office environment can help reduce work stress and improve working efficiency. However, one big issue when it comes to interior design is that hiring a professional can be costly, and impractical for minor changes. Besides that, interior design by a professional does not always suit the likings of the business owners but designing the interior themselves often ends up with issues such as estimation errors, colour misfit and unsuitable design compared to the theme of the room. Often time the selected furniture turn out to be much larger or smaller than expected.

To solve this issue, multiple interior design applications are created such as Houzz, Room Planner, Homestyler and Measure. However, weakness can still be identified in these existing applications such as unable to let user try out own customed design, lack of auditory and haptic interaction, lack of room area calculation and unoptimized application.

Due to the weakness and limitations mentioned, OfficeIT is proposed to tackle that identified issues. The expected outcome of this project is to deliver an interior design application that is able to help office owners create their own office design using augmented reality technology and increase the quality of working experience. After constantly revising and testing the developed application, it can be concluded that all the objectives of the project have been achieved and the system is able to carry out all the expected outcome of the project.

7.2 Recommendation

There are several ways to improve the OfficeIT application in the future which can help provide a more thorough understanding of the object and its surrounding. Currently, the application is able to identify a horizontal plane and a vertical plane on the same time. However, the application is unable to correctly interact the object with the vertical plane. For example, the user is able to place a chair on a vertical plane although a chair should only be placed on a horizontal plane. Therefore, an obstacle detection feature can be added into the application in the future where objects will stop moving when it hits the edge of the horizontal plane connected to the vertical plane when the user is moving the object around using the drag gesture. Similarly, an object that is meant to be placed on a wall such as a wall fan or a whiteboard should only be able to be placed on a vertical plane and stop moving when being moved to a horizontal plane. Since the objects in the application are separated into different categories, the category of the object can be used as the deciding factor for which type of plane the object can be placed on and which type of plane should be considered as an obstacle for the object.

Besides that, a search bar and category filter can be added in the future to allow the user to directly input the name of the object to directly search for the object instead of scrolling through all the object images in the application. This can also help with the application performance with the consideration of having more and more objects included in the future. By adding the search function, it can improve the user experience in a way that it would require less time for the user to find the desired object. Other than that, it also allows the application to only fetch and display the objects that are important and wanted by the user instead of having to fetch and display all the object images. On a similar note, a category filter function can also be added to the application where the user can access the filter setting and select the category that the user wants. The application can then exclude objects and categories that are not needed by the user which can provide a clearer view for the user when searching for an object and at the same time reduce the number of images to load by the application.

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FINAL YEAR PROJECT WEEKLY REPORT

(Project I)

Trimester, Year: Trimester 1, Year 4	**Study week no.: 1**
Student Name & ID: Wong Kai Jie 19ACB03336	
Supervisor: Dr Manoranjitham a/p Muniandy	
Project Title: OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Revise and plan on functions implementation and documentation

2. WORK TO BE DONE

- Planning on implementation of plane detection
- Estimate realistic scale of 3D models to the plane area

3. PROBLEMS ENCOUNTERED

- Some features need to be revised due to time constraint of the project and improve general flow of the system.

4. SELF EVALUATION OF THE PROGRESS

- Acceptable progress

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Trimester 1, Year 4	**Study week no.: 3**
Student Name & ID: Wong Kai Jie 19ACB03336	
Supervisor: Dr Manoranjitham a/p Muniandy	
Project Title: OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Planned on implementation of plane detection.
- Estimated realistic scale of 3D models to the plane area.

2. WORK TO BE DONE

- Implement plane detection.
- Scale object to the plane area and apply maximum and minimum scale.

3. PROBLEMS ENCOUNTERED

- Hard to decide on the correct scale of the object since it is dependent on the user point of view and model size.

4. SELF EVALUATION OF THE PROGRESS

- Acceptable progress.

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Trimester 1, Year 4	**Study week no.: 5**
Student Name & ID: Wong Kai Jie 19ACB03336	
Supervisor: Dr Manoranjitham a/p Muniandy	
Project Title: OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Implemented plane detection feature.
- Scaled object to the plane area and applied maximum and minimum scale.

2. WORK TO BE DONE

- Change the translation method.

3. PROBLEMS ENCOUNTERED

- System will freeze for a short period when object is being moved.

4. SELF EVALUATION OF THE PROGRESS

- Acceptable progress.

Supervisor's signature

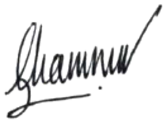
Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Trimester 1, Year 4	**Study week no.: 7**
Student Name & ID: Wong Kai Jie 19ACB03336	
Supervisor: Dr Manoranjitham a/p Muniandy	
Project Title: OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment	

1. WORK DONE [Please write the details of the work done in the last fortnight.] - Changed the translation method from calculating the vectors at the end of drag gesture to constantly assigning pointer position to the object.
2. WORK TO BE DONE - Implement import model function.
3. PROBLEMS ENCOUNTERED - No problem encountered.
4. SELF EVALUATION OF THE PROGRESS - Acceptable progress



Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Trimester 1, Year 4	**Study week no.: 9**
Student Name & ID: Wong Kai Jie 19ACB03336	
Supervisor: Dr Manoranjitham a/p Muniandy	
Project Title: OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Implemented import model function.

2. WORK TO BE DONE

- Implement haptic vibration feature.
- Implement haptic touch effect.
- Implement auditory feedback feature.

3. PROBLEMS ENCOUNTERED

- Found out the there are no MIME types for 3d models file type and therefore the system needed to perform file type checking after user imported the file instead of filtering the files when user open the device file directory.

4. SELF EVALUATION OF THE PROGRESS

- Acceptable progress

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Trimester 3, Year 4	**Study week no.: 11**
Student Name & ID: Wong Kai Jie 19ACB03336	
Supervisor: Dr Manoranjitham a/p Muniandy	
Project Title: OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment	

1. WORK DONE

[Please write the details of the work done in the last fortnight.]

- Implemented haptic vibration feature.
- Implemented haptic touch effect.
- Implemented auditory feedback feature.

2. WORK TO BE DONE

- Finalizing the report.
- Perform system testing.

3. PROBLEMS ENCOUNTERED

- The haptic touch effect is unified throughout all the models in the application and therefore can only be done as a prove of concept.

4. SELF EVALUATION OF THE PROGRESS

- Acceptable progress, all proposed features have been implemented in the system.

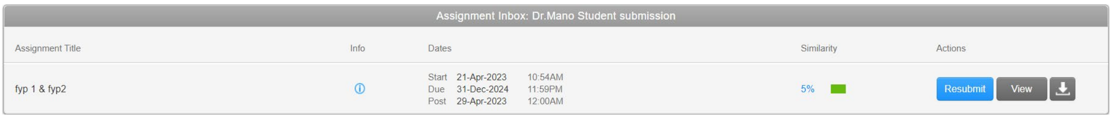
Supervisor's signature

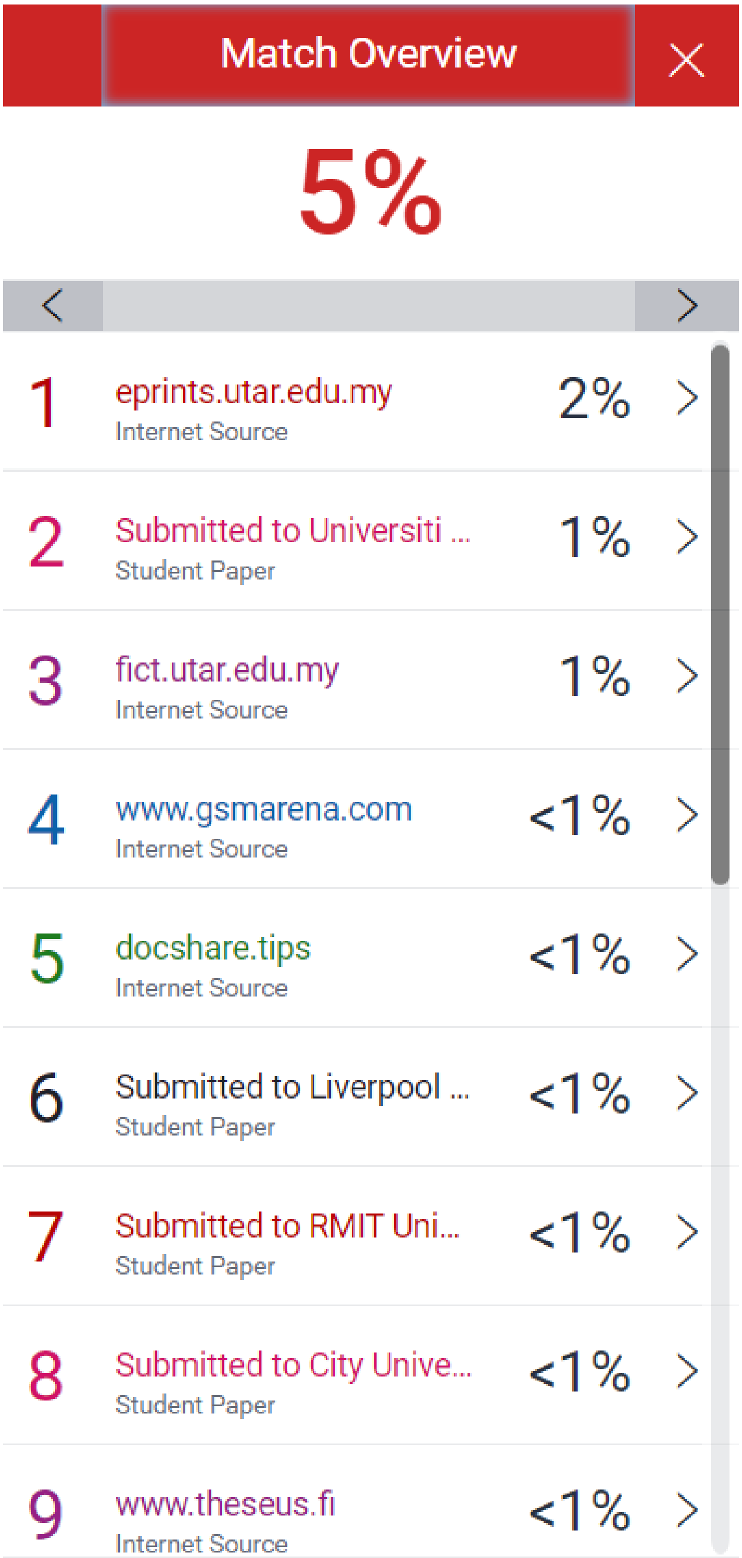
Student's signature

Poster


Objectives
1. To create a new interior design application optimized for designing an office indoor environment using markerless augmented reality.
2. To implement a new auditory system with haptic feedbacks that is able to interact with the user to produce an interactive experience between the system and the user.
3. To implement area detection and calculation system to scale the objects to the measurements of the surface area.
4. To increase the usability of the application by allowing user to add in own custom design of furniture and accessories for wider designing options.
Problem Statement
1. Users are confined to choose the products available in the application.
2. Existing systems are not optimized to design an office indoor environment.
3. Lack of auditory and haptic interactions between users and system.
4. Lack of precision in the existing systems for area calculation.
Proposed Method
1. Provide audio cues when user interacts with the 3D object.
2. Identify the area measurements and scale 3D object to fit the measurement based on user point of view.
3. Use plane detection to place 3D object in place.
OfficeIT – An Augmented Reality Application with Visual and Auditory Interaction Ability to Design and Construct the Office Indoor Environment
This project is aimed to solve weaknesses in the current existing interior design application using interactive augmented reality technology.
Conclusion
Augmented Reality is a technology used to solve the interior design mistakes while applying auditory interaction allows business owners to select suitable additions to the office environment.

Plagiarism Check Result





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Form Number: FM-IAD-005	Rev No.: 0	Effective Date: 01/10/2013	Page No.: 1of 1

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Wong Kai Jie
ID Number(s)	1903336
Programme / Course	IA
Title of Final Year Project	Augmented Reality Application with Visual and Auditorial Interaction Ability to Design and Construct The Office Indoor Environment

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceed the limits approved by UTAR)**
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Note: Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

Signature of Supervisor	Signature of Co-Supervisor
Name: Dr Manoranjitham a/p Muniandy	Name:
Date: 27/4/2023	Date:

FYP 2 CHECKLIST

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Student Id	19ACB03336
Student Name	Wong Kai Jie
Supervisor Name	Dr Manoranjitham a/p Muniandy

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