

**INTERACTIVE AUGMENTED REALITY STORYBOOK
FOR EARLY CHILDHOOD EDUCATION**

BY

Kuek Poh Seng

A REPORT

SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfilment of the requirements

for the degree of

BACHELOR OF INFORMATION SYSTEMS (HONS)

INFORMATION SYSTEMS ENGINEERING

Faculty of Information and Communication Technology

(Kampar Campus)

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Date: 6 September 2020

Date: 11/09/2020

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DECLARATION OF ORIGINALITY

I declare that this report entitled “**INTERACTIVE AUGMENTED REALITY STORYBOOK FOR EARLY CHILDHOOD EDUCATION**” is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

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Date : _____ 6 September 2020 _____

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Abstract

In this advance era of technology, the application of integrating Augmented Reality has become more commonly used in education compare to last decade. This project is carried in terms of study whether implementing AR technology in education will solve or improve the problem of current situation faced by almost every student in any ages which is feeling loss of engagement towards study, do not have reading habits since youth, did not found fun while study and also the interaction between teacher and student.

This project is a development of a proposed mobile application which in the field of integration of Augmented Reality technology with the physical storybook. The target audience of this application are children in early childhood education from aged 2 to 7 to cultivate their reading habits since youth. The scope of this proposed application is aim to increase the motivation, engagement and interaction of the target audience in a better and interesting learning environment compare with an ordinary storybook. Intergrading Augmented Reality in an ordinary storybook creates an immersive experience toward children and raise their interest in the content of storybook. Parental supervision is required while using the application, which also benefits the interaction between parents and also their children. Questionnaire are constructed and analysed to seek user's opinion on the proposed mobile application where the proposed application is needed by the community and also analysing the reading habits of children.

Agile Model of methodology are applied as the approach in order to develop this proposed system is this project. There are five phases included in Agile Model which is planning, requirement analysis, design, implementation and evaluation performing different task which helps to develop the project. Development tools such as Shotcut, Vuforia SDK, Visual Studio 2017, Blender and Unity 3D is used to develop the proposed mobile application. The appropriate computer language for developing this application will be C#.

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LIST OF ABBREVIATIONS

<i>AR</i>	Augmented Reality
<i>GUI</i>	Graphical User Interface
<i>UI</i>	User Interface
<i>UML Diagram</i>	Unified Modelling Language Diagram
<i>SDK</i>	Software Development Kit
<i>3D</i>	Three-Dimensional
<i>2.5D</i>	Two-And-A-Half-Dimensional
<i>2D</i>	Two-Dimensional
<i>APK</i>	Android Package Kit
<i>PDF</i>	Portable Document Format
<i>.PNG</i>	Portable Network Graphics
<i>.JPEG</i>	Joint Photographic Experts Group
<i>.MP3</i>	MPEG Audio Layer III
<i>.CDA</i>	Disk Image

Chapter 1: Introduction

1.1 Problem Statement

The problem statements of this project are shown as follow:

1. Loss of engagement in learning.

Children are naturally curious about new things and playful. Children learn when they play and explore new things. With the advancement in technology today, many entertainments out there are more interesting compared to learning in preschool such a traditional way with physical books and copy files provided by the teacher (Parhizkar et al. 2011). Other than that, several researchers found out that another limitation of the usual learning materials such as physical books that contains less interactive content which may cause the students got bored and exhausted about learning (Abadi et al., 2018). Hence, children have trouble with focus and concentration in studies. Some studies conducted by researcher also shown that an interactive learning environment could change a passive learner to an engaging active learner. Therefore, instead of providing traditional one-way communication learning materials, an integrated element of multimedia such as audio, animation and interactable mobile application can be an effective learning material for children.

2. Loss of reading habits in youth

Due to the mass media in the current world, not only children but also adults do not show much interest in reading books, magazines, journals and others (Palani, 2012). It is important to cultivate reading habits from the youth. The earlier a child starts to receive education, the faster the child could absorb more knowledge. Positive early reading experiences predict better reading and language developments and children who experienced rich verbal and affective interactions during shared book reading are more likely to enjoy and show interest in reading later in childhood.

3. Lack of interaction in traditional classroom.

Traditional teaching method often uses teacher-centred which only providing one-way communication. This is hard to ensure a student can absorb the knowledge effectively. Teacher-centred traditional classroom aims to impart knowledge to students, in which teacher performs as the main role in the classroom, and students will focus and listen on something that the teacher is taught to the student, write down some information or notes about what they are receiving, think something independently what they are listening (Li et al, 2014). So, the lack of interaction between students and teachers resulting in students often behaves passive behaviours. Studies conducted by researchers found out that the traditional teaching method is failing in knowledge transfer and its transfer power from teacher to student (Fahiminezhad et al., 2012).

4. Lack of enjoyment during studies.

Lack of enjoyment during studies is a crucial problem faced in the education field from past to present and it was a factor examined in this study. Researchers stated that enjoyment is closely related to learning, motivation, and interest in the learning material that can be improved (Yilmaz, Kucuk & Goktas, 2017). Attractive elements in computer technology applying in the form of education could be helpful in learning. (Wang, He and Dou, 2013) found out that students have positive attitudes towards AR applications, in the student perspective of view, AR is easier to use and more inspirational compare to traditional learning activities.

Chapter 1 Introduction

1.1.2 Motivation

The motivation to develop this project is to improve the problems stated in section 1.1 and also encourage children to cultivate reading since youth. Other than that, the author wishes to provide the students to have an interactive and interesting reading experience. Instead of learning in the traditional method such as reading from an ordinary storybook, an interactive augmented reality storybook that consists of text, image, audio, and animation is more likely to attract attention from the children. Besides, as the children are interested in reading, language development can also be enhanced. The author also encourages children to play and learn. Playing is also one of the study methods, it is an essential part of children's development (Hinske et al., 2008). Hence, the reading process will become more attractive and interesting by integrating interactive activities such as augmented reality during the story-telling.

Chapter 1: Introduction

1.2 Project Scope

The scope of this project covers the integration of augmented reality (AR) technology in a learning-based mobile application in helping the target audience to gain more interaction, engagement, provides immersive experience towards learning using AR and to cultivate reading habits from youth. The intention of propose this application is to improve or best to solve the cons of traditional classroom which is lack of interaction between teacher, adding extra fun towards learning, motivation and engagement for target user during study.

Throughout the planning, an interactive mobile-based augmented reality storybook application will be designed and developed in this project. This application is an Android-based application so its deployment limited to the Android user. The target audience for this mobile application is from preliminary school and primary school students between the ages of 2 to 7. Other than that, this application requires support from the teacher and parental supervision. An alert message will be generated while every time launched the application to aware user to stay aware of their surroundings. Moreover, English will be used as the application's default transmission language.

The output of this project aims to benefit in terms of successfully cultivating reading habits among the target audience by carrying out interesting content of learning material. The application of AR technology enables the target users to visualize the animation and flow of the story by scanning the marker of the storybook. The contents of the application are going to integrate the elements of multimedia such as text, audio, animation, and image to gain better attention from the target audience and provide a better learning environment. Meanwhile, the models of the 3D object and animation in the proposed system will be designed based on the flow of the story. A guide of the proposed application will be provided for the target audience, parents and teachers to fully understand how the application works.

1.3 Project Objectives

The main objectives of this research project are:

- 1. To develop a mobile storybook application with augmented reality technology contains different visual representation compare to an ordinary storybook.**

As the problem statement mentioned above, loss of engagement in the study is mainly caused by uninteresting teaching material and methods. An interactive mobile augmented reality storybook application for early childhood education provides interesting elements and enhance their engagement in studies to improve reading skills, language development. The impact of different visual representations provided by AR could turn an ordinary storybook to be more interesting and livelier for children to attract their attention with a 3D animated model and sound.

- 2. To identify the reading habits among early-childhood students.**

Lack of Reading habits affects the interest in studies after children grow up. To find out the reason why the student does not interest in reading, a questionnaire will be designed and distributed to analyse the reasons.

- 3. To propose a learning application that contains interaction between user and enhancing knowledge transfer.**

Lack of interaction in traditional class room is another critical issue for children to gain knowledge effectively. As state in problem statement, students often listen and learn according to the teacher's talk which resulting student become passive learner. An interactive mobile augmented storybook not only can transform the boring learning content into an engaging learning experience but also create interest and improve the attractiveness among students. Interaction is also an essential element required in the application; therefore, children's involvement will be more than usual compared to traditional learning method.

4. To improve enjoyment during study by learning through augmented reality technology.

Lack of enjoyment during studies is a crucial problem faced in the education field from past to present and it was a factor examined in this study. AR technology provides immersive experience towards target audience and could easily grab the attention of the kids without being easily distracted. Besides, AR represents an innovative way of study for the kids in their early childhood education. AR is easier to use and more inspirational compared to traditional learning activities.

1.4 Impact, Significance and Contribution

The first problem of this project is the loss of engagement towards studies. This interactive mobile augmented reality storybook application can raise the engagement of students through attractive multimedia elements. The second problem is a loss of reading habits in youth, this application will encourage the student to read the books innovatively. This is to help them to play and learn the vocabulary while they participate in the story and make the ordinary storybook looks more attractive. The third problem is students are lack of interactive in learning. This application will provide interaction that comes with the story to play with and learn. The last problem is the lack of enjoyment during learning. This application provides mini-games related to story and vocabulary for the target audience to play with it.

This project will improve the interest and motivation of children to enhance language development in an effective way. Developing an interactive mobile augmented reality storybook for learning English and cultivate reading habits is not to replace the traditional teaching-learning process in the classroom, but to aid the student and learner's learning experiences. According to (Shabiralyani et al. (2015)), visual aids such as sensory objects or images that can initiate or support learning better. It can also be used to make the learning process more real, more active and more accurate. By using the application, it can help children to learn effectively and in terms of understanding the content of the study materials. Augmented Reality contains multimedia elements such as sound, image, and animation that are included in the system. Moreover, the most important element is the participation required by the children. From a children's perspective of view, these elements can attract their attention better and they might be more interested in learning rather than learning through a book in words. Words can explain everything but visual elements help to improve their understanding.

1.5 Background Information

The main focus of this project is using augmented reality technology to develop an interactive mobile-based augmented reality storybook application for early childhood education. Storybook is one kind of learning materials for the student to learn and develop language skills. Augmented reality technology can be a potential teaching material in the form of education. Children nowadays are easily distracted by their surrounding environment. The advance in technology also affects the children during the learning process. Children often feel that learning is boring and uninteresting compared to watching YouTube and playing games. Loss of interest and attention in the learning process will affect the student's perspective towards learning which also resulting in poor performance in school. Some studies also found out students might feel anxiety and refuse to learn because of loss of attention in class resulting in poor performance in school (Von Der Embse, Barterian & Segool,2013).

To encourage those kids who are easily distracted, loss of interest and attention from their study towards learning, a mobile-based learning application that implemented AR technology helps to increase the curiosity of children towards learning and reading innovatively. Certain studies conducted by researchers found that the traditional teaching methods in the existing education system are defects and flawed (Von Der Embse, Barterian & Segool,2013), (Fahiminezhad et al., 2012)). One of the limitations in the traditional teaching method is failing in knowledge transfer and the transfer power from the teacher to students because of the one-way communication teaching method (Fahiminezhad et al., 2012). Due to the problem of using the traditional method for teaching and learning languages, there are getting more learning-based mobile applications have been proposed to overcome the challenges encountered in language learning. Last by not least using the AR system and environment for learning is not replacing the traditional classroom activities but it is an additional aided learning tool to enhance the students learning experience.

The outcome of this project by utilizing AR will have a better performance compared to other 2D learning applications which is able to grab the children's attention and motivate them during the learning process. This project outcome provides material of learning for kids which are more interactive, attractive compared to the contents of physical books and textbooks. Meanwhile, this proposed application requires teacher and parental guidance to use.

Chapter 1 Introduction

1.6 Report Organization

The content of this report divides into seven different chapters. Each chapter will discuss on different contents in detailed, this session will briefly describe the contents in every chapters.

The first chapter will be containing the introduction of the proposed project background information, problem statement, problem objectives, project scopes, motivation, impact, significance and contribution to create this entire project.

The second chapter will be containing literature review regarding Augmented Reality technology and Augmented Reality technology in education sector. Moreover, three similar application that fits the project scopes will be reviewed by the author and compare between the proposed application. A table of Comparison will be created to have a clear view of what is the different between each other. Other than that, a set of questionnaires will be distribute towards participant and analysis on the collected data.

The third chapter will be containing the rough system design or blueprint to create this the proposed application. Methodology, development tools including software and hardware, user hardware and software requirement, system design in system flowchart diagram, use case diagram and also the application's storyboard design will be discussed in this chapter.

The fourth chapter will be containing the preliminary work did in previous final year project session.

The fifth chapter will be containing the system development process and implementation and also the guidance to recreate this application in scratch. Setup in Unity3D, download Vuforia database, extract image target and audio narration, tool used, 3D model design, animation design and AR scene design, user interface design, mini games design and also splash screen design will cover in this chapter.

The sixth chapter will be containing evaluation of the created application which including system testing and evaluation of project objectives.

The final chapter will be containing the conclusion which includes project review, implement issues and challenges, discussion of proposed project and also improvement in future works.

Chapter 2: Literature Review

2.1 Literature Review

2.1.1 Augmented Reality (AR) Technology

In this 21st century, the growth of technology is developing at a rapid stride that has dramatically affected education and Mobile Augmented Reality (AR) technology is one of the new technologies that implement in education. AR is a technology that using the existing environment and overlay the virtual things on top of the real environment. The visualize object or graphics could be designed in a 2D or 3D model and it is interactable with the user.

2.1.2 Augmented Reality (AR) Technology in Education Field

Augmented reality in education brings elasticity and flexibility among the learner as the learner can observe how the contents look like. According to research indicated by El Syed, Zayed & Sharawy in the year 2010, AR systems and the environment could help learners to develop skills and knowledge in the technology-enhanced environment in an effective way. Other than that, AR systems and the environment with interactivity needed could also help learners to increase their interest in learning (Yen, Tsai, & Wu, 2013). Several researchers also indicated that children enjoying story activities that include 3D graphic and interactive sound (Fridin, 2014). Moreover, AR teaching material is a good alternative to a conventional picture book and physical interactions (Hung, Chen & Huang, 2016). Research has shown positive effects that AR could bring to education such as they have a better academic performance. (Bressler & Bodzin, 2013; Yilmaz, 2016).

Several researchers have developed many kinds of AR picture and storybooks for educational purpose (Behzadan & Kamat, 2013; Cheng & Tsai, 2014; Cheng & Tsai, 2016). The researcher states that the AR storybook provides an attractive learning experience towards children (Dünser & Hornecker, 2007). As a result, we can know that the AR-based learning application can provide effective learning if there is a proper interaction that takes place. However, there are also some negative effects on children if they spend too much time on digital technology. Studies also show that spending too much time on digital technology will also affect the poor academic performance and to be unhealthy (Park, Kang, & Kim, 2014). Finally, time spending and management on digital technology should be maintained appropriately although there are lots of beneficial digital technology for students to use.

2.2 Critical Remark of Previous Work

2.2.1 The Beautiful Butterfly

The Beautiful Butterfly is a smartphone learning-based mobile application developed by Pelangi Books which founded in the year 1979. This application is implementing augmented reality technology to the storybook for young children who are just beginning to explore the wonders of their world through pictures and words. This application is a fully market-based system, users are required to use their pictures as a marker provided to see the content of the story. The application contains 16 markers to fully explain the story. Other than that, the application provides a simple guide for the users to manipulate and rotate the 3D graphics. The application also provides modules and features on explaining the habitats of the insects related to the story. Lastly, the graphical user interface for the users is simple and easy to use.



Figure 2.2.1.1: Main Menu of The Beautiful Butterfly Application

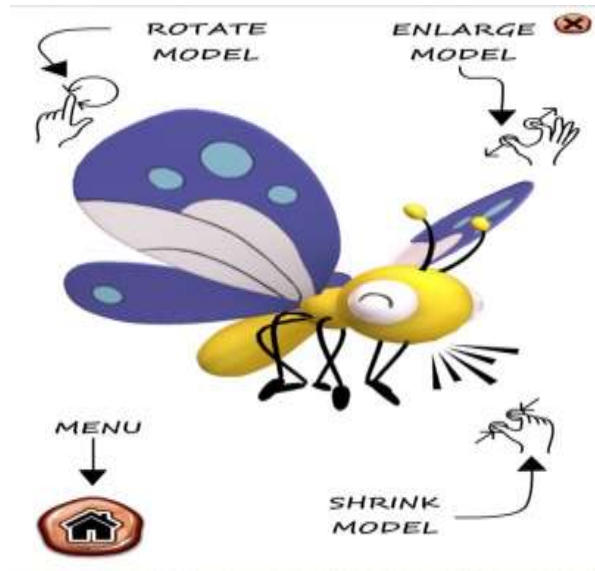


Figure 2.2.1.2: Guide for Manipulate Model in Application



Figure 2.2.1.3: Marker for AR in Application



Figure 2.2.1.4: Actual Outcome of Main Function



Figure 2.2.1.5: Safety Warning in Application

2.2.2 Strength

One of the main strengths of this application is that the graphical user interface (GUI) is simple and easy to use. Other than that, the interface designed colourfully with special effects can help them capture the children's attention. Moreover, a simple guide is provided for users on how to manipulate the models. 2D animation features also provided for the user to watch the full story instead of using augmented technology. Narration in this application is provided when the cameras successfully capture the marker. Before turning on the in-app camera, a notice will pop up in the application that reminds of parental and teacher supervision is needed. This notification also reminds users to aware of their surroundings. Lastly, this application is free of charge.

2.2.3 Weaknesses and Limitations

The physical book of the story is absence, the users might prefer using physical book with AR to see the contents. Other than that, the animation model is created in 2.5D, therefore it is less attraction compare to 3D models. The absence of the subtitle or caption provided is another limitation of this application. In this case, children might not understand the tone of the narrator or miss several words resulting in unable to understand the content of the story. Lack of modules such as quiz for the target audience to ensure they are understood the content of the story or the exact meaning of some words. Lastly, this application does not support interaction when the user clicks on the models.

2.2.4 Suggestion

The interaction between user and the 3D model can be considered to added in order to attract the user attention and participate in the storytelling process. Module such as quiz and mini-games can be implement in the application to test the understanding of the user in this story. Instead of using 2.5D model, it is better to create a 3D animation model for the story. 3D model can be more attractive compare to 2.5D models. Since this application does not require a physical book to perform AR activity, the subtitle or words should be adding in the application to shows the accurate content of the story otherwise user might misunderstand the content.

2.2.2 Toy Story

Toy Story is a famous 3D animation created by Pixar Animation Studios which acquisition by Disney. Toy Story movie was first to come out in the year 1995, 4 movies are being developed in this series and the development is still proceeding. This application provides fascinating interactive 3D models with the implementation of Augmented Reality technology. This application is a fully marker-based application that required the users to have their storybook to fully utilize the application. Therefore, it is different compared to The Beautiful Butterfly application, Toy Story does not provide users the marker in the application. This application contains many interactive elements for the users to manipulate with it. For example, once the user clicks on the 3D model, different posture will be shown to user.



Figure 2.2.2.1: Main interface of Toy Story



Figure 2.2.2.2: Different action is done while clicking the 3D model



Figure 2.2.2.3: Interactive Game in Application [1]

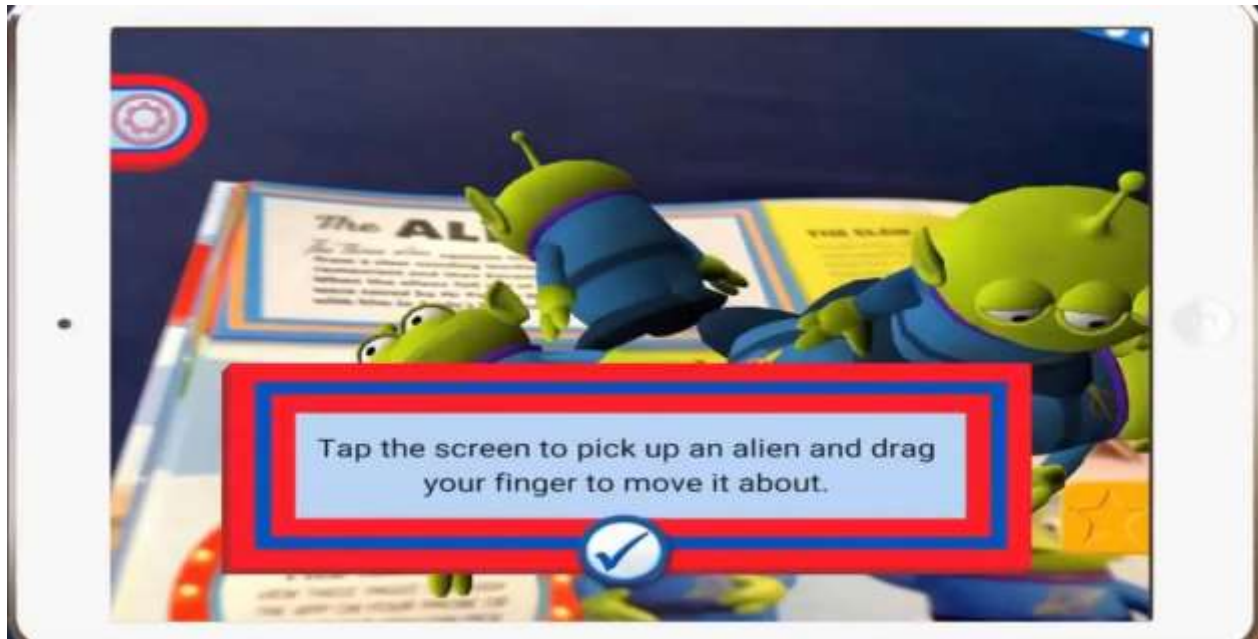


Figure 2.2.2.4: Interactive Game in Application [2]

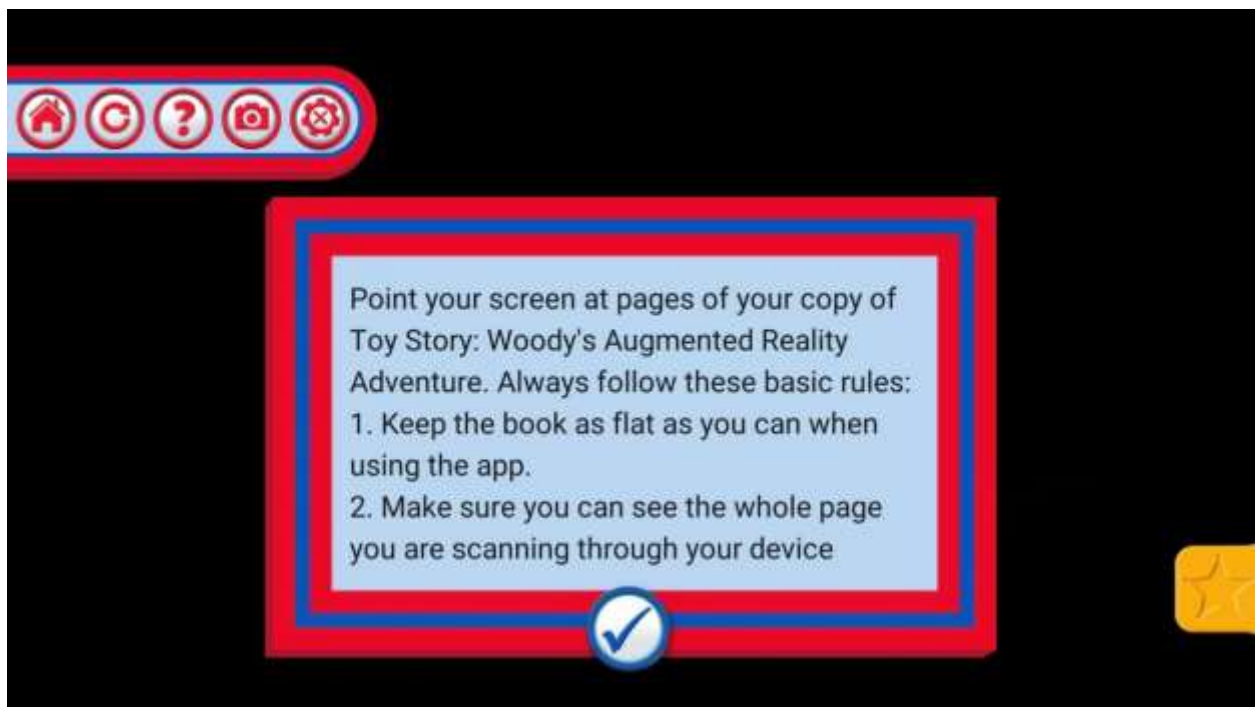


Figure 2.2.2.5: Guideline for User to Manipulate the Application

2.2.2 Strength

The strength of this application contains fascinating well-designed 3D models that able to grab the attention of the users. This application also contains several different interactive game elements to play with it. Other than that, this application is also free of charge except for the physical book.

2.2.3 Weaknesses

First of all, the main interface of the application is too simple to capture the children's first impressions. This application does not provide safety alert or warning towards the users. Other than that, the narration in this application is absence. Although it provides a fascinating 3D model and interactive games for the users, however, it does not provide the flow of the story. In the physical book, it does provide the storyline of each character, however, this application seems mainly to focus on previewing each character's model in the story only.

2.2.4 Suggestion

Interface of this application could be designed to be more attractive, for example background can be in the scene of story and with others 3D model instead of just "Woody" itself. The application could provide a safety notice for user that informing them to aware of the surroundings. The most important part is that this application does not shows the full story of the books in AR. Hence, narration also without in this application. Developer can consider to develop a storyline in AR for the characters.

2.2.3 Story World Augmented Reality

Story World Augmented Reality is developed by Anwarissa Asbah and published by Sawsan Tech Sawsan (Tech, 2019). The story world is an application for children that integrates the new augmented reality technology with the narration of the stories. It is designed to inherit the old cultural stories to new generations entertainingly and interactively (Sawsan Tech, 2019). This application is also marker-based. In this application, several features had provided by the developer. For example, an in-app puzzle of the stories, guidelines for the users to use the application, and narration for the story is provided. Other than that, this application is also free to charge but it is also required to buy the physical book to fully utilize this application.



Figure 2.2.3.1: Main interface of Story World AR



Figure 2.2.3.2: Actual Outcome of the Main Function



Figure 2.2.3.3: Additional Interactive module in Application (Puzzles)



Figure 2.2.3.4: Puzzle Game in Application

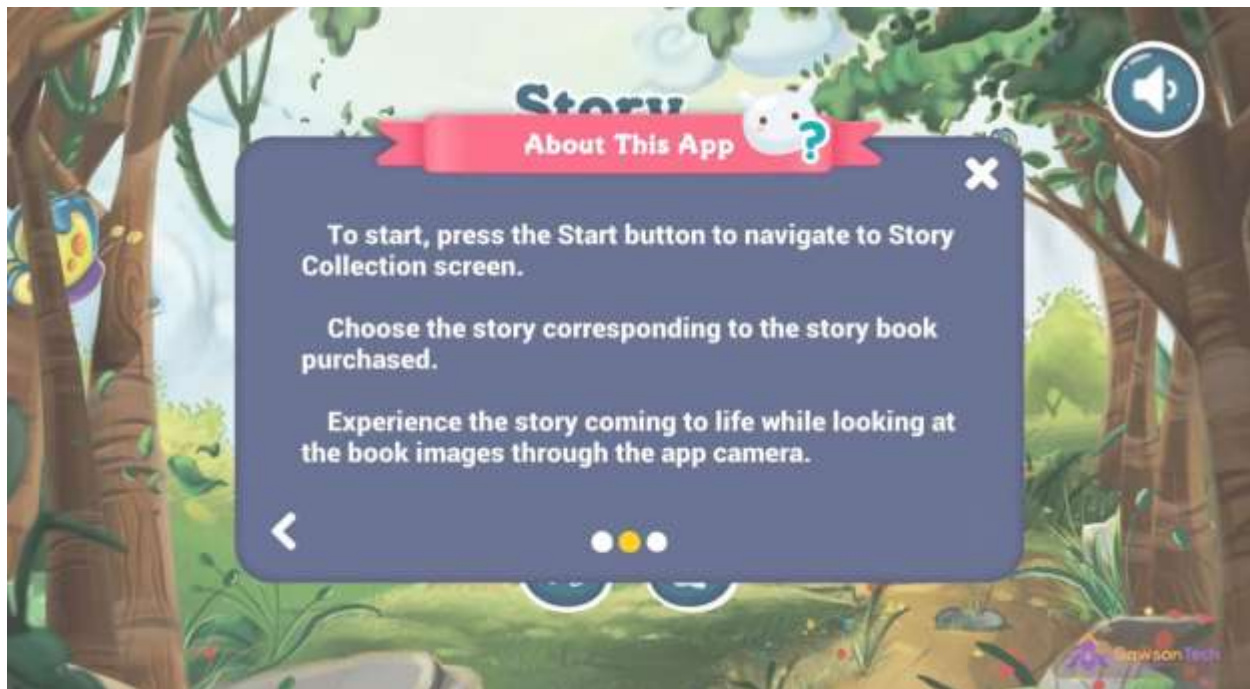


Figure 2.2.3.5: Guideline for Users to use the Application

2.3.3 Strength

The main interface of this story is designed colourfully which gives a better impression. This application provides a guideline for the user to manipulate with their application. The main function of this application provides the complete flow of the story by using AR. Narration is provided while the in-app camera captures the marker on the physical book. The puzzle game is provided in this application, the user can unlock the puzzle stage by stage. The application is providing a feedback section, which enables the user to ask a question and collect their feedback. Finally, the application is free of charge.

2.3.3 Weaknesses

The weaknesses in this application are that the safety alert or notice is absence, this might cause children who are not aware of the surroundings. Interactivity during the storytelling is also absent in this application.

2.3.4 Suggestion

Safety notice can be considered to add in the application that aware of user's surroundings. This application does not provide interaction while user using the application. Developers should consider to add interaction with it to attract user's attention.

2.3 Table of Comparison Between Reviewed System and Proposed System

Features	The Beautiful Butterfly	Toy Story	Story World AR	Proposed System
Platform	Android, IOS	Android, IOS	IOS	Android
Interaction needed while storytelling	x	x (no story telling in this application)	✓	✓
Mini Games (Puzzle)	x	✓	✓	✓
Subtitles	x	x	x	✓
Safety Alert or Notice	✓	x	x	✓
User Guideline for Application	✓	✓	✓	✓
3D Augmented Reality Model	x	✓	✓	✓
Complete Flow of the Story	✓	x	✓	✓
Narration for Storytelling	✓	x	✓	✓
Required Physical Book to Utilize Application	x	✓	✓	✓
Free of Charge Application	✓	✓	✓	✓

Table 2.3.1: Table of Comparison

2.4 Data Collection

Data collection is a method to gather user requirements and information needed for development to prove the problem statement and come out with solutions or improvements. For this project, a survey questionnaire through Google Form is selected as a tool to collect data and information. The survey questionnaire is mainly close-ended questions for the participator. A researcher has pointed out that the questionnaire is an effective way to collect data (Brace, 2018). According to (Brace, 2018) survey questionnaires easily to check for reliability because each of the questionnaires is set in standardized form by the individuals who are collecting the data, the same question and the same order. Google Form provided convenience to the data collector since it provides real-time auto-generates the pie chart after the participator submits the survey.

The survey questionnaire contains 16 questions and 50 respondents answered the survey question. The purpose of creating these survey questionnaires is mainly to identify the needs of this application. Several important questions and data submitted by the respondent will be further analysed.

2.4.1 Data Analysis

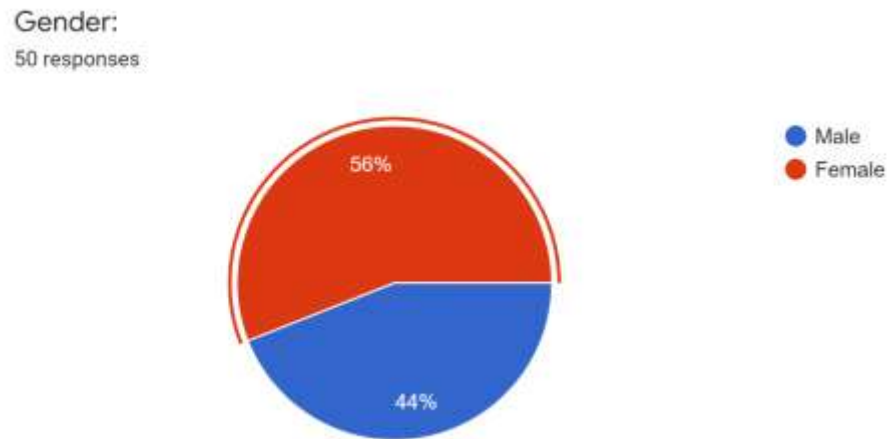


Figure 2.4.1: Question 1 of Survey Questionnaire

Figure 2.4.1 shows that the number of the respondents and their gender in this survey.

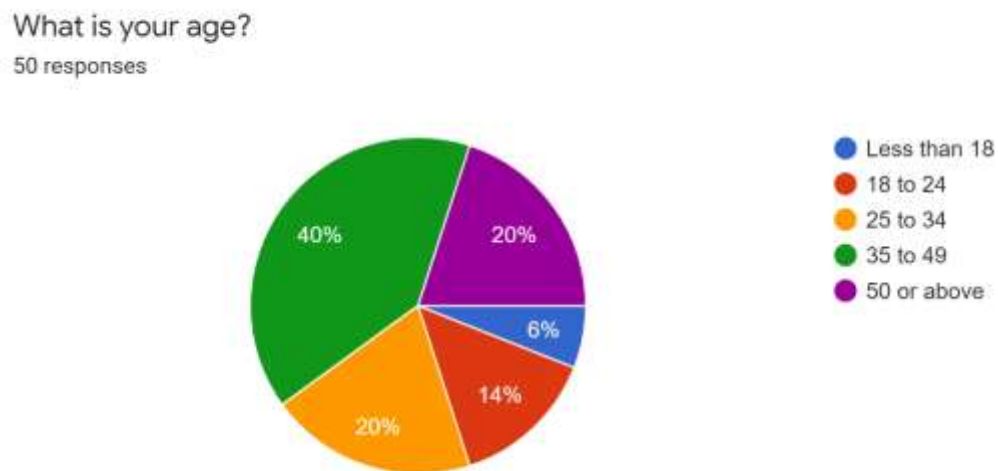


Figure 2.4.2: Question 2 of Survey Questionnaire

Figure 2.4.2 shows that the age group of the participant. The participants are from different age group to give provide a feedback on their perspective towards AR in early childhood education.

Do you think AR is suitable to implement in the early childhood education?
50 responses

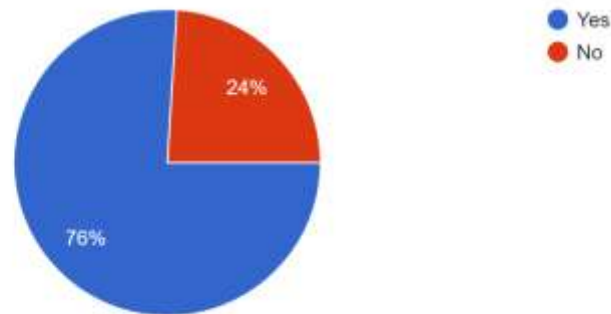


Figure 2.4.3: Question 3 of Survey Questionnaire

Figure 2.4.3 shows that 76% of the respondents agrees that AR is suitable to implement in early childhood education, whereas 24% of respondent disagree with it. From the graph, we can see that AR in early-childhood education are mostly accepted by the respondent.

Do you think children should cultivate reading habits in youth?
50 responses

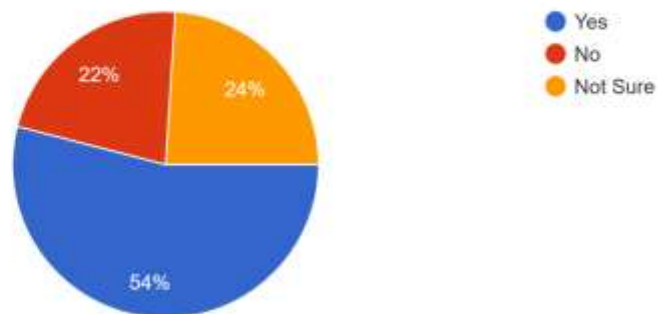


Figure 2.4.4: Question 4 of Survey Questionnaire

Figure 2.4.4 shows that 54% of the respondents agrees that children should cultivate reading habits in youth. 22% of the respondent disagrees and 24% of respondents are remain neutral.

Chapter 2: Literature Review

Do you think negative effects such as addiction to mobile devices will happen to children as if they spend too much time on digital technology?

50 responses

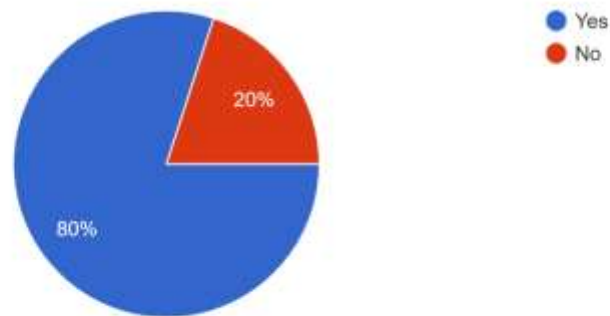


Figure 2.4.5: Question 5 of Survey Questionnaire

Figure 2.4.5 shows that that 80% of the respondents agrees that children who spending too much time on digital technology will have some negative effects. However, 20% of respondents does not agrees.

Do you think one-way communication teaching method in the traditional classroom is a lack of interaction between student and teacher?

50 responses

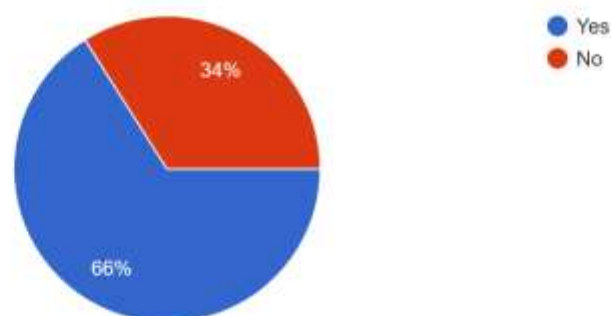


Figure 2.4.6: Question 3 of Survey Questionnaire

Figure 2.4.6 shows that 66% of the respondent feels that traditional classroom that using one-way communication teaching method is a lack of interaction between student and teacher.

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Instead of just studying, do you think that play and learn is more suitable for children?
50 responses

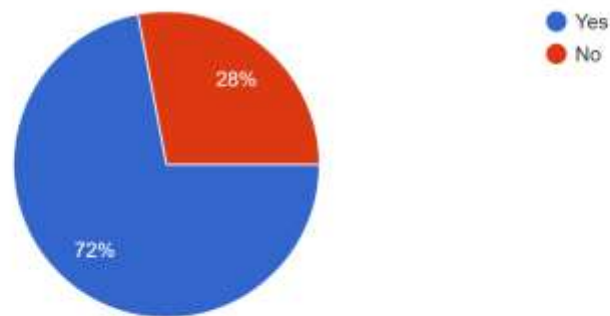


Figure 2.4.7: Question 3 of Survey Questionnaire

Figure 2.4.7 shows that 72% of the respondents agrees that play and learn method is more suitable for children in learning process. 28% of respondents disagrees with that.

Do you think the multimedia elements such as video, audio, picture, text, and animation can attract children's attention effectively?
50 responses

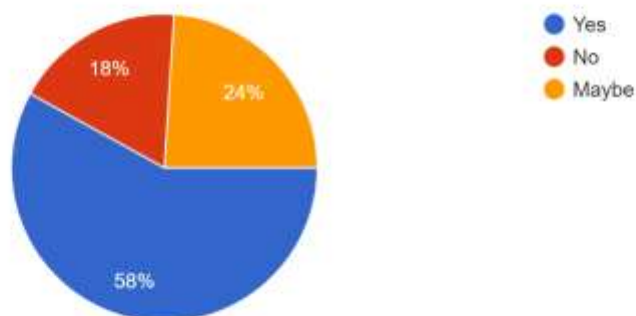


Figure 2.4.8: Question 8 of Survey Questionnaire

Figure 2.4.8 shows that 58% of the respondents agrees that the 5-multimedia element which is video, audio, text, animation and images can grab more attention from the children. 18% of respondent disagree with it and 24% of respondent remains neutral.

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In general, how do you feel about AR implement in education?

50 responses

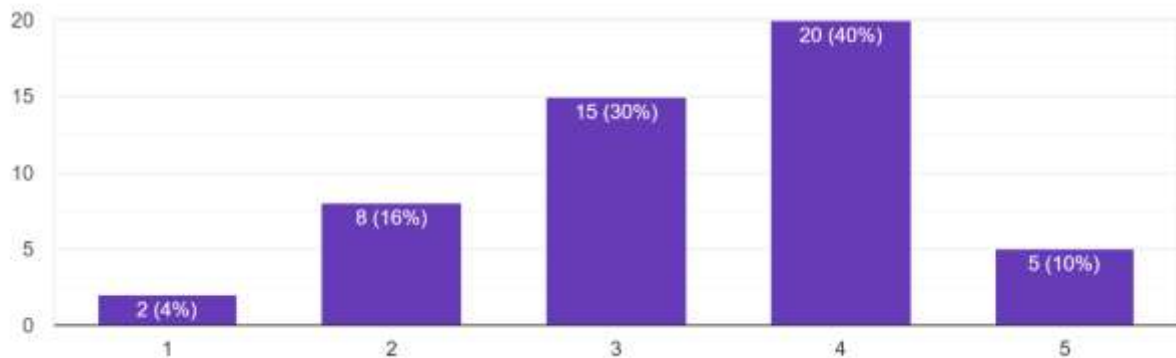


Figure 2.4.9: Question 9 of Survey Questionnaire

Figure 2.4.9 shows that the rating 1 to 5 which indicates 1(very dislike) to 5 (Very Like). In this bar chart, the respondents show their perspective on AR implementation in education. 2% of the respondent are very dislike, 16% of respondent dislike and 30% of the respondents remains neutral, 40% of the respondents likes it and 10% of respondents love it.

In general, how would you say the children will feel about AR implement in education?

50 responses

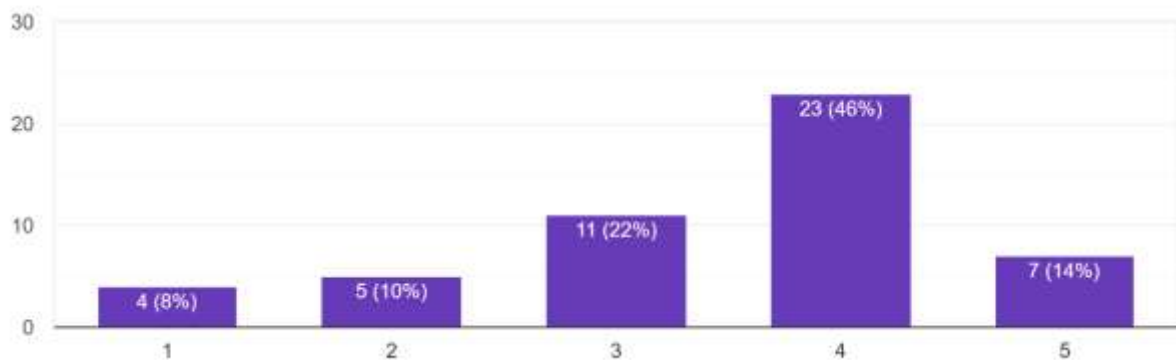


Figure 2.4.10: Question 10 of Survey Questionnaire

Figure 2.4.10 shows that the respondent perspective on how children will feel about AR implement in education. In total of 60% of the respondent felt that the children might be interested in AR learning.

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Do you think to implement AR in education can make a positive difference to the children's reading habits?

50 responses

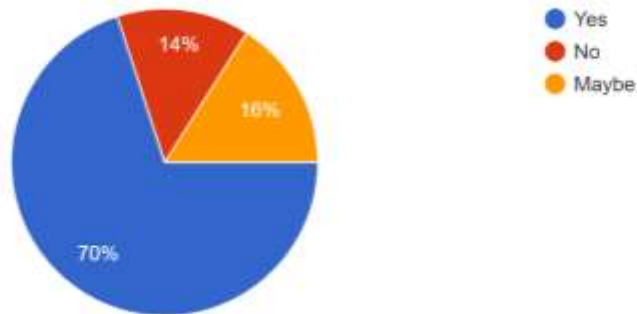


Figure 2.4.11: Question 11 of Survey Questionnaire

Figure 2.4.11 shows that 70% of the respondent felt that AR in education can make a positive difference to the children's reading habits and skills. However, 14% of the respondents does not agree with it and 16% of the respondent remains neutral.

Do you think the implementation of AR will help to motivate the children to read more?

50 responses

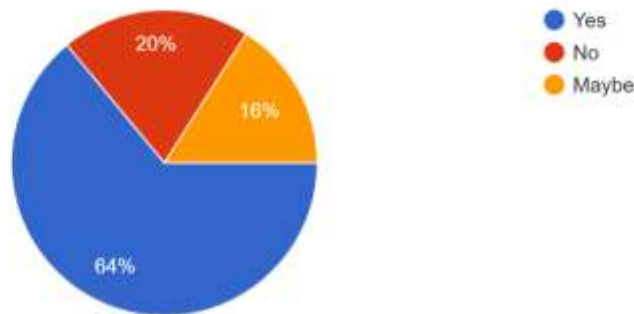


Figure 2.4.12: Question 12 of Survey Questionnaire

Figure 2.4.12 shows that 64% of the respondents felt that implementation of AR will encourage children to read more. 20% of the respondents does not agree with it and 16% of the respondents remains neutral.

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Do you think the implementation of AR will make a deep and lasting impression on the children when reading?

50 responses

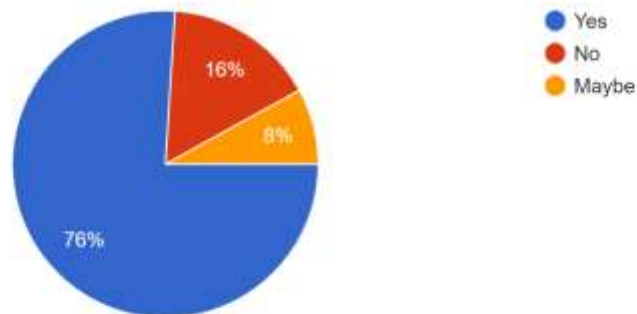


Figure 2.4.13: Question 13 of Survey Questionnaire

Figure 2.4.13 shows that 76% of the respondents agrees that AR can make a deep and lasting impression on the children when reading. However, 16% of respondents does not agree and 8% of respondents remains neutral.

Do you think which type of the storybook do you think children will have more motivation to read?

50 responses

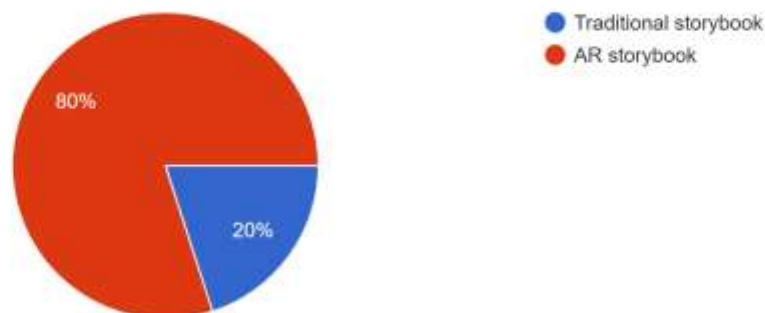


Figure 2.4.14: Question 14 of Survey Questionnaire

Figure 2.4.14 shows that 80% of respondents felt that children will probably like AR storybook compared to traditional storybook. However, 20 % of the respondents disagree with that and felt that traditional storybook is better.

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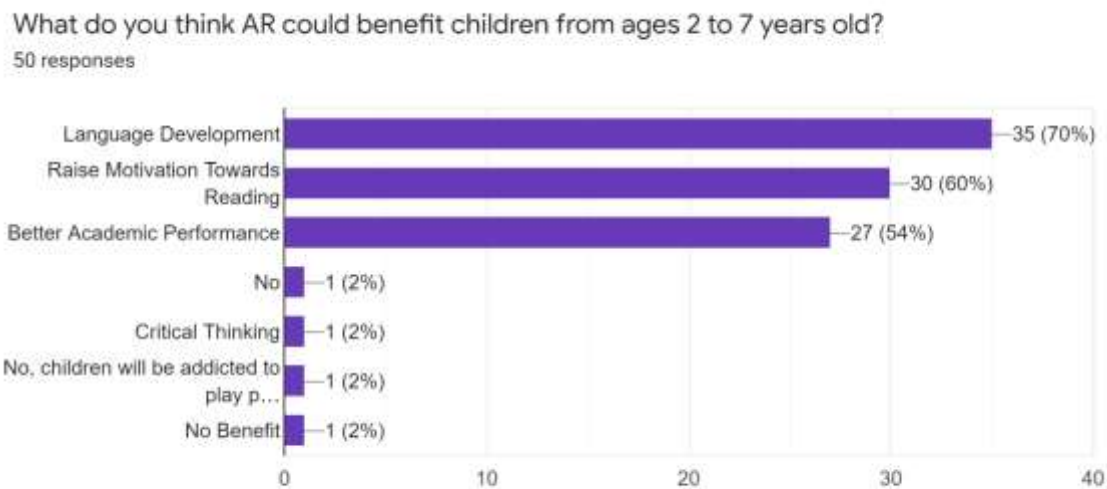


Figure 2.4.15: Question 15 of Survey Questionnaire

Figure 2.4.15 shows that the respondent's perspective on what might benefit children when they using AR storybook. 70% of the respondents felt that AR storybook able to enhance children's language development and 60% of respondent felt that, it is able to raise motivation towards Readings. 54% of the respondents felt that children will get a better academic performance. 2% of respondent felt that the children can be more critical thinking. 6% of respondent disagree all of that and felt AR does not benefit children.

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If you as a parent, would you download a similar AR storybook for your children to play with?
50 responses

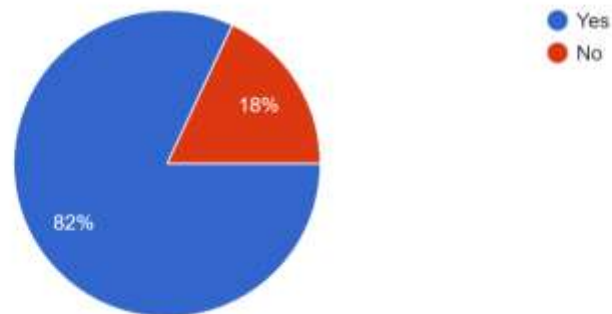


Figure 2.4.16: Question 16 of Survey Questionnaire

Figure 2.4.16 shows that 86% of respondents would download similar AR storybook for children to play with if they were parents. However, 18% of the respondents would not try to use AR storybook to learning for their children.

2.4.2 Conclusion of Analysis

Based on the survey questionnaire data the author collected, the author achieved the additional prove to problem statement in section 1.1. which traditional classrooms with using a one-way communication method are a lack of interaction between student and teacher, multimedia elements could grab more attention from children and solving the problems that children are easy to get distracted by the surrounding environment. Other than that, cultivate reading habit from youth is important. Therefore, AR Storybook can enhance children's language development, raise motivation towards reading. Play and learn are more suitable for children, therefore an interactive AR storybook could become suitable learning material for children.

Chapter 3: System Design

3.1 Overview

In this chapter, the author is going to discuss the system design, methodologies and procedures to develop the application in each phase. Furthermore, the author is using the Agile software development approach to create the application. The justification for choosing this approach for application development includes user involvement, time constraint, and project size. Agile software development usually involves 6 major phases of the process which are planning, analysis, design, implementation, testing, and maintenance. The following contents will show the detailed version of this chapter.

3.2 Methodologies and General Work Procedures

For the overall development process, the most suitable methodology applying for this project is the concept of Agile software development. Thus, the justification of choosing this approach is a process that able to produces software with quality guarantee and lowest cost which is affordable by the author. Besides that, time management is also essential and important element for this project.

By using this methodology, the developers are able to saves a great amount of time but with the task quality guaranteed because of fast development and testing (Balaji, 2012). This methodology ensures that the author's time management in an efficient way and ensures the whole phase of development is going with systematic to develop the proposed application that expected. Moreover, this methodology is capable of accommodating new changes, expectancy or enhancement occurs during the development phase without the budget constraint. Another benefit of this methodology is very flexible that the author can quicky generate some alternative plan to deal with uncertainties. Lastly, the small project size of the proposed system does fit the requirement of the agile software development which able to maximize efficiency while developing the proposed system.

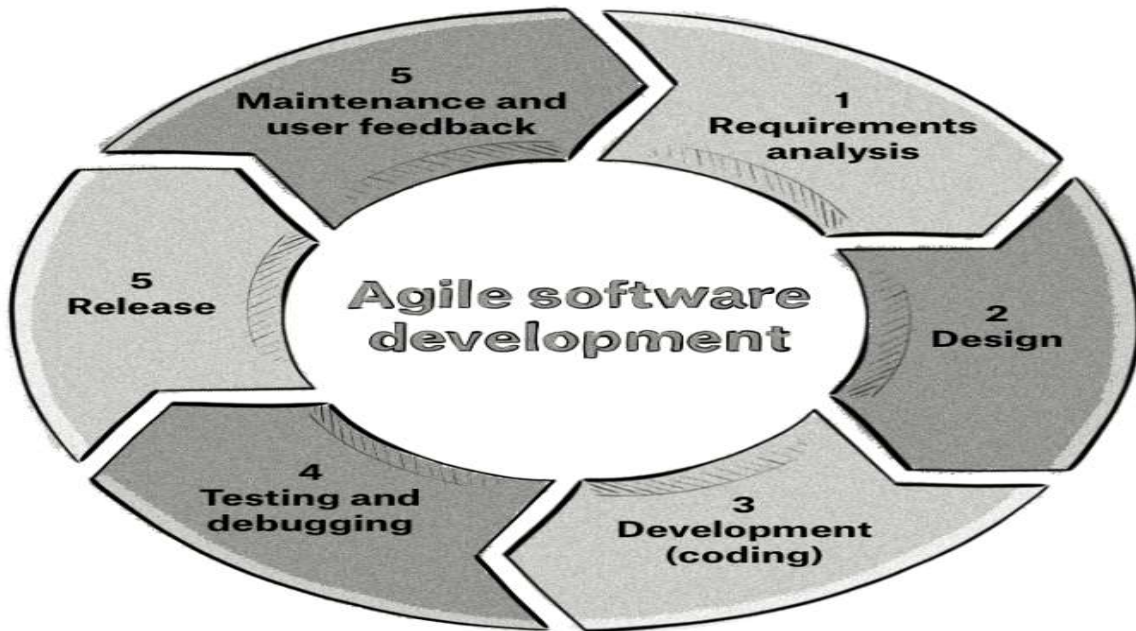


Figure 3.2.1: Agile Software Development Phases

First Phase: Planning

In the planning stage, the initial proposal is evaluated to express the problem statement, determine the project scope and come out with the project objectives. Furthermore, project timeline planning is important for the author to achieve well time management to carry out the proposed application on time. Moreover, in this stage also determined the software tools such as Unity3D to be a main software application to develop the application, Vuforia SDK to import AR tools and element in order to create a AR scene in Unity3D, and Visual Studio 2017 to generate C# script. Other than that, methods to collect reliable data for further analysis such as google form, 3D Model designing engines such as blender version 2.82, suitable programming language such as C# to use and hardware needed in order develop the proposed application.

Chapter 3: System Design

Second Phase: Requirement Analysis

In the analysis phase, a literature review is to be done on the existing similar application that fits the project scope. In the process of reviewing a similar application, their strengths and weaknesses will be recorded for analysis afterward. After analysing, a table of comparison which comparing the similar application and proposed application is generated by the author. Other than reviewing the existing application, the survey questionnaire will be designed through google form and distributed towards the target audience by the author to do further analysing on user requirement. The user feedback collected from the target audience should enable the author to understand the user requirement and inventive idea to design the proposed application.

Third Phase: Design

In the design phase, the required material such as software tools, development tools, hardware and the feedback collected from the target audience are gathered by the author to proceed to the system design. The system design will be more towards to satisfy the user's requirement that collected from the requirement phase. The blueprint of the system design will be carried out by the user. Other than that, the UML diagram and the flow of the application is created by the author to show the detailed way of each module in the proposed system.

Forth Phase: Prototyping

After the design stage, the following is the prototyping stage where the development of the prototype will begin. The function of the module specified will be developed and evaluated according to the user requirement and feedback. In the first iteration, the initial prototype is developed and allows the user to provide their feedback for the proposed application. The initial prototype is expected to consist of a vital component, such as the 3D model of the characters is created and virtually projected in an AR approach via marker-based surface.

Fifth Phase: Improvement in Upcoming Iteration

After the initial prototyping is created and tested by the user, the feedback collected from the user will take into consideration by the author to modify or improve the version tested by the user. This process will undergo several times to collect more useful user feedback for any possible system modification such as improvement of 3D model design, interface design, and improvised controls.

Sixth Phase: Implementation

Toward the end of the testing and development timeline, the proposed project's intended function which is to provide an interactive augmented reality storybook with the 3D model should be achieved for the target audience. Once the proposed application is determined to be error-free and receives satisfaction from the user, the latest prototype will be published and deliver to the target audience. At this point, the user who used the application and their feedback is collected for further updates and maintenance.

3.3 Development Tools

3.3.1 Software Development Tools

The following table shows the software tools and description of each function that used to develop the proposed application.

Software	Description
	<p>Unity 3D is a cross-platform development engine which is also compatible with Android Studio. Unity 3D is mainly used to develop the augmented reality view of the story, importing the 3D model that created in blender and merge them in to a complete AR scene.</p>
	<p>Vuforia is a free-source software development kit compatible with Unity 3D engine. Vuforia is used for the augmented reality features in tracking the marker and displaying 3D model on top of it.</p>
	<p>Blender is a 3D model drawing platform offers to developer to draw their own 3D model. Flexible for developer to add rig, animation into their 3D models.</p>
	<p>Visual Studio 2017 is an integrated and flexible development tools for developers. Visual Studio 2017 is used by the author to generate C# script for game development.</p>
	<p>Shotcut Video Editor provides many features to edit video and audio, it is simple to use and user friendly for beginner.</p>

Table 3.3.1.1: Software Tools for Development

3.3.2 Hardware Development Tools

The following table shows the hardware tools specification that used to develop the proposed application.

1. Computer Model: MSI - GE75 Raider 8RE

System	Information
Operating system	Windows 10 Home
Processor	Intel® Core™ i7-8750H
Graphic Card	Nvidia GeForce® GTX 1060
CPU	2.20 GHz
Memory (Ram)	16.00GB
System Type	64-bit operating system, x64-based processor

Table 3.3.2.1: Hardware Tools for Development

2. Mobile Phone Model: Samsung Galaxy S8 Plus

System	Information
Operating system	Android
Android version	9.0 Pie
Resolution	1440 x 2960 pixels, 18.5:9 ratio
CPU	Octa-core (4x2.3 GHz Mongoose M2 & 4 x 1.7 GHz Cortex-A53) - EMEA
Internal Storage	64 GB
Memory (Ram)	4 GB

Table 3.3.2.2: Hardware Tools for Development

3.4 User Requirement

3.4.1 User Hardware Specification Requirement

Description	Basic Requirement
CPU	2.0GHz or higher
Internal Storage	2GB
Memory (RAM)	2GB or higher
Front Camera	5MP or higher

Table 3.4.1.1: User Hardware Specification Requirement

Table 3.4.1.1 shows that the minimum requirement of user's hardware specification in order to launch the proposed application without problem or error. In order to provides a better user experience, it is recommended user has hardware with 2.0 Giga Hertz, 2GB internal storage, 2GB of memory and front camera has a 5 Mega Pixel or higher.

3.4.2 User Software Requirement

Description	Basic Requirement
Android Version	Android 6.0 or higher

Table 3.4.2.1: User Software Requirement

Table 3.4.2.1 shows that the minimum requirement of user software requirement. This application is purposely made for Android system; therefore, it is unfortunately that this application is not able to support IOS system.

3.5 System Design

3.5.1 System Flowchart Diagram

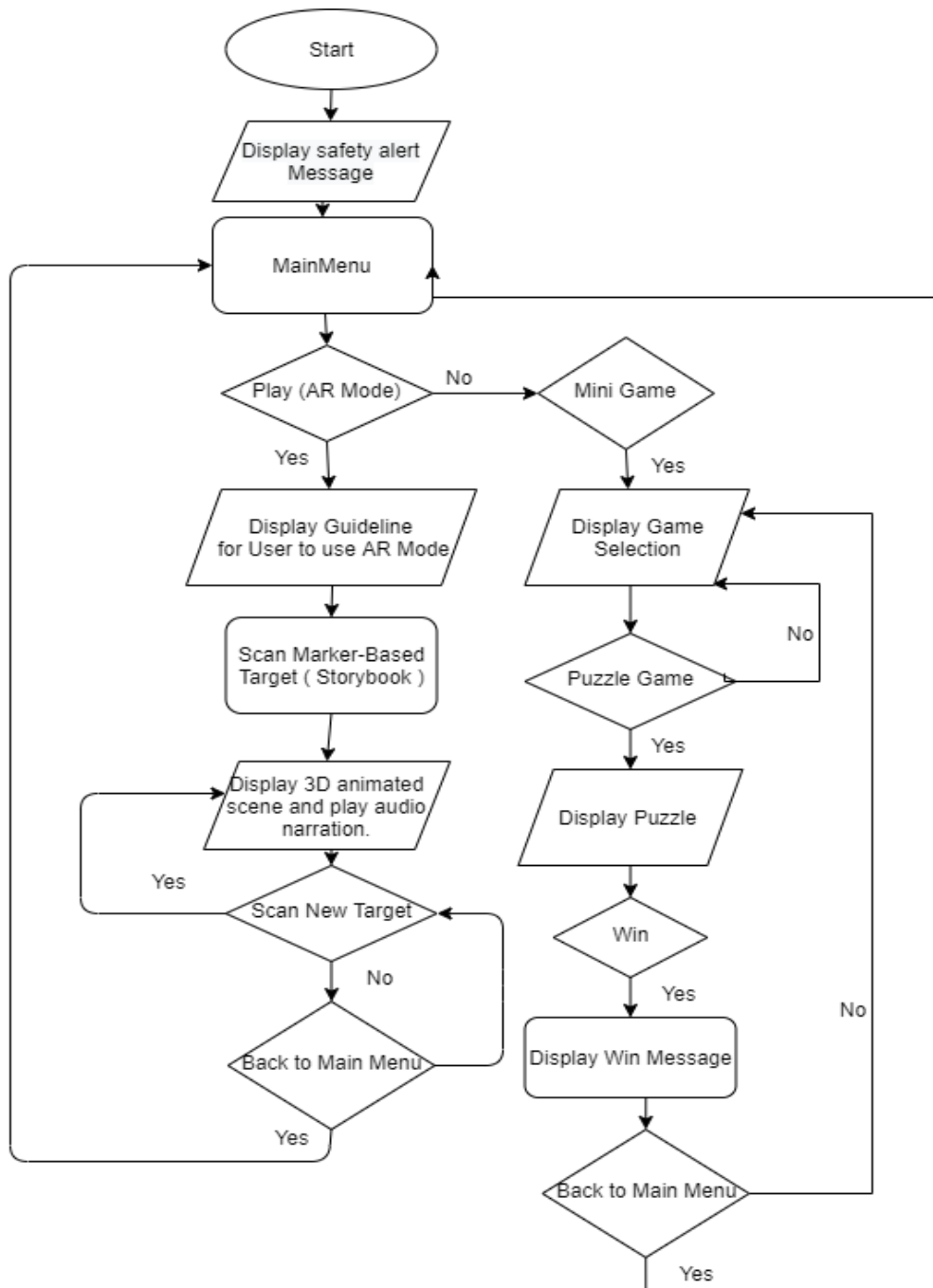


Figure 3.5.1.1 Full System Flowchart (Part 1)

Chapter 3: System Design

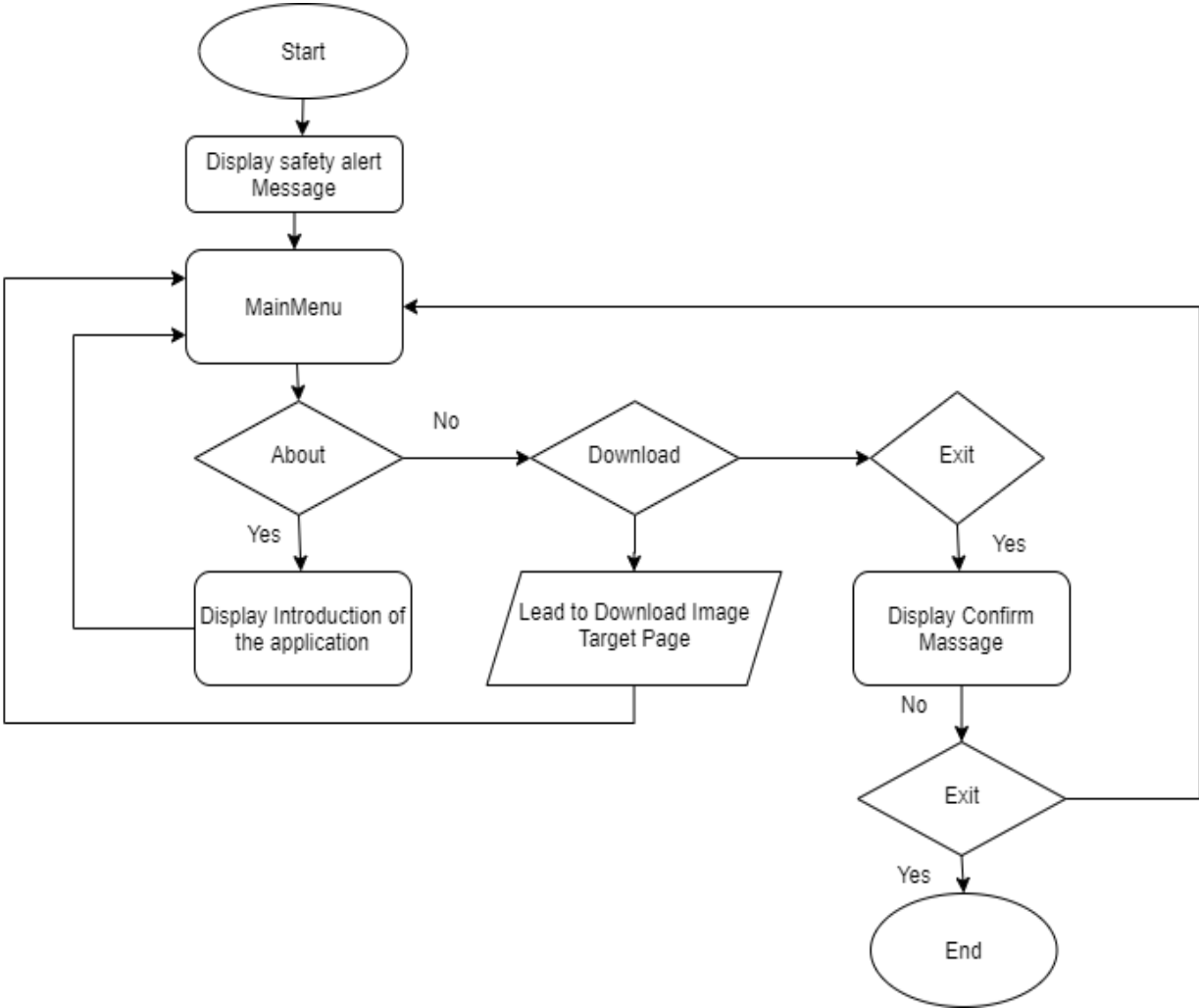


Figure 3.5.1.1 Full System Flowchart (Part 2)

Chapter 3: System Design

Visual Paradigm Online Diagrams Express Edition

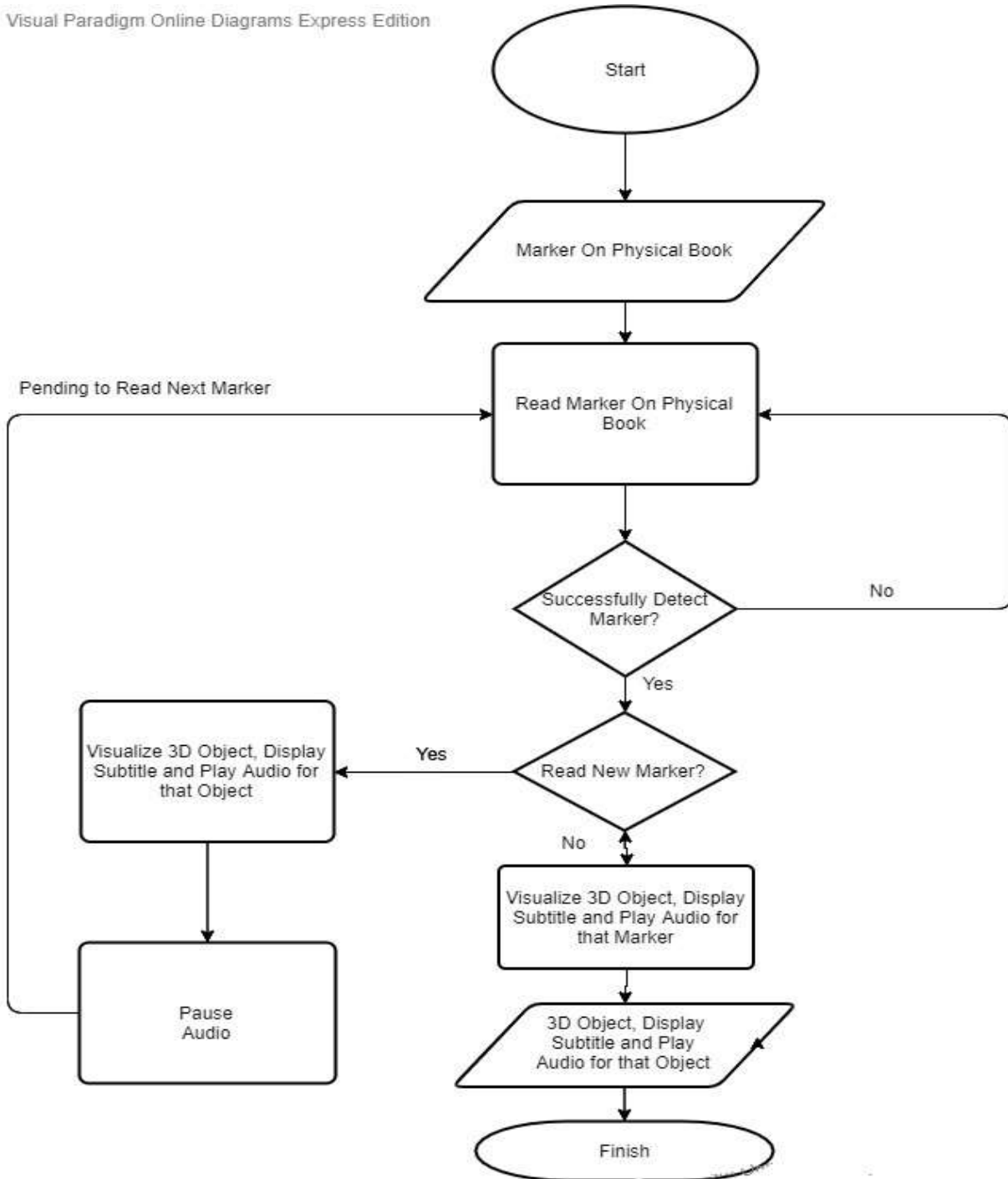


Figure 3.5.1.2: Augmented Reality function Flowchart in Detailed Version

3.5.2 Use Case Diagram

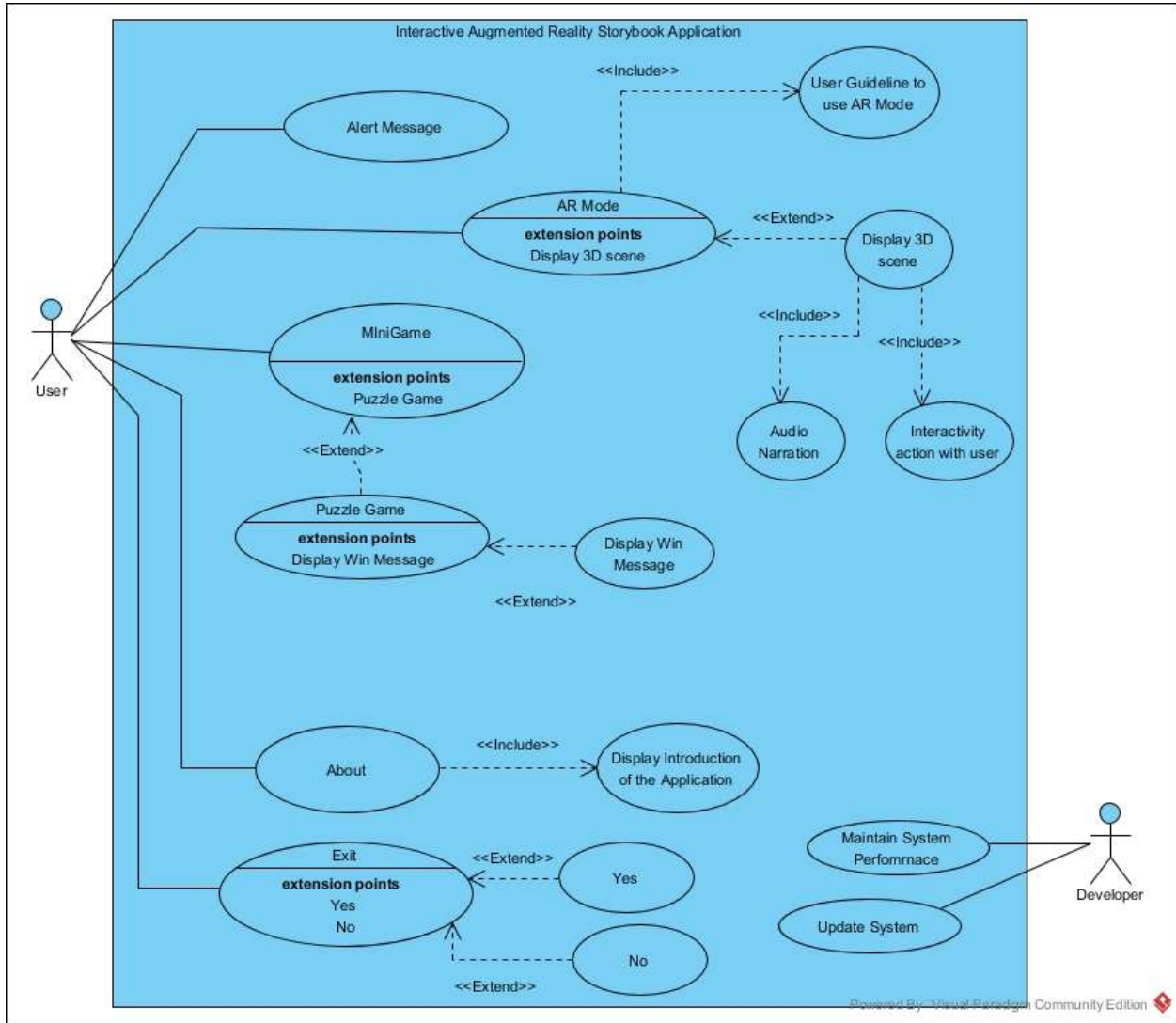


Figure 3.5.2.1: System Use Case Diagram

3.5.3 Storyboard Design

No. of Storyboard	: 1
Title of Project	: Interactive Augmented Reality Storybook for Early Childhood Education
Page Name	: Alert
Internal Link Page	: Main Menu

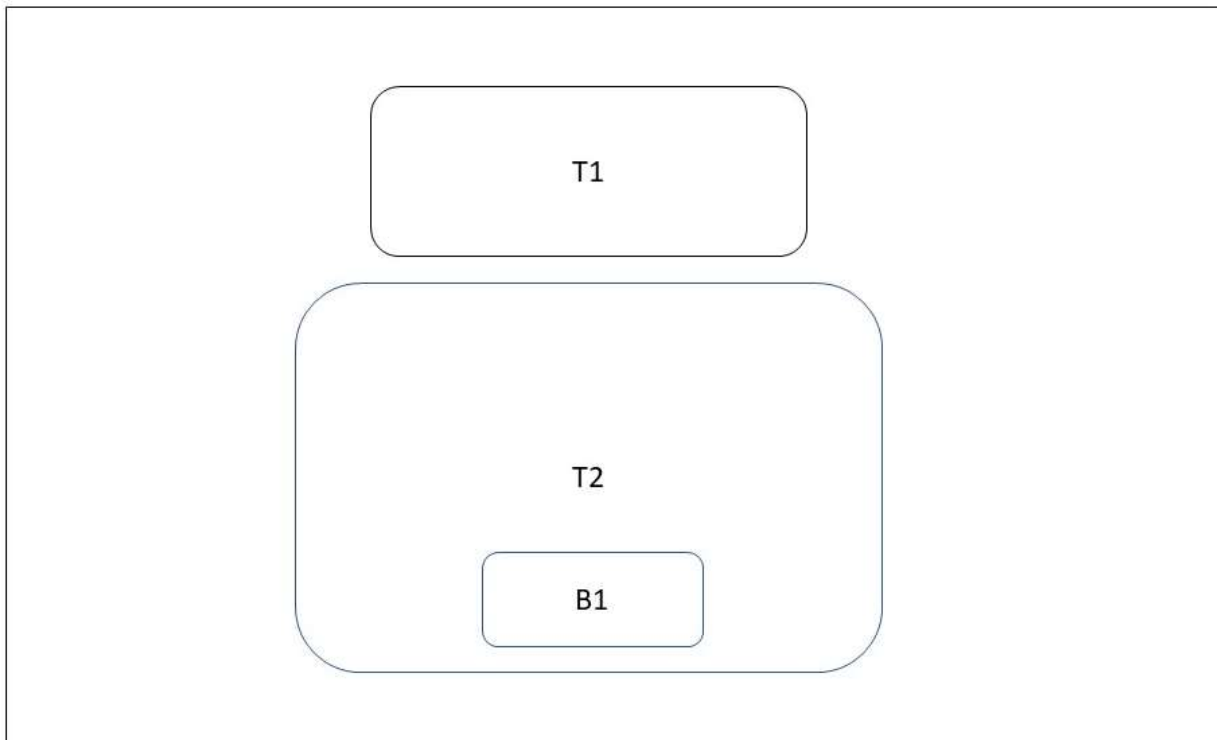


Figure 3.5.3.1: Alert Page of Application

Label	Type	Description
T1	Text	A big “Warning” text to grab user first attention.
T2	Text	Contains advice and reminder for user to stay aware of surroundings and better with parental supervision.
B1	Button	An “OK” button to ensure the user read the text and when user clicks it will enable user proceed to next interface.

Chapter 3: System Design

No. of Storyboard	: 2
Title of Project	: Interactive Augmented Reality Storybook for Early Childhood Education
Page Name	: Main Menu
Internal Link Page	: Alert, Mini Game, AR Camera, About, Exit

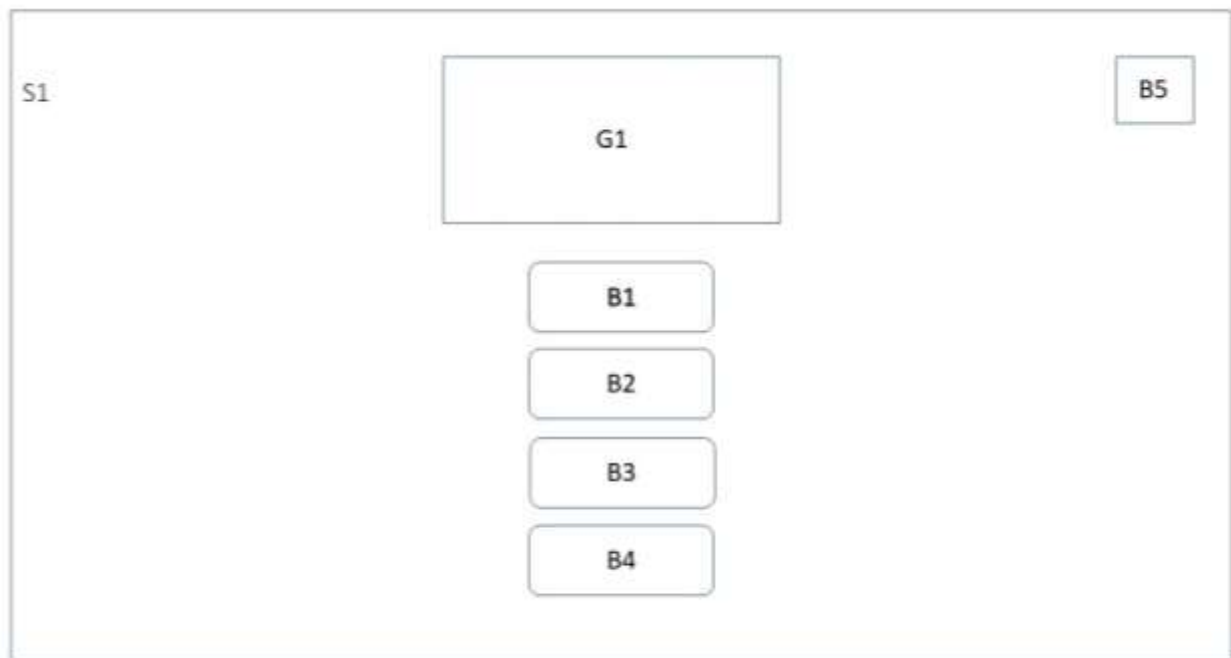


Figure 3.5.3.2: Main Menu of Application

Label	Type	Description
S1	Background	A background for application's main menu.
G1	Title	Name of the Storybook.
B1	Button	Name "Play", Link to AR camera interface.
B2	Button	Name "Mini Game", Link to Mini Game interface.
B3	Button	Name "About", Pop up About this application information
B4	Button	Name "Exit", Pop up message and ask whether user wanted to quit.
B5	Icon Button	Audio Icon, when pressed can be mute or unmute background music.

Chapter 3: System Design

No. of Storyboard	: 3
Title of Project	: Interactive Augmented Reality Storybook for Early Childhood Education
Page Name	: AR Camera
Internal Link Page	: Main Menu, Guideline

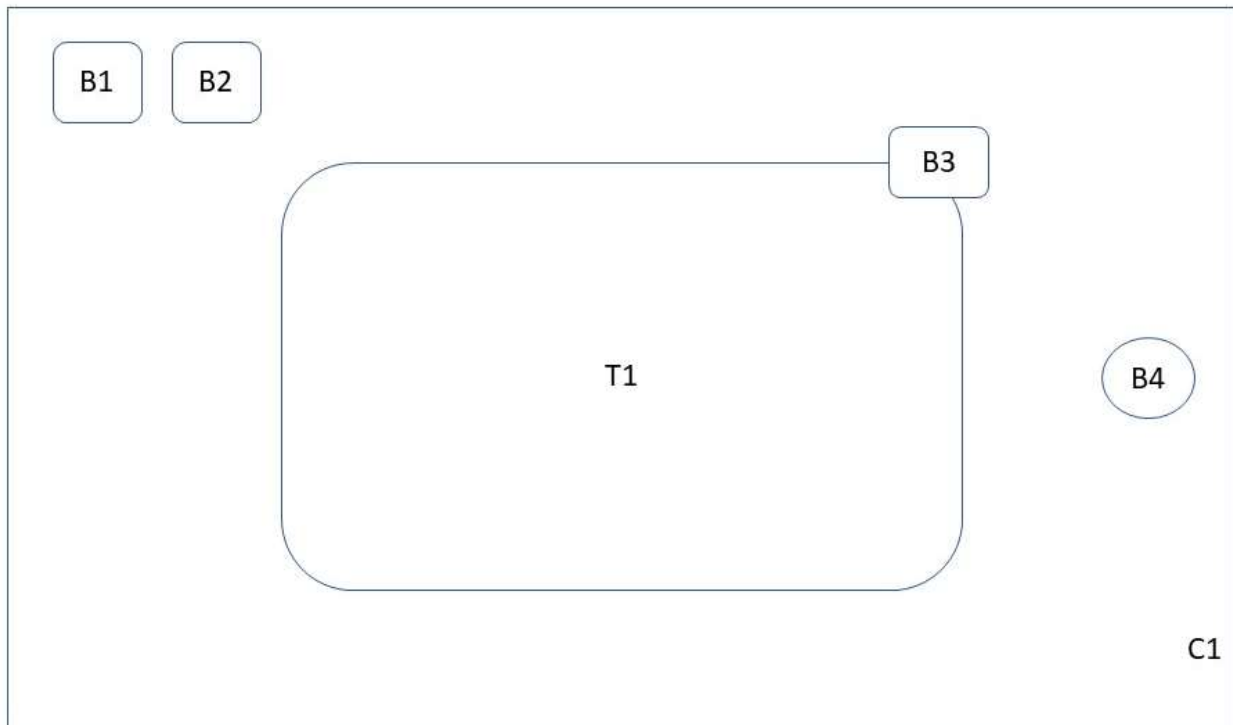


Figure 3.5.3.3: AR Camera interface of Application

Label	Type	Description
B1	Icon Button	A house icon button, brings user to main menu when clicked
B2	Icon Button	A question mark icon button, shows guideline for user when clicked
B3	Icon Button	A red cross for user when wanted to close the guideline (T1)
B4	Button	Able to do screen capture when clicked.
T1	Text	Guideline for user to use the AR Camera.
C1	Camera	Display objects on device.

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No. of Storyboard	: 4
Title of Project	: Interactive Augmented Reality Storybook for Early Childhood Education
Page Name	: Mini Game selection
Internal Link Page	: Main Menu, Puzzle Game (Easy), Puzzle Game (Hard), Maze Ball Game

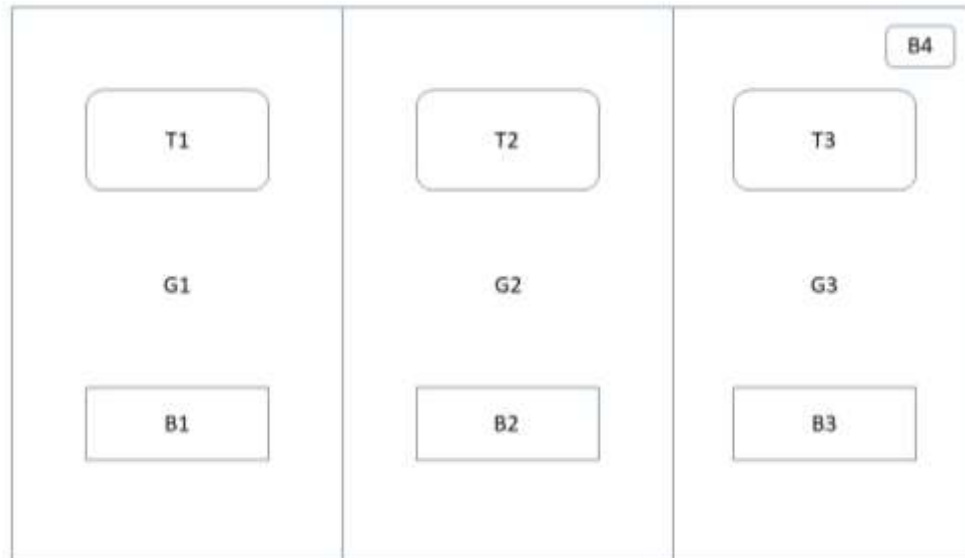


Figure 3.5.3.4: Mini Game Interface

Label	Type	Description
T1	Text	Show the difficulty of Puzzle (Easy)
T2	Text	Show the difficulty of Puzzle (Hard)
T3	Text	Show Maze Ball Game
G1	Background	Background of the Puzzle Section (Easy)
G2	Background	Background of the Puzzle Section (Hard)
G3	Background	Background of the Maze Ball Game
B1	Button	Select Difficulty (Easy)
B2	Button	Select Difficulty (Hard)
B3	Button	Select Maze Ball Game
B4	Icon Button	Alter to Main Menu interface.

Chapter 3: System Design

No. of Storyboard	: 5
Title of Project	: Interactive Augmented Reality Storybook for Early Childhood Education
Page Name	: Puzzle
Internal Link Page	: Main Menu



Figure 3.5.3.5: AR Camera Interface of Application

Label	Type	Description
B1	Icon Button	A house icon button, alter user to main menu when clicked
A1	Game	Puzzle game activity

Chapter 3: System Design

No. of Storyboard	: 6
Title of Project	: Interactive Augmented Reality Storybook for Early Childhood Education
Page Name	: About
Internal Link Page	: Main Menu

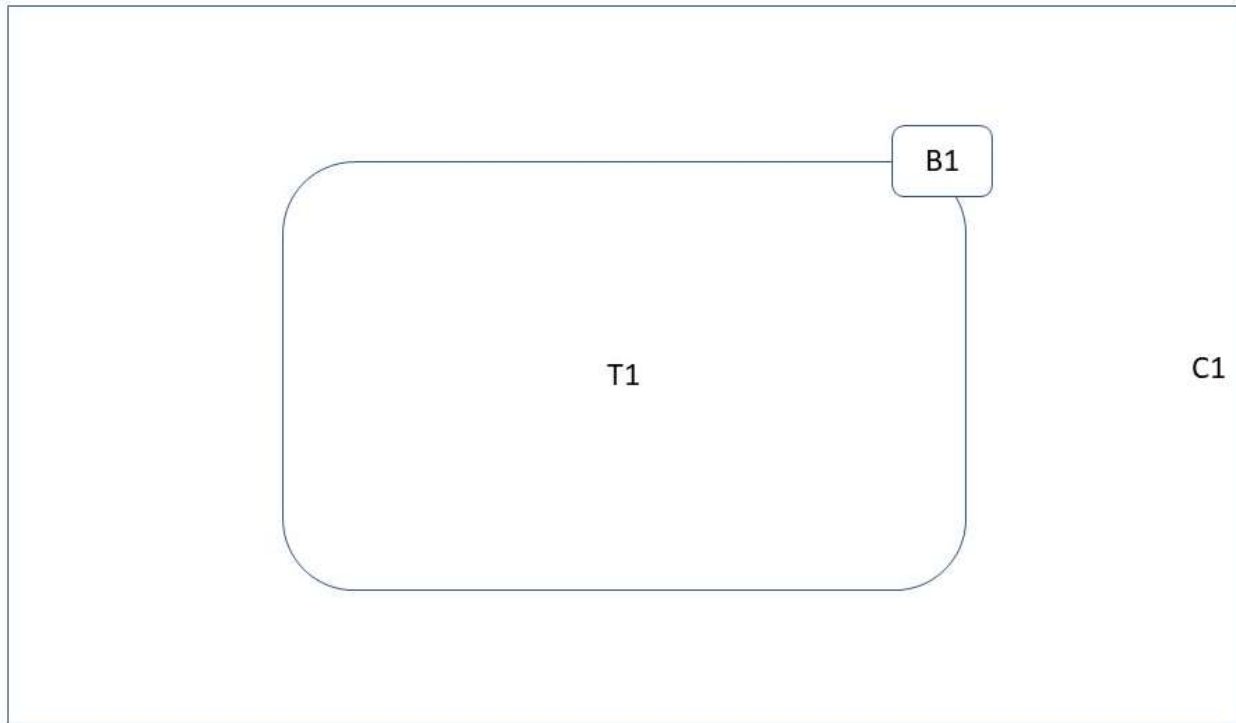


Figure 3.5.3.6: About the Application Information

Label	Type	Description
T1	Text	Text that introduce the application to users.
B1	Icon Button	A red cross for user when wanted to close the pop-up text (T1)
C1	Background	Background of the application

Chapter 3: System Design

No. of Storyboard	: 7
Title of Project	: Interactive Augmented Reality Storybook for Early Childhood Education
Page Name	: Exit interface
Internal Link Page	: Main Menu, Quit application

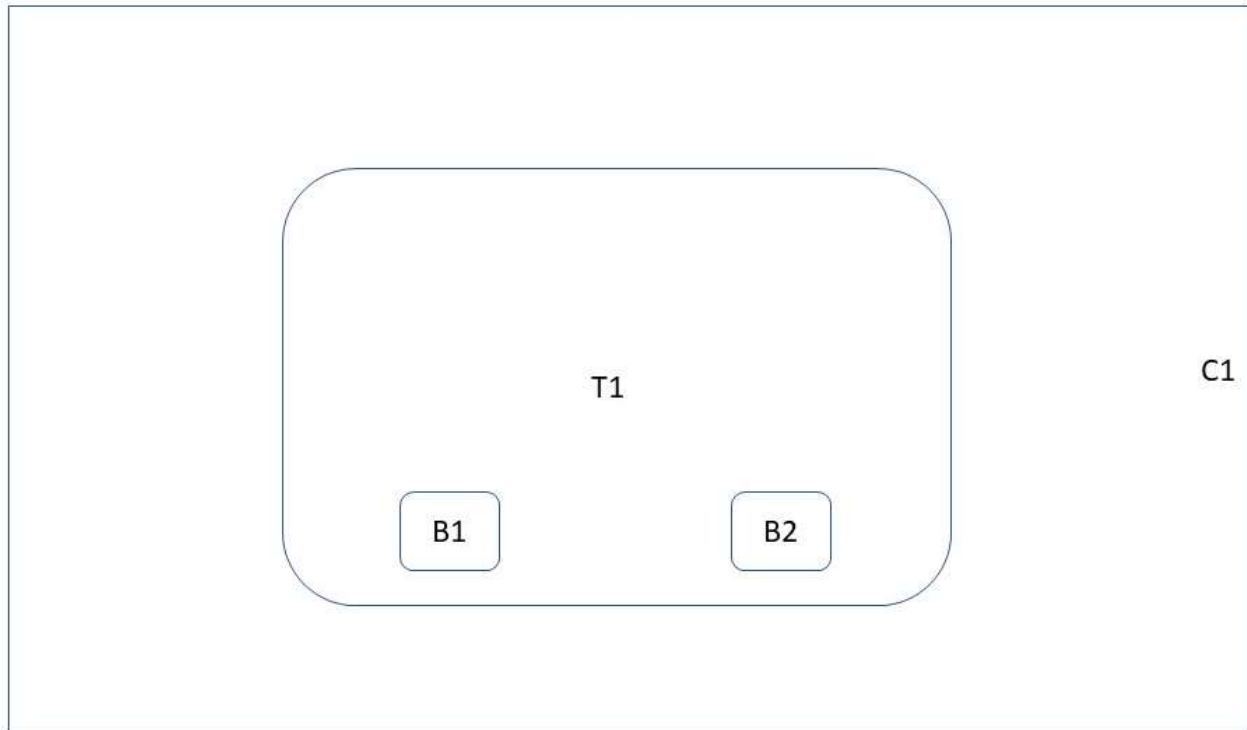


Figure 3.5.3.7: Exit Confirmation

Label	Type	Description
B1	Icon Button	A Green Tick for user when decided to quit application.
B2	Icon Button	A Red Cross for user when wanted to continue the application.
C1	Background	Background of the application.
T1	Text	Text that enquire the user whether wanted to quit or not.

3.6 Timeline of Project

Task Name	Duration	Start	Finish
Interactive Augmented Reality StoryBook (FYP1)	60 days	Mon 13/1/20	Fri 3/4/20
Phase 1 : Planning	10 days	Mon 13/1/20	Fri 24/1/20
Define Problem Statement and Motivation	3 days	Mon 13/1/20	Wed 15/1/20
Define Project Scope	3 days	Tue 14/1/20	Thu 16/1/20
Define Project Objectives	2 days	Fri 17/1/20	Mon 20/1/20
Define Impact, Significance and Contribution	3 days	Mon 20/1/20	Wed 22/1/20
Define Background Information	3 days	Wed 22/1/20	Fri 24/1/20
Phase 2 : Initial Analysis	15 days	Sat 25/1/20	Thu 13/2/20
Research	3 days	Sat 25/1/20	Tue 28/1/20
Research on Existing Similar Application	2 days	Wed 29/1/20	Thu 30/1/20
Define Development Tools	1 day	Fri 31/1/20	Fri 31/1/20
Data Collection	8 days	Sat 1/2/20	Tue 11/2/20
Critical Review of Previous Work	2 days	Wed 12/2/20	Thu 13/2/20

Figure 3.6.1: Timeline of FYP 1

Chapter 3: System Design

Phase 3 : System Design	10 days	Fri 14/2/20	Thu 27/2/20
Develop System Flowchart Diagram	2 days	Fri 14/2/20	Sun 16/2/20
Develop Use Case Diagram	2 days	Sun 16/2/20	Mon 17/2/20
Storyboard Design	7 days	Mon 17/2/20	Tue 25/2/20
Define Implementation Issues and Challenges	3 days	Tue 25/2/20	Thu 27/2/20
Phase 4 : Prototyping	17 days	Fri 28/2/20	Sun 22/3/20
Collect Multimedia Elements	5 days	Fri 28/2/20	Thu 5/3/20
Prototype Developing	12 days	Fri 6/3/20	Sun 22/3/20
Bug Fixing	12 days	Fri 6/3/20	Sun 22/3/20
Phase 5 : Implementation	5 days	Sun 22/3/20	Thu 26/3/20
Documentation Preparation for FYP1 Submission	5 days	Sun 22/3/20	Thu 26/3/20
Phase 6 : Final Implementation of Incomplete Prototype	5 days	Thu 26/3/20	Wed 1/4/20
Final Implementation	5 days	Thu 26/3/20	Wed 1/4/20
Prototype Testing	5 days	Thu 26/3/20	Wed 1/4/20
Phase 7 : Delivery of Documentation and Prototype	1 day	Fri 3/4/20	Fri 3/4/20
Submission of FYP1	1 day	Fri 3/4/20	Fri 3/4/20

Figure 3.6.2: Timeline of FYP 1

Chapter 3: System Design

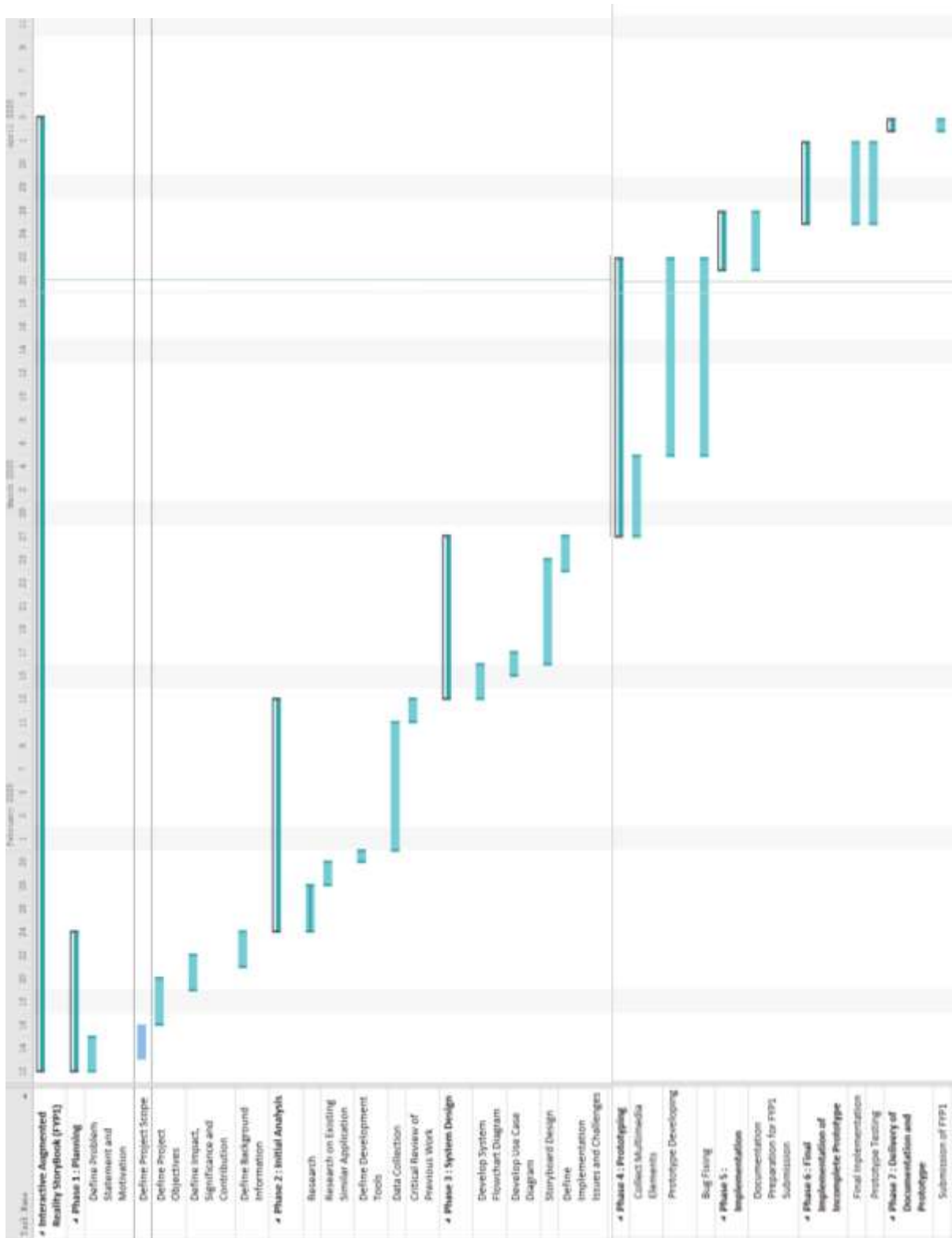


Figure 3.6.3: Gantt Chart for FYP 1

Chapter 3: System Design

Task Name	Duration	Start	Finish
Interactive Augmented Reality StoryBook (FYP2)	80 days	Mon 4/5/20	Fri 21/8/20
Development Phase	35 days	Mon 4/5/20	Fri 19/6/20
Develop Modules	15 days	Mon 4/5/20	Fri 22/5/20
Coding	15 days	Mon 4/5/20	Fri 22/5/20
Bug Fixing	5 days	Fri 22/5/20	Thu 28/5/20
Test Each Module	1 day	Thu 28/5/20	Thu 28/5/20
Intergrade All Modules	2 days	Fri 29/5/20	Mon 1/6/20
Testing the Application	2 days	Tue 2/6/20	Wed 3/6/20
Further Enhancement	12 days	Thu 4/6/20	Fri 19/6/20
Implementation	45 days	Sat 20/6/20	Thu 20/8/20
Beta Testing	2 days	Sat 20/6/20	Mon 22/6/20
Collect Feedback	2 days	Sat 20/6/20	Mon 22/6/20
Fix Bug and Proceed Further Enhancement	15 days	Tue 23/6/20	Mon 13/7/20
Application Testing	2 days	Tue 14/7/20	Wed 15/7/20
Beta Test 2.0	2 days	Thu 16/7/20	Fri 17/7/20
Collect Feedback	2 days	Thu 16/7/20	Fri 17/7/20
Fix Bug and Proceed Further Enhancement	18 days	Sat 18/7/20	Tue 11/8/20
Document Preparation for FYP2 Submission	7 days	Wed 12/8/20	Thu 20/8/20
Delivery of Documentation and Application	1 day	Fri 21/8/20	Fri 21/8/20
Submission of FYP2	1 day	Fri 21/8/20	Fri 21/8/20

Figure 3.6.4: Timeline of FYP 2

Chapter 3: System Design



Figure 3.6.5: Gantt Chart of FYP 2

Chapter 4: Preliminary Work in FYP 1

4.1 Description of Preliminary Work



Figure 4.1.1: Warning Sign to use the Application

Figure 4.1 shows a warning sign in the application. This sign will firstly come out when the user runs the application right after the splash screen. The sign is mainly to remind the user to be careful and stay aware of surroundings before using this application. This is very important that the user should always look after themselves about their surroundings while using any of AR application. Other than that, these signs also advise that the application is required parental supervision. After clicking the “OK” button will, therefore, go into the main page of the application.



Figure 4.1.2: Main Menu of Proposed System

Figure 4.2 shows the Main Menu of the application system. The main menu consists of 4 buttons which are “PLAY”, “MINI GAMES”, “ABOUT” and “EXIT”. Each button will perform a different action which will link into the following page or scene. Other than that, the author is including background music in the main menu. The application is using horizontal view to display the user interface.

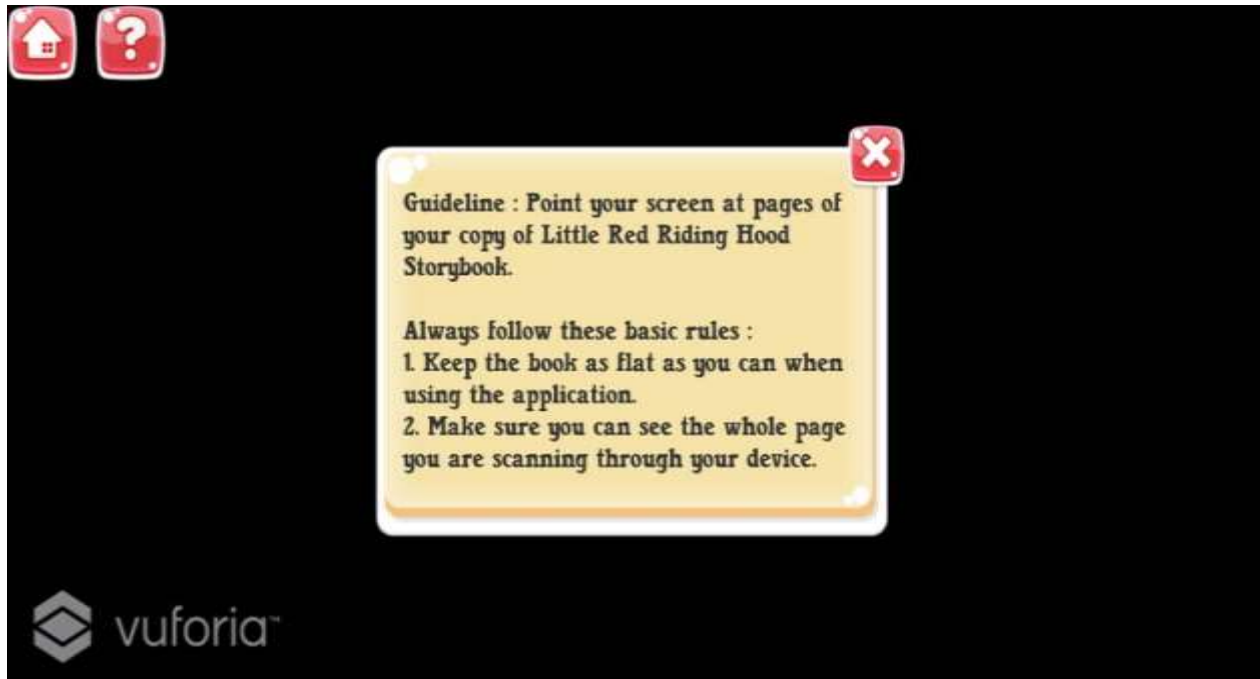


Figure 4.1.3: Guideline to use the AR camera

Figure 4.4 shows that if the user clicks on the “PLAY” button, the application will open the AR camera for the user to scan on the marker. Other than that, on the top left corner of the AR camera appears 2 icons. The house button will perform action that link back to the main menu page and the other question marks button will perform show the guideline about basic information on how to use the AR camera for the user.



Figure 4.1.4: 3D model appears on the marker

Figure 4.4 shows that when the AR camera successfully detects the marker, the 3D model will be displayed on the screen. However, the author is currently not finished the scene based on the storybook. This part will be carried on to FYP2 to complete the flow of story.



Figure 4.1.5: “About the Application” Button

Figure 4.5 shows that the “About” button information. If the user clicks on the “About” button, this message will pop up.



Figure 4.1.6: Exit button in the Application

Figure 4.6 shows that the “Exit” button on the main menu. If the user clicks on the exit button, this message will pop up and ask whether the user really wanted to exit.

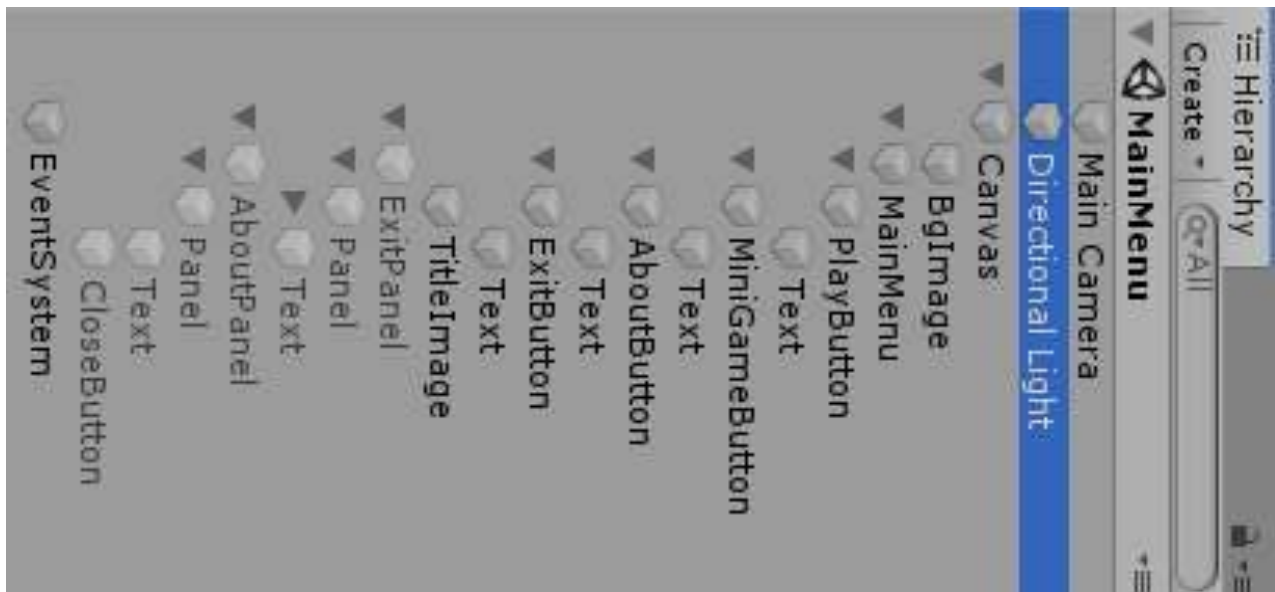


Figure 4.1.7: Hierarchy of the Main Menu

4.2 3D-Model Design

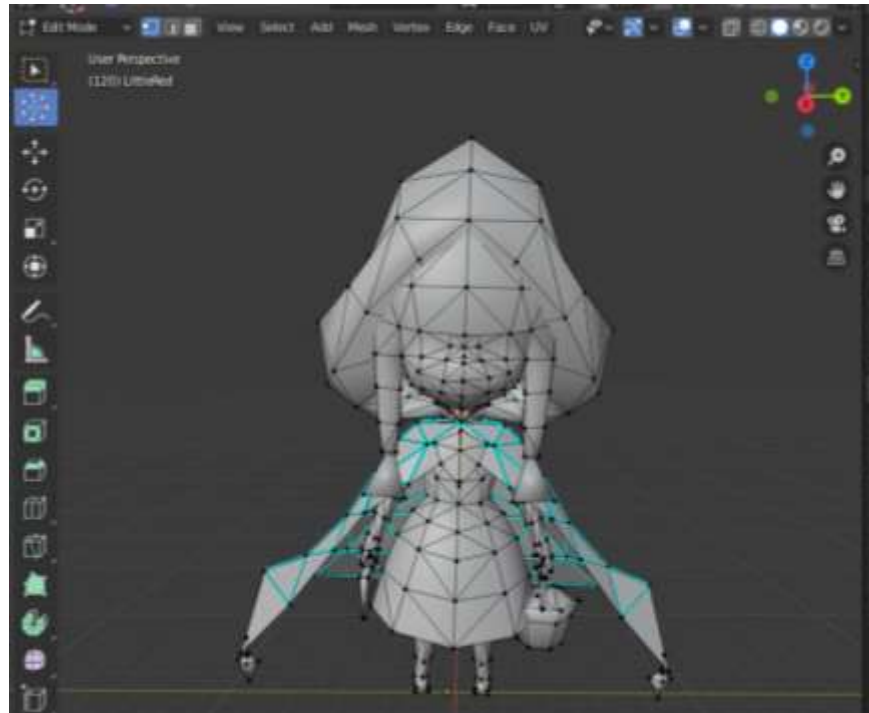


Figure 4.2.1 Creating and designing of the 3D character using Blender 2.82



Figure 4.2.2 Rigging the 3D model using Blender 2.82

Blender 2.82 is a software to create 3D models and animation for developers. Flexible for developer to add rig, animation into their 3D models. This is the 3D model of the story's main character named "Little Red Riding Hood". After finished the 3D model mapping, the author is adding bone into the 3D model in order to generate animation. Furthermore, the author is required to create texture for the character.

Chapter 5: System Development and Implementation

5.1 Marker-Based Target and 3D Models Creation

5.1.1 Storybook Selection as Marker-Based Target and Audio Extraction

First of all, before the author proceed to development phase, the marker-based target is the essential element of this project. The author had selected a storybook which is “Little Red Riding Hood” publish by Award Publication Ltd. The justification of selecting this storybook is that the target audience of this application is student who is in early childhood education and aged can be specify at two to seven years old. Other than that, the content of the story is suitable to the target audience to read and it can help children encourage and develop reading skills and confidence.

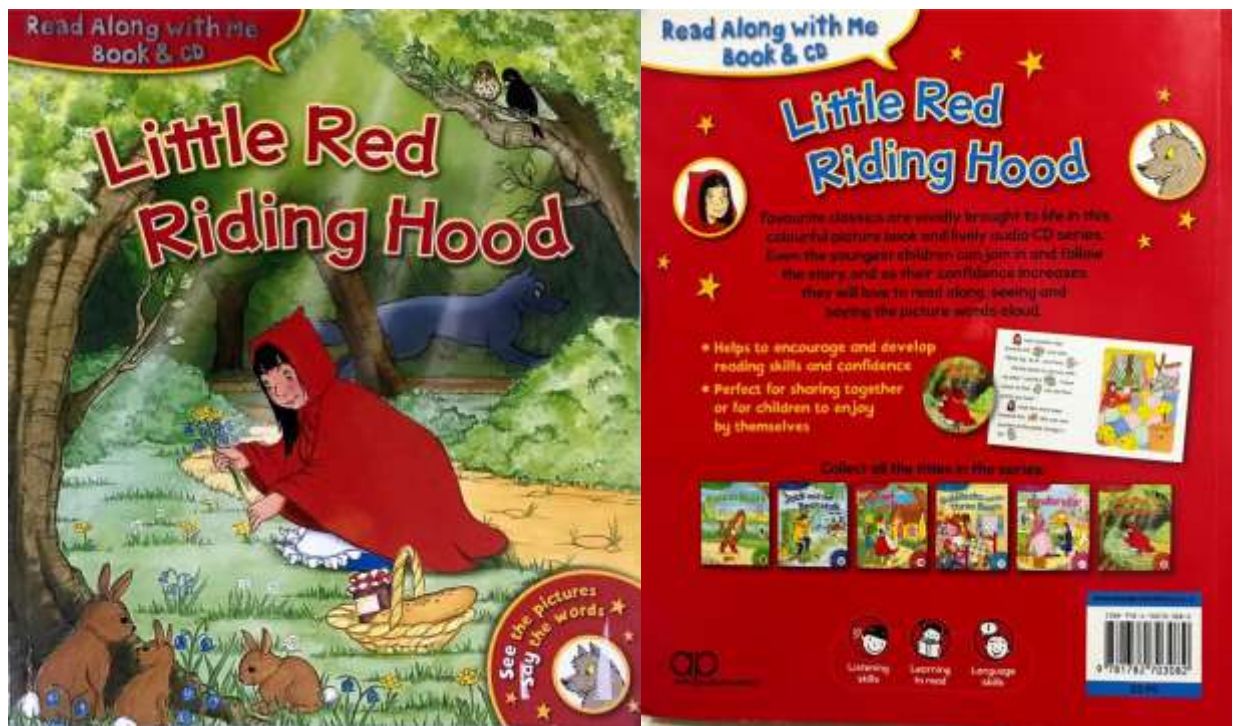


Figure 5.1.1.1 Image of Selected Storybook for Proposed Application

Figure 5.1 shows that the front page and last page of the storybook. The storybook contains 22 pages and inside it contains 10 pages of pictures which can be set as the marker-based target for the application. The author will turn these 10 pages of pictures into 10 Augmented reality scenes by using Unity3D game engine.

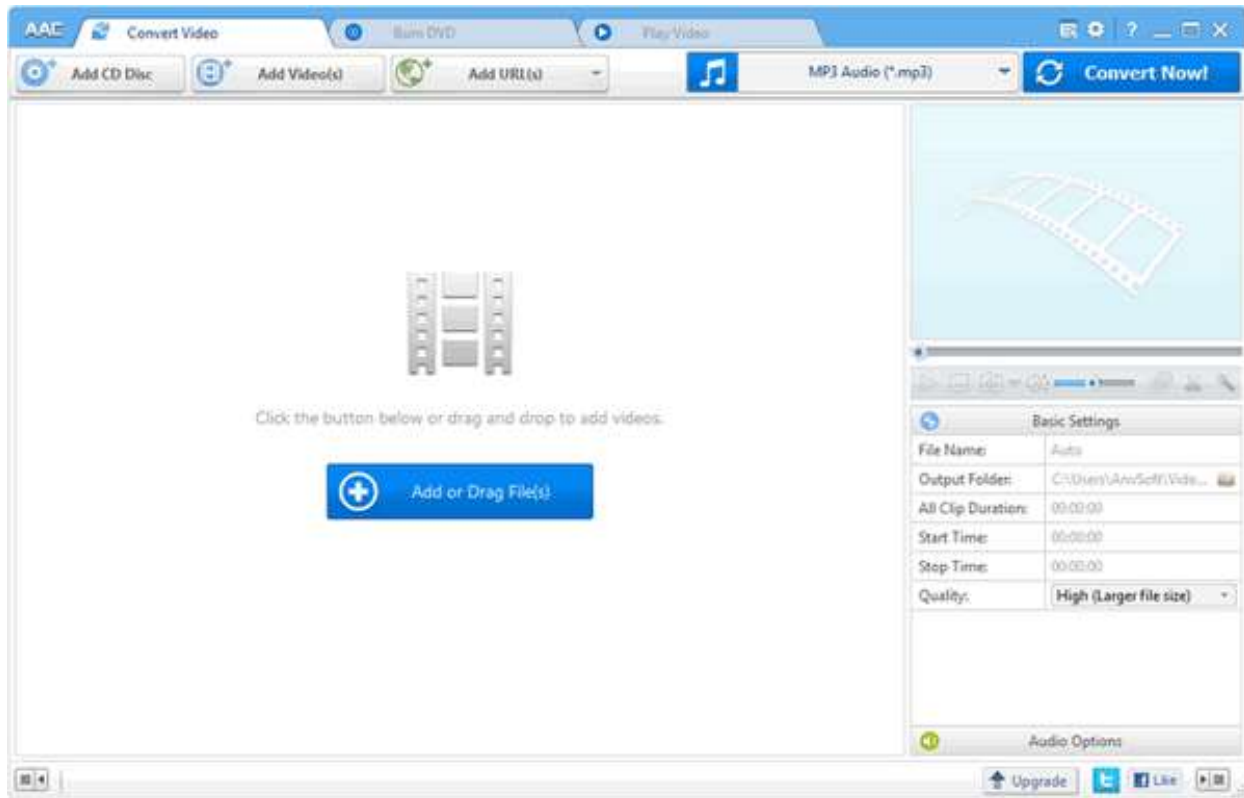


Figure 5.1.1.2 Main Interface of Any Audio Converter Software

Other than that, this storybook provides a CD that contains the audio of narration but it is in .cda format. As an information, .cda format can only run when the CD is attached in the CD-Room. However, the author's laptop does not have an CD-Room therefore the author converted the .cda file format to MP3 file format using the software "Any Audio Converter". This software is very user friendly and simple to use, just drag the audio file into it and select the output file to download. The figure 5.2 shows the main interface of the software.

5.1.2 3D Model Construction

The author is using Blender Ver.2.82a to construct the 3D model. Blender is a flexible and had numerous of fantastic features to make your 3D model become more realistic, beautiful and others. However, this software is not very user-friendly for beginners. The author spends many weeks to get used to it. Hopefully, there is many online tutorials to guide the author.

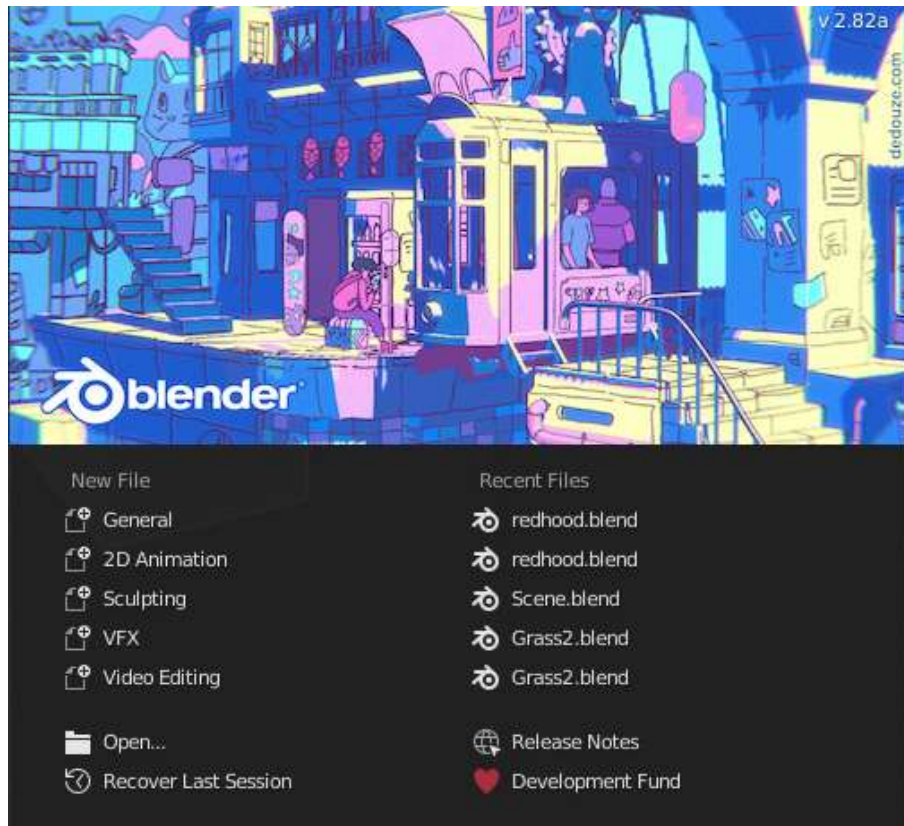


Figure 5.1.2.1 Main Menu of Blender Software

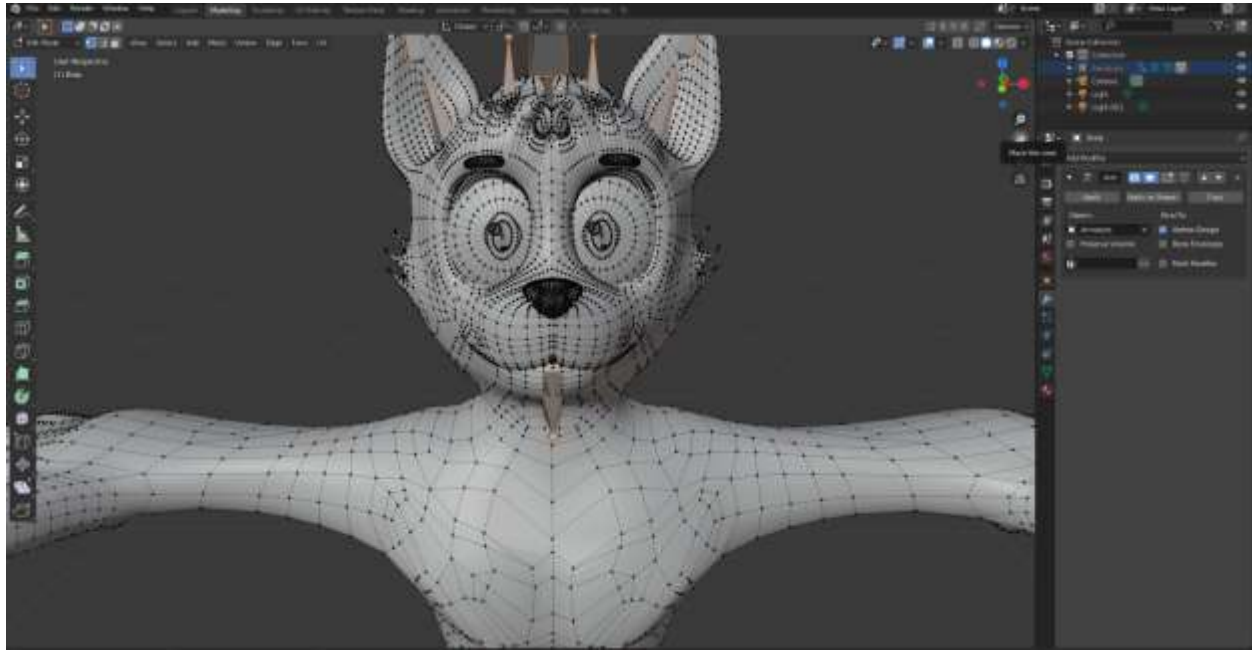


Figure 5.1.2.2 Modelling using Blender Software

Figure 5.1.2.2 shows the model that modelling using blender software. It is a wolf and also one of the characters in the story. The model is designed at a T-shape of posture because it is easy for rig the model. After finish the modelling, 3D model can be also do texturing in blender. After that, the author will add bones into it, this action makes the 3D model able to move which can later become an animation. The author will only show one of the 3D models in this report. The detailed way to construct a proper 3D model can be found at online tutorial.

5.2 Unity3D Game Engine and Vuforia SDK Setup

5.2.1 Unity3D

The author's Unity is in version 2018.4.11f1, please note that any different user interface in Unity might be because of different version of Unity. The proposed application is designed for Android system; therefore, it is needed to setup in Unity before starting to do the scene. The author will provide a guide on how to setup in Unity3D.

Firstly, In Unity, opens build setting where you can press CTRL+SHIFT+B or go to File > Build Setting to open. Secondly, select Android in Platform and clicks switch platform. Another important thing is that, windows operating system is unable to build IOS system, do not try to build on IOS. The consequences might be heavy, files can be deleted and unable to recover back.

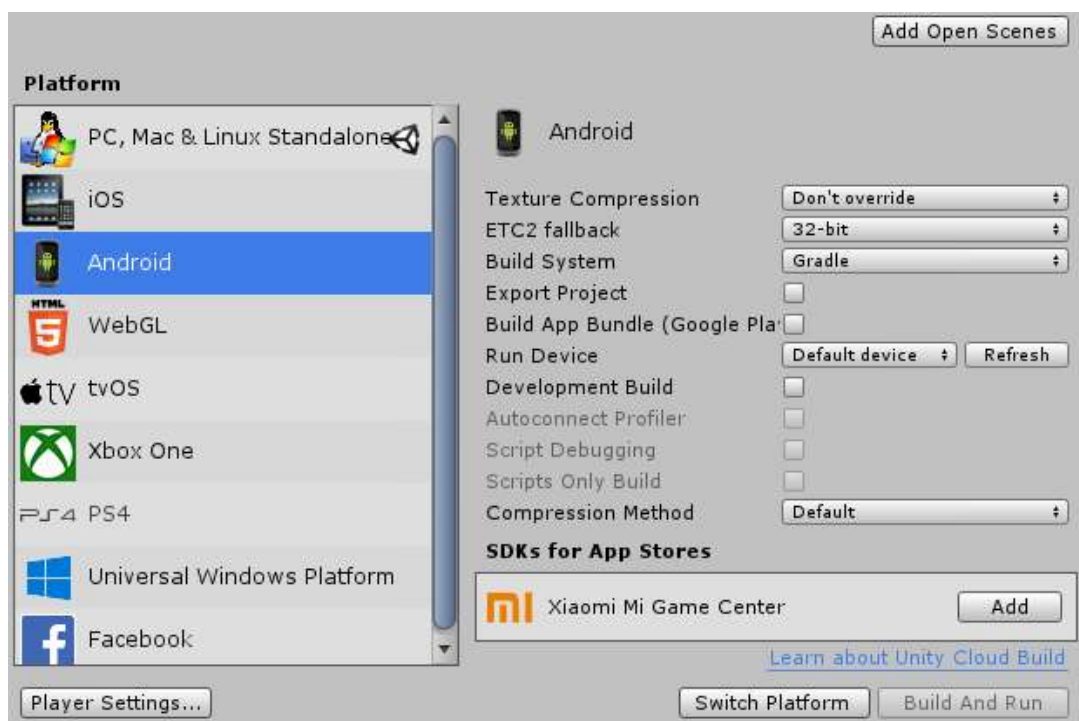


Figure 5.2.1.1 Unity Platform Setup.

5.2.2 Import VuforiaSDK and Plugin into Unity

In order to build Augmented Reality project by using Unity3D, it is better that using Vuforia SDK plugin. Access to <https://developer.vuforia.com> download the Vuforia SDK from the website. After that, go to File > Build Settings > Player Settings > XR Settings and select/tick Vuforia Augmented Reality Supported to activate Vuforia Engine.

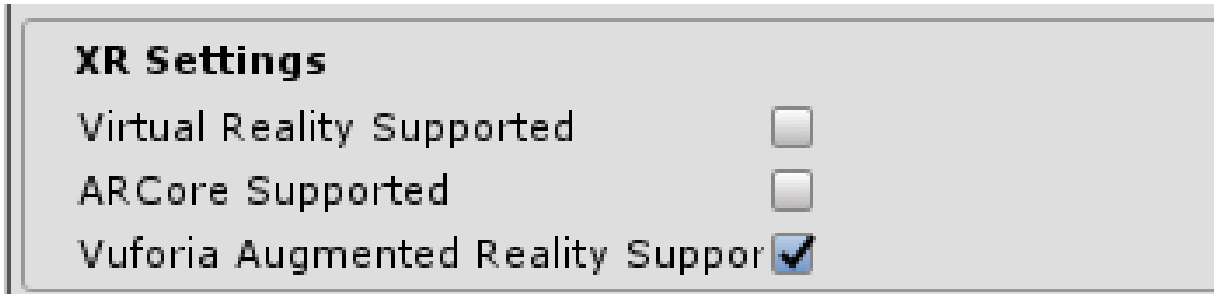


Figure 5.2.2.1 Activate Vuforia Engine in Unity

5.2.3 Setup for Player Setting in Unity

Player Setting is basically configuring the icon Image, Product Name and Company Name of your project. First go to File > Build Settings > Player Setting and fill in the information. Example below shows that the author configuration.

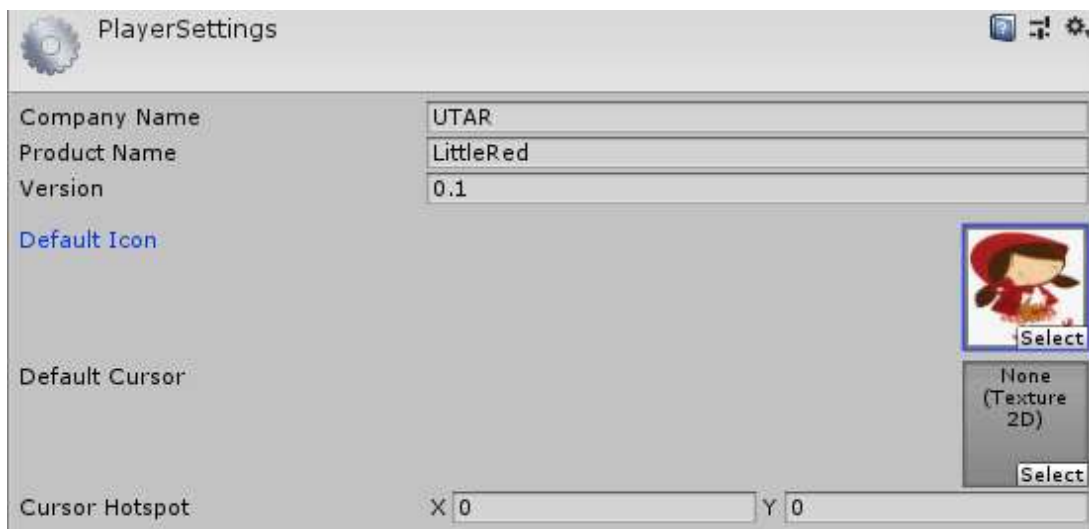


Figure 5.2.3.1 Player Setting Setup in Unity3D

5.3 Vuforia License and Setup Image Target

5.3.1 Obtain Vuforia License

Vuforia License is another essential element in order to use the VuforiaSDK in Unity. Firstly, create an account in <https://developer.vuforia.com> if you are first time user, otherwise sign in and generate a development license key for the application. In the website, Go to Develop > License Manager > and Get Development Key. After successfully generated development key will result in the figure below.

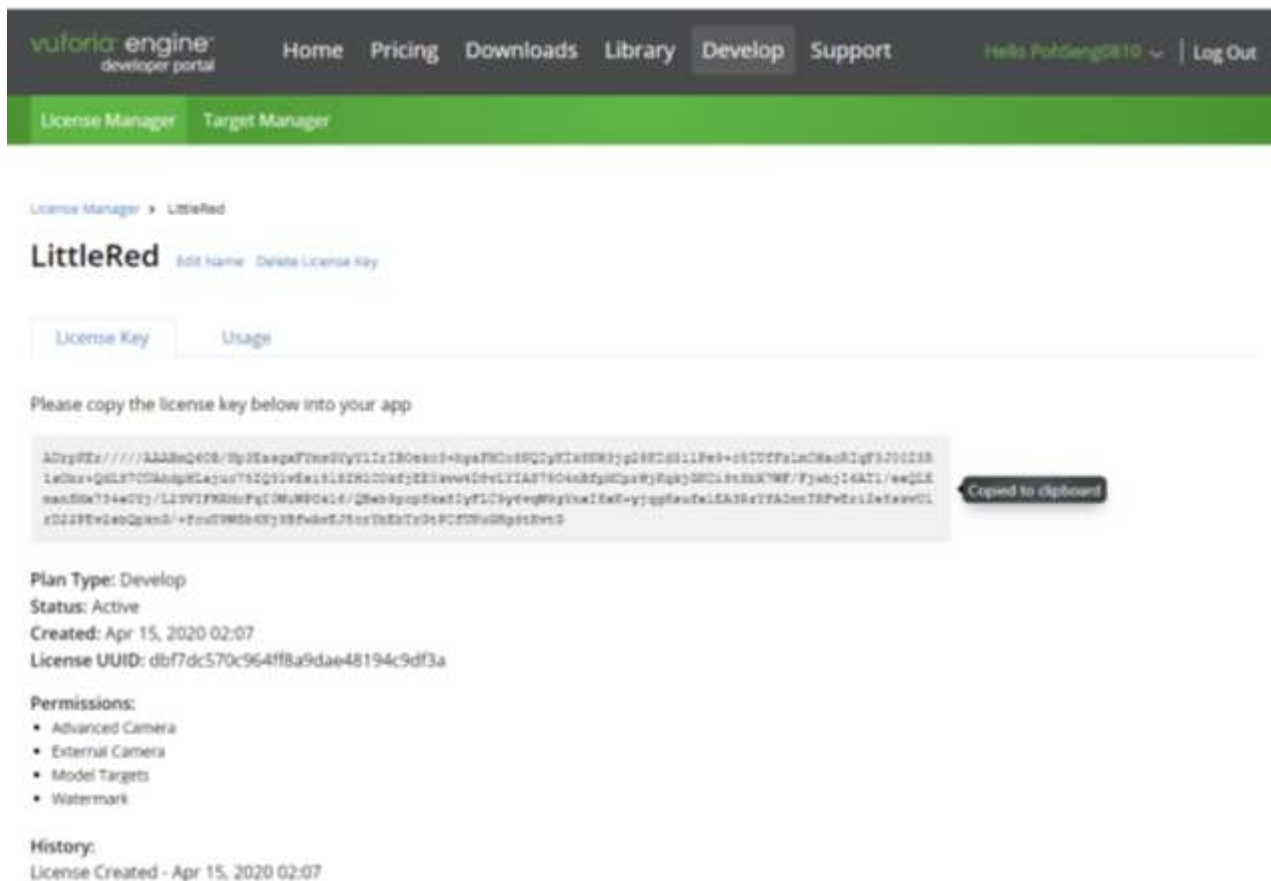


Figure 5.3.1.1 Vuforia Engine Developer Portal – Generate License

Figure 5.3.1.1 shows that the auto generated license key. Next, copy the license key generated by the website and follow the following steps and image to paste in Unity3D.

5.3.2 Input License Key in Unity3D

After created the license key, copy the generated license key and paste in Vuforia configuration in Unity3D. In Unity, Go to Windows > Vuforia Configuration or CTRL+SHIFT+V and paste the copied license key in “App License Key” section.

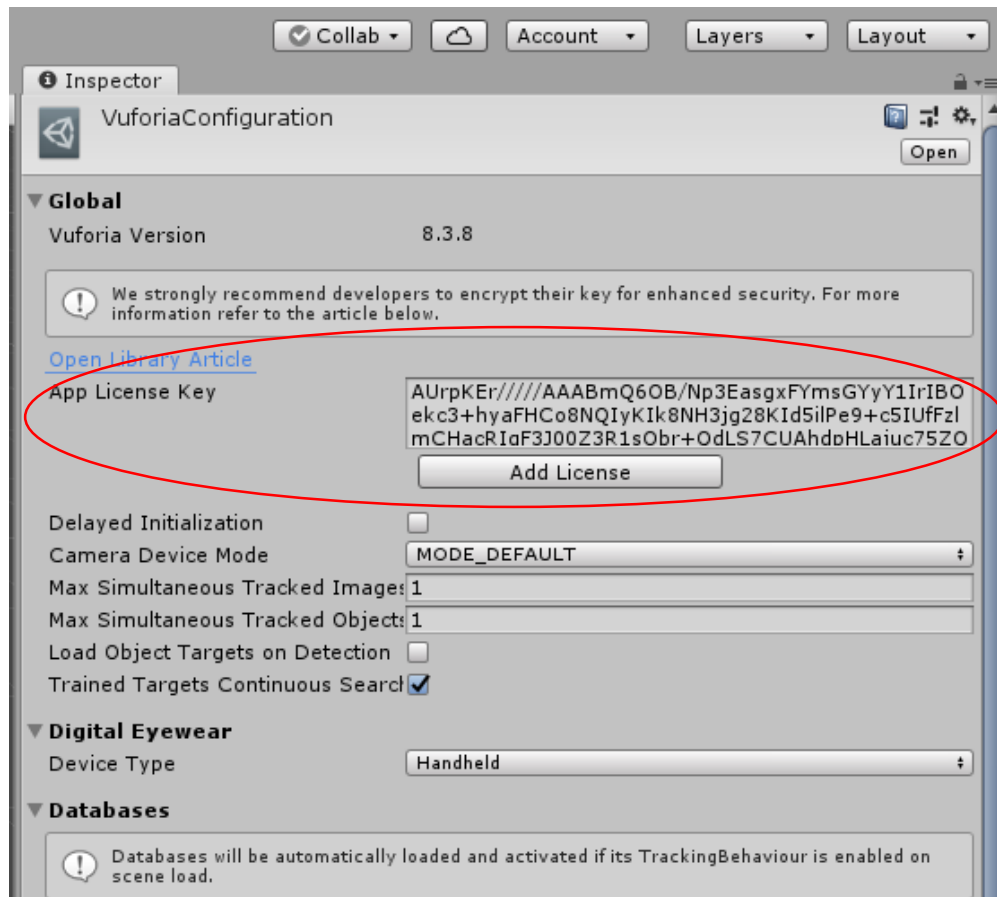


Figure 5.3.2.1 Vuforia Configuration in Unity3D – Paste App License Key

5.3.3 Add Image Target in Vuforia Database

First, sign in to <https://developer.vuforia.com> and click on Develop > Target Manager > Add Database. Create a database in Vuforia which used to store the image as the marker-based target.

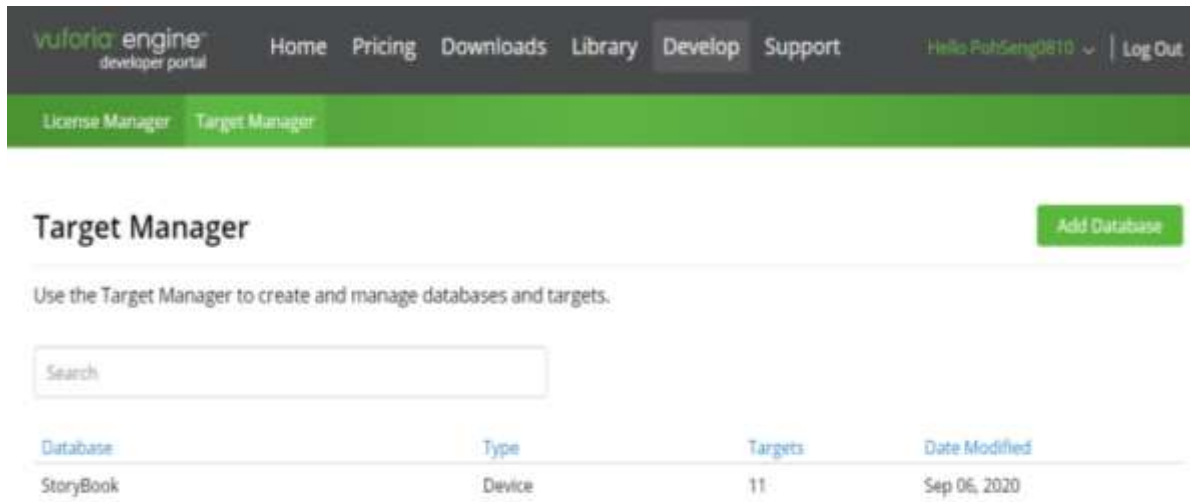


Figure 5.3.3.1 Vuforia Engine Developer Portal – Create Database

After created the database, click the database you created and hit “Add Target” where you can upload the image you wish to use as marker-based target to do Augmented Reality project.

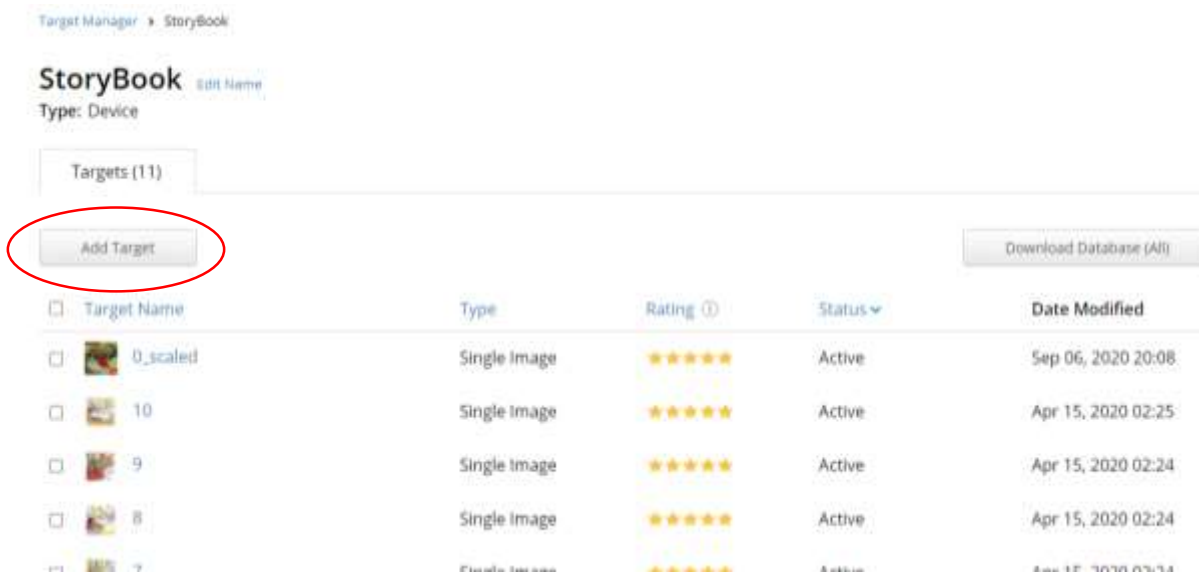


Figure 5.3.3.2 Vuforia Engine Developer Portal – Add Image Target (1)

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When click on Add Target, this interface should come out. It is recommended to upload .PNG and .JPG file format. Secondly, it is important that you need to set the “Width” to 1 and type the image name. After finished fill in the information, click on “Add” and the image is successfully uploaded in Vuforia database.

Add Target

Type:

Single Image Cuboid Cylinder 3D Object

File:

Choose File Browse...

.jpg or .png (max file 2mb)

Width:

1

Enter the width of your target in scene units. The size of the target should be on the same scale as your augmented virtual content. Vuforia uses meters as the default unit scale. The target's height will be calculated when you upload your image.

Name:

Example

Name must be unique to a database. When a target is detected in your application, this will be reported in the API.

Cancel Add

Figure 5.3.3.3 Vuforia Engine Developer Portal – Add Image Target (2)

5.3.4 Download Vuforia Database and Import in Unity

After finished adding all the image target, download the database from the website and import it into Unity3D so that you can use the Image target in Unity.

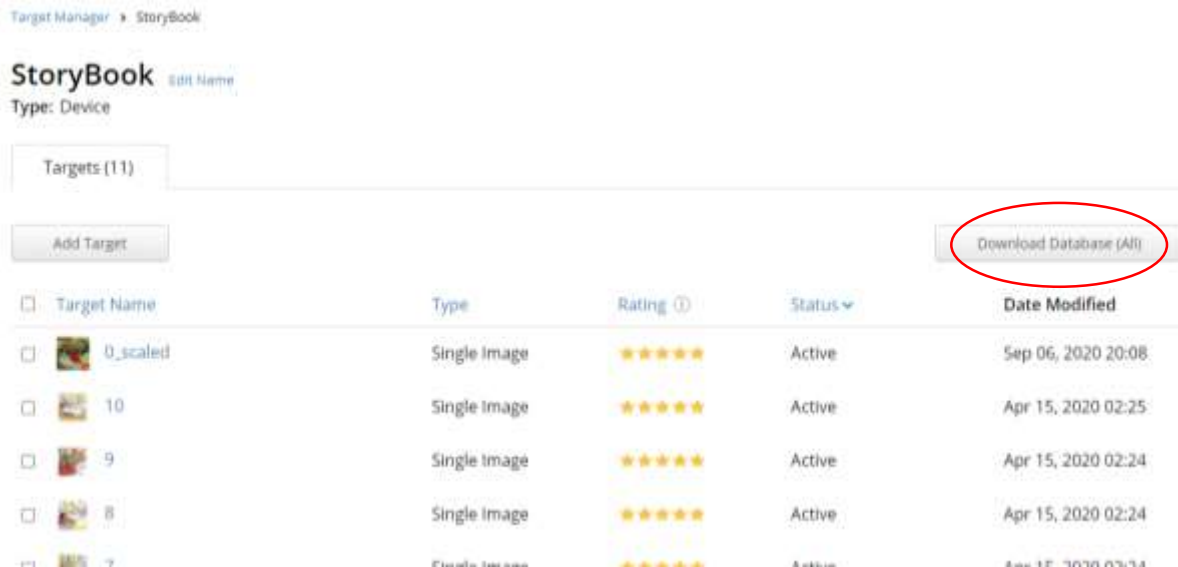


Figure 5.3.3.4 Vuforia Engine Developer Portal – Download Database

In Unity, Go to Windows > Vuforia Configuration or CTRL+SHIFT+V, in Database section click Add Database to add Database. The Figure 5.3.3.5 shows that the author’s database is successfully imported and it is all ready to develop the AR storybook.

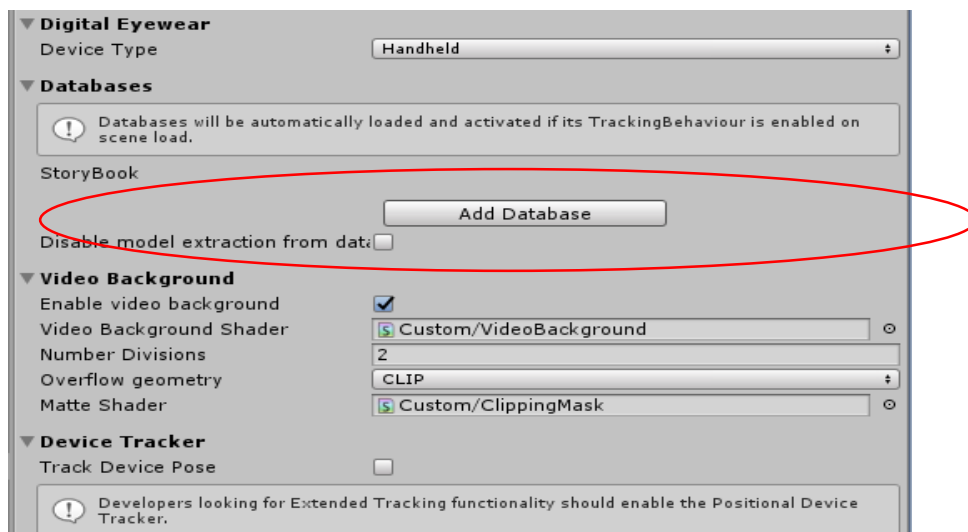


Figure 5.3.3.5 Unity3D Game Engine – Add Database

5.4 Develop Augmented Reality Storybook with Unity3D

5.4.1 Alert Message Scene

Alert Message that aware of user's surroundings is the most important thing that needed to include in this Augmented Reality Application. Therefore, the concept of design this Alert Message is plan to located right after the splash screen scene so that the user can always see the message at first.

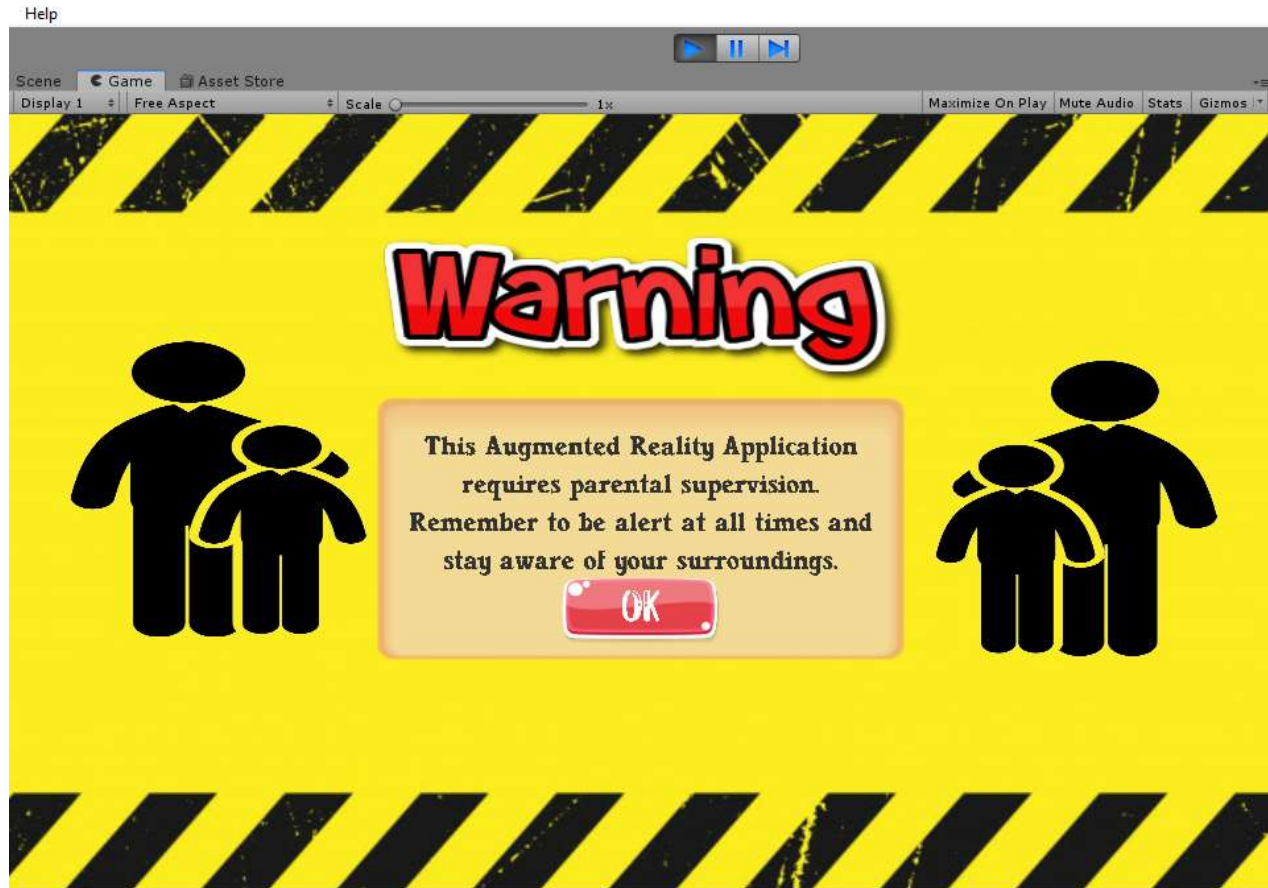


Figure 5.4.1.1 Output Interface of Alert Message

Figure 5.4.1.1 shows that the author generated alert scene in Unity3D. The content of this alert message will be:

1. Requires Parental Supervision.
2. Stay Aware of Surroundings.

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Figure 5.4.1.2 Adding Image in Unity3D (1)

To create this scene is simple, Firstly, gather all the images and import it into Unity3D. Secondly, go to “Canvas” > UI > Image to add a game object. You can rename it and it is easier to align in your scene later. Next, drag the image from project folder and drop it in the “Source Image” tab.

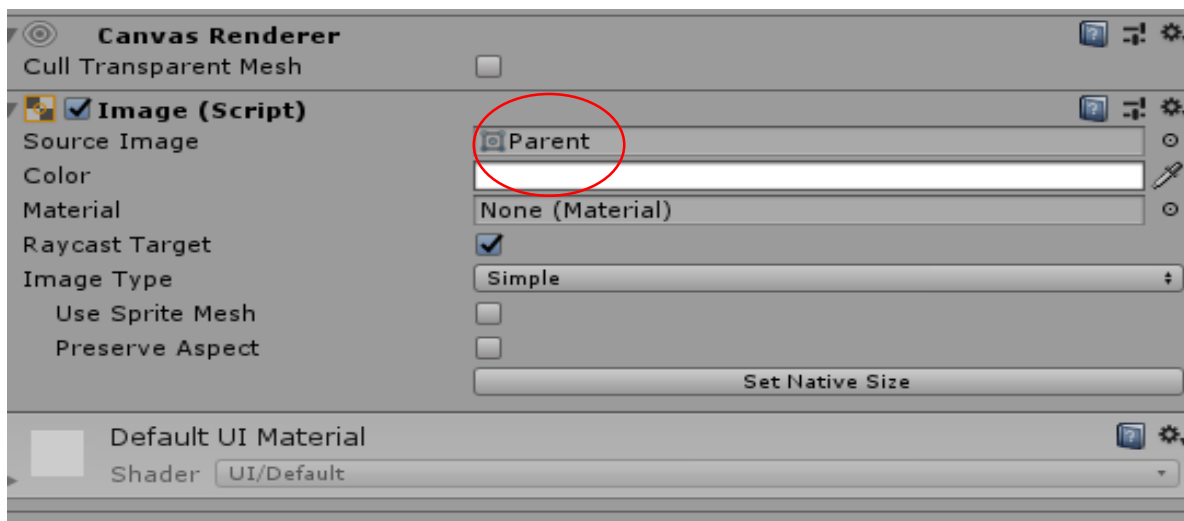


Figure 5.4.1.3 Adding Image in Unity3D (2)

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Next, create a “OK” button that when click is detected will link to main menu page. Go “Canvas” > UI > Button to create a new button. After created a button, you can decorate your button with pictures by drag the image to “Source Image” tab.

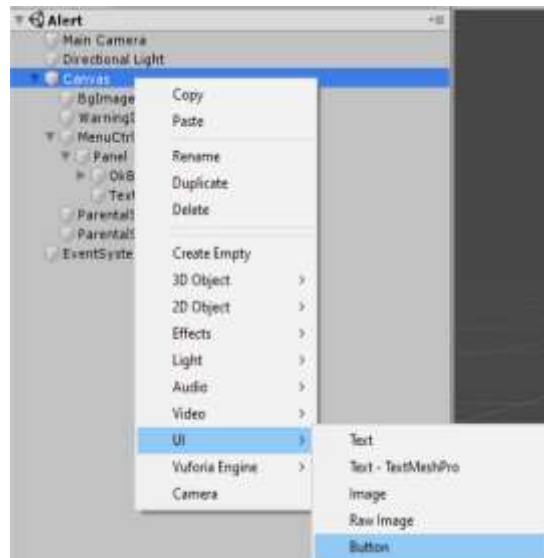


Figure 5.4.1.4 Adding Button in Unity3D (1)

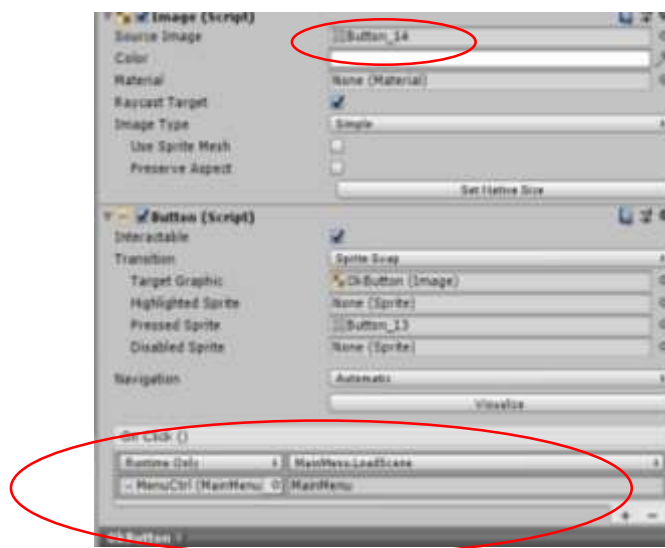


Figure 5.4.1.4 Adding Button in Unity3D (2)

Next, a C# script is created in order to lead the user to main menu when click the button. The C# script can refer to Figure 5.4.1.5. After created the C# script, drag the script into “On Click ()” tab. Follow the setting and the button can be work perfectly.

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```

1  using System.Collections;
2  using System.Collections.Generic;
3  using UnityEngine;
4  using UnityEngine.SceneManagement;
5
6  public class MainMenu : MonoBehaviour
7  {
8      public AudioSource myFx;
9      public AudioClip clickFx;
10
11     public void ClickSound()
12     {
13         myFx.PlayOneShot(clickFx);
14     }
15     public void LoadScene(string sceneName)
16     {
17         SceneManager.LoadScene(sceneName);
18     }
19     public void Download()
20     {
21         Application.OpenURL("https://s.docworkspace.com/d/AOFB8mbChq1GmuWRlpSnFA");
22     }
23
24     [SerializeField] GameObject exitPanel;
25     void Update()
26     {
27         if (Input.GetKeyDown(KeyCode.Escape))
28         {
29             if (SceneManager.GetActiveScene().buildIndex != 0)
30             {
31                 SceneManager.LoadScene(0);
32             }
33             else
34             {
35                 if (exitPanel)
36                 {
37                     exitPanel.SetActive(true);
38                 }
39             }
40         }
41     }
42
43     public void onUserClickYesNo(int choice)
44     {
45         if (choice == 1)
46         {
47             Application.Quit();
48         }
49         exitPanel.SetActive(false);
50     }
51 }

```

Figure 5.4.1.5 MainMenu.cs

Main Component	Function
Main Camera	Display Alert Scene
Directional Light	Create light for the scene
Canvas	Create a button and implemented “MainMenu” script in Figure 5.4.1.5 in order to load into Main Menu Scene.

Table 5.4.1.1: Main Components in Alert Scene

5.4.2 Main Menu Scene

This section will guide and describe the functionality and the development process in Main Menu Scene. Main Menu Scene is the internal link page for all the modules which are AR storybook and Mini Games Scene. Let the author describe the functional in this scene first.



Figure 5.4.2.1 Main Menu Scene

Figure 5.4.2.1 shows that the Main Menu of this application. When the author reaches this main menu will first plays the background music. If the user clicks on “Play” will then enter AR mode which is the AR storybook scene. Other than that, when user click “Mini Games” will lead to 3 choices of Mini Game which is rotation puzzle with easy and hard difficulties and a maze ball game. Next, the “Download” button will lead the user to a website that enable the user to download the target marker for this application. “About” button shows the general information of this application. Finally, for the “Exit” button will prompt user exit confirmation.



Figure 5.4.2.1 About Panel in Main Menu



Figure 5.4.2.2 User Exit Confirmation

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To create this Main Menu Page is also very simple, it is not much different compare to create Alert Message Scene. The main difference is that this scene contains background music. How to do it is simple, In Hierarchy > Create > Audio > Audio Source and drag the MP3 format audio into the “AudioClip”. You can also adjust the volume, pitch in this section.

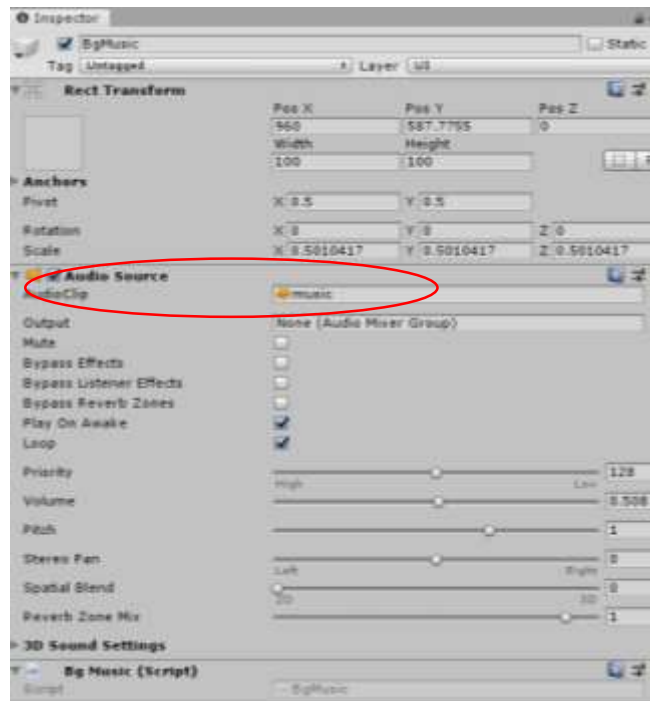


Figure 5.4.2.3 Background Music Setup

In order to make the background music continue to play and stop in specific scene, we will need a simple C# script.

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

public class BgMusic : MonoBehaviour
{
    private void Awake()
    {
        GameObject[] objs = GameObject.FindGameObjectsWithTag("music");
        if (objs.Length > 1)
            Destroy(this.gameObject);

        DontDestroyOnLoad(this.gameObject);
    }
}
```

Figure 5.4.2.4 BgMusic.cs

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Other than that, for the “Download” button, we can use the MainMenu.cs script in Figure 5.4.1.5. A function called “Download()” can alter the user to the specific website to download the Image Target. The user can save all image target into a .PDF file and generate a share link for user to download the image target.

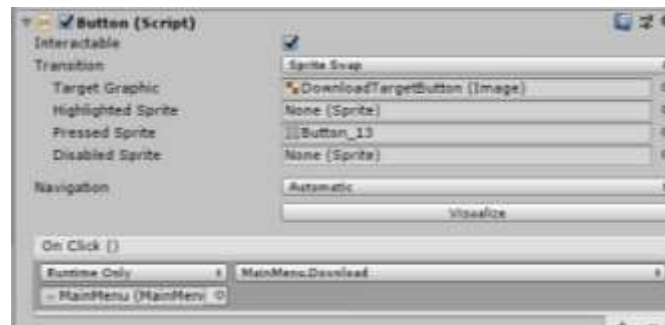


Figure 5.4.2.5 Download Button Configuration

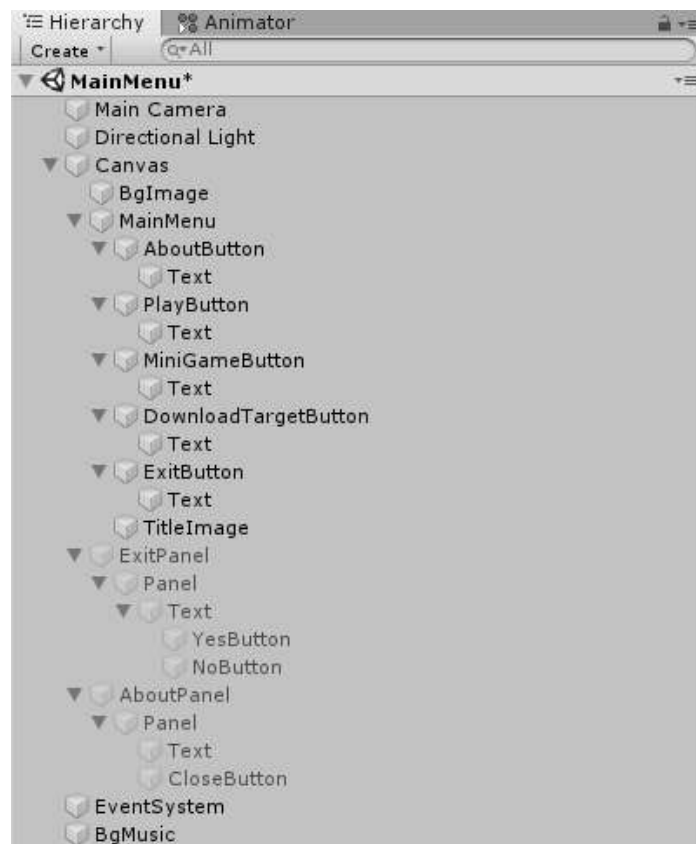


Figure 5.4.2.6 Hierarchy of Main Menu Scene

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Figure 5.4.2.6 shows the structure of the Main Menu scene. The function of the main components is stated in detailed in Table 5.4.2.1.

Main Component	Function
Main Camera	Display Main Menu Scene
Directional Light	Provide Light in Scene
Canvas	Implemented MainMenu.cs script in Main Menu which used to load scene, exit function, interactive click sound. In Canvas also included “Play”, “Mini Game”, “Download”, “About” and “Exit” Button
About Panel	A panel that show introduction of application
Exit Panel	A panel to prompt user exit confirmation
BgMusic	Implemented BgMusic.cs that plays background music. Allows the music to continue or stop in specific scene.

Table 5.4.2.1: Main Component in Main Menu Scene

5.4.3 AR Storybook Scene

5.4.3.1 Part 1

In this session, the author will show how to create an AR scene, importing 3D models, ways to create animation and import narration sound. First of all, AR scene have some different compare to original scene. Instead of using default main camera, we would use AR camera from VuforiaSDK. Therefore, delete the default main camera and add AR camera. For how to add AR camera can refer to Figure below.

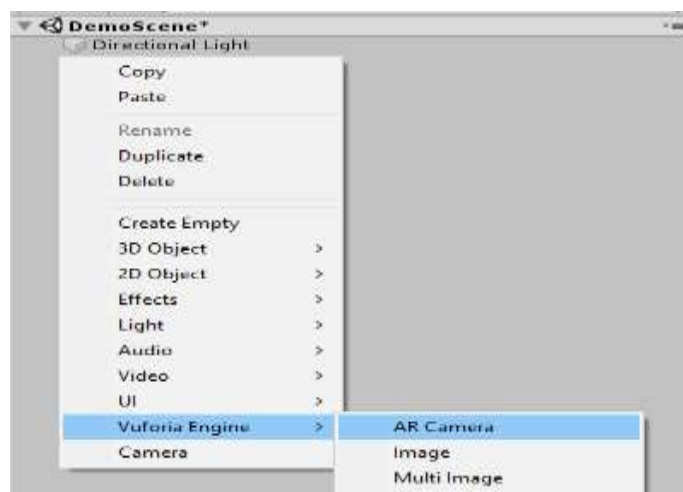


Figure 5.4.3.1.1 Create AR Camera from Vuforia Engine

Next create an Image target inside AR Camera, so that when the camera detected the image target it is able to show the scene. In AR Camera > Right Click > Vuforia Engine > Image.

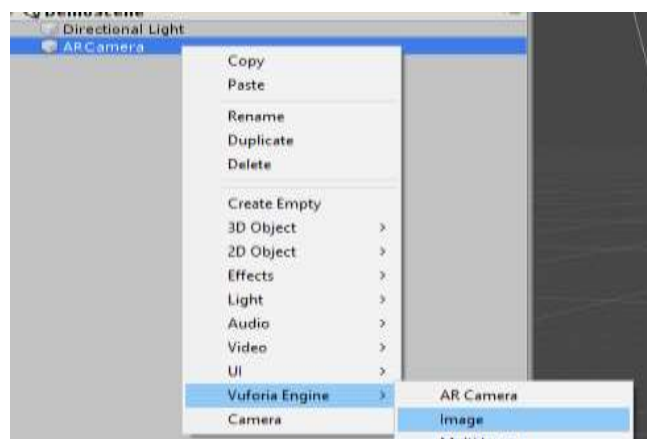


Figure 5.4.3.1.2 Create Image Target from Vuforia Engine

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After successfully created an image target in AR camera, choose any image that downloaded previously from the Vuforia database that you wish to use as a marker-based target. For example, the author’s Vuforia Database named “Storybook” and “0_scaled” used for scene 0 which is introduction of the storybook content.

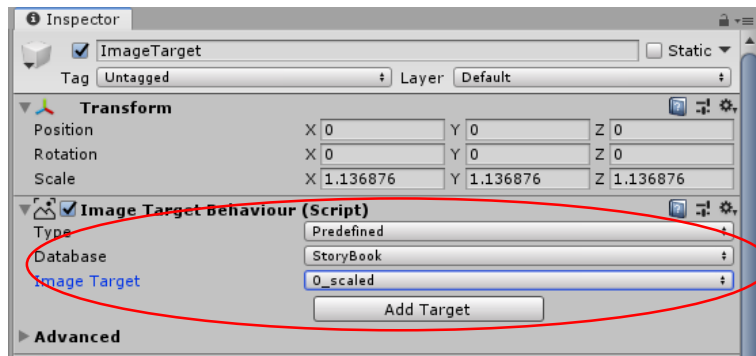


Figure 5.4.3.1.3 Select Image Target from Vuforia Database

Next, rename the Image Target to “Scene1” and drag the 3d Model into it. At this point, you are able to display 3D model in Augmented Reality when the camera detected the image target. For example, the author has three 3D model inside scene 1 which is kitchen and 2 characters.



Figure 5.4.3.1.4 Add 3D Model to Image Target

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Before we can configure and use the audio narration file (MP3) to be responsive when the camera detected an image target, the MP3 has to be imported into Unity3D first. Create a folder, place the MP3 file inside, drag and drop the MP3 into your asset folder.

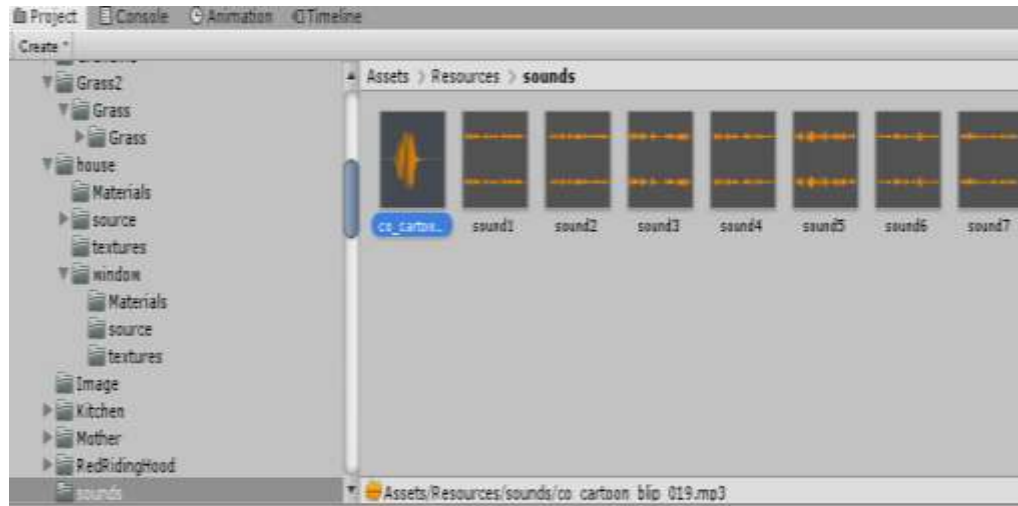


Figure 5.4.3.1.5 Import Audio to Unity3D (1)

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Next, a C# script is needed as to be the event handler. The function of this C# script is that when the camera detected a specific image target, then the specific audio clip will play at that moment. This script also contains the function when the camera lost to detect a target, audio and timeline asset will be stopped and reset until the marker-based target can be detected again. This script also enable the played audio not looping.

```
8
9  using UnityEngine;
10 using Vuforia;
11 using System.Collections;
12 using System.Collections.Generic;
13 using UnityEngine.Playables;
14 using UnityEngine.Timeline;
15
16 /// <summary>
17 /// A custom handler that implements the ITrackableEventHandler interface.
18 ///
19 /// Changes made to this file could be overwritten when upgrading the Vuforia version.
20 /// When implementing custom event handler behavior, consider inheriting from this class instead.
21 /// </summary>
22 public class DefaultTrackableEventHandler : MonoBehaviour, ITrackableEventHandler
23 {
24     //-----Begin Sound-----
25     public AudioSource soundTarget;
26     public AudioClip clipTarget;
27     private AudioSource[] allAudioSources;
28     //public Animator story_Anim;
29     [SerializeField] private PlayableDirector director;
30     private PlayableDirector[] allDirector;
31     public PlayableAsset newTimelineAsset;
32
33     //function to stop all sounds
34     void StopAllAudio()
35     {
36         allAudioSources = FindObjectsOfType(typeof(AudioSource)) as AudioSource[];
37         foreach (AudioSource audioS in allAudioSources)
38         {
39             audioS.Stop();
40         }
41     }
42
43     void StopAllDirector()
44     {
45         allDirector = FindObjectsOfType(typeof(PlayableDirector)) as PlayableDirector[];
46         foreach (PlayableDirector directorS in allDirector)
47         {
48             directorS.Stop();
49         }
50     }
51 }
```

Figure 5.4.3.1.6 DefaultTrackableEventHandler.cs (1)

```
//function to play sound
void playSound(string ss)
{
    clipTarget = (AudioClip)Resources.Load(ss);
    soundTarget.clip = clipTarget;
    soundTarget.loop = false;
    soundTarget.playOnAwake = false;
    soundTarget.Play();
}
//-----End Sound-----

void playDirector(string ds)
{
    director.playableAsset = newTimelineAsset;
    timeline = director.playableAsset as TimelineAsset;

    // rebuild for runtime playing
    director.RebuildGraph();
    director.time = 0.0;
    director.Play();
}

#region PROTECTED_MEMBER_VARIABLES
protected TrackableBehaviour mTrackableBehaviour;
protected TrackableBehaviour.Status m_PreviousStatus;
protected TrackableBehaviour.Status m_NewStatus;
private object PlayableState;
private TimelineAsset timeline;

#endregion // PROTECTED_MEMBER_VARIABLES

#region UNITY_MONOBEHAVIOUR_METHODS

protected virtual void Start()
{
    mTrackableBehaviour = GetComponent<TrackableBehaviour>();
    if (mTrackableBehaviour)
    {
        mTrackableBehaviour.RegisterTrackableEventHandler(this);
    }
    if (!director) director = GetComponent<PlayableDirector>();

    //Register / add the AudioSource as object
    soundTarget = (AudioSource) gameObject.AddComponent<AudioSource>();
}
}
```

Figure 5.4.3.1.7 DefaultTrackableEventHandler.cs (2)

```

109     }
110
111     protected virtual void OnDestroy()
112     {
113         if (mTrackableBehaviour)
114             mTrackableBehaviour.UnregisterTrackableEventHandler(this);
115     }
116
117     #endregion // UNITY_MONOBEHAVIOUR_METHODS
118
119     #region PUBLIC_METHODS
120
121
122     /// <summary>
123     ///     Implementation of the ITrackableEventHandler function called when the
124     ///     tracking state changes.
125     /// </summary>
126     public void OnTrackableStateChanged(
127         TrackableBehaviour.Status previousStatus,
128         TrackableBehaviour.Status newStatus)
129     {
130         m_PreviousStatus = previousStatus;
131         m_NewStatus = newStatus;
132
133         Debug.Log("Trackable " + mTrackableBehaviour.TrackableName +
134             " " + mTrackableBehaviour.CurrentStatus +
135             " -- " + mTrackableBehaviour.CurrentStatusInfo);
136
137         if (newStatus == TrackableBehaviour.Status.DETECTED ||
138             newStatus == TrackableBehaviour.Status.TRACKED ||
139             newStatus == TrackableBehaviour.Status.EXTENDED_TRACKED)
140         {
141             OnTrackingFound();
142         }
143
144         else if (previousStatus == TrackableBehaviour.Status.TRACKED &&
145             newStatus == TrackableBehaviour.Status.NO_POSE)
146         {
147             OnTrackingLost();
148         }
149         else
150         {
151             // For combo of previousStatus=UNKNOWN + newStatus=UNKNOWN|NOT_FOUND
152             // Vuforia is starting, but tracking has not been lost or found yet
153             // Call OnTrackingLost() to hide the augmentations
154             OnTrackingLost();
155         }
156     }
157

```

Figure 5.4.3.1.8 DefaultTrackableEventHandler.cs (3)

```
DefaultTrackableEventHandler.cs  X
Miscellaneous Files  DefaultTrackableEventH

157
158     #endregion // PUBLIC_METHODS
159
160     #region PROTECTED_METHODS
161
162     protected virtual void OnTrackingFound()
163     {
164         if (mTrackableBehaviour)
165         {
166             var rendererComponents = mTrackableBehaviour.GetComponentsInChildren<Renderer>(true);
167             var colliderComponents = mTrackableBehaviour.GetComponentsInChildren<Collider>(true);
168             var canvasComponents = mTrackableBehaviour.GetComponentsInChildren<Canvas>(true);
169
170             // Enable rendering:
171             foreach (var component in rendererComponents)
172                 component.enabled = true;
173
174             // Enable colliders:
175             foreach (var component in colliderComponents)
176                 component.enabled = true;
177
178             // Enable canvas':
179             foreach (var component in canvasComponents)
180                 component.enabled = true;
181
182             director.Play();
183         }
184         //Play Sound, IF detect an target
185
186         if (mTrackableBehaviour.TrackableName == "0_scaled")
187         {
188             playSound("sounds/sound1");
189             playDirector("timeline/Scene0Timeline");
190         }
191
192         if (mTrackableBehaviour.TrackableName == "1")
193         {
194             playSound("sounds/sound2");
195             playDirector("timeline/Scene1Timeline");
196         }
197
198         if (mTrackableBehaviour.TrackableName == "2")
199         {
200             playSound("sounds/sound3");
201             playDirector("timeline/Scene2Timeline");
202         }
203
204         if (mTrackableBehaviour.TrackableName == "3")
205         {
206             playSound("sounds/sound4");
207             playDirector("timeline/Scene3Timeline");
208         }

```

Figure 5.4.3.1.9 DefaultTrackableEventHandler.cs (4)

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```
DefaultTrackableEventHandler.cs - Microsoft Visual Studio
File Edit View Project Debug Team Tools Test Analyze Window Help
DefaultTrackableEventHandler.cs
Miscellaneous Files
208     }
209
210     if (mTrackableBehaviour.TrackableName == "4")
211     {
212         playSound("sounds/sound5");
213         playDirector("timeline/Scene4Timeline");
214     }
215
216
217     if (mTrackableBehaviour.TrackableName == "5")
218     {
219         playSound("sounds/sound6");
220         playDirector("timeline/Scene5Timeline");
221     }
222
223     if (mTrackableBehaviour.TrackableName == "6")
224     {
225         playSound("sounds/sound7");
226         playDirector("timeline/Scene6Timeline");
227     }
228
229     if (mTrackableBehaviour.TrackableName == "7")
230     {
231         playSound("sounds/sound8");
232         playDirector("timeline/Scene7Timeline");
233     }
234
235     if (mTrackableBehaviour.TrackableName == "8")
236     {
237         playSound("sounds/sound9");
238         playDirector("timeline/Scene8Timeline");
239     }
240
241     if (mTrackableBehaviour.TrackableName == "9")
242     {
243         playSound("sounds/sound10");
244         playDirector("timeline/Scene9Timeline");
245     }
246
247     if (mTrackableBehaviour.TrackableName == "10")
248     {
249         playSound("sounds/sound11");
250         playDirector("timeline/Scene10Timeline");
251     }
252 }
253
254
```

Figure 5.4.3.1.10 DefaultTrackableEventHandler.cs (5)

```
254
255 protected virtual void OnTrackingLost()
256 {
257     if (mTrackableBehaviour)
258     {
259         var rendererComponents = mTrackableBehaviour.GetComponentsInChildren<Renderer>(true);
260         var colliderComponents = mTrackableBehaviour.GetComponentsInChildren<Collider>(true);
261         var canvasComponents = mTrackableBehaviour.GetComponentsInChildren<Canvas>(true);
262
263         // Disable rendering:
264         foreach (var component in rendererComponents)
265             component.enabled = false;
266
267         // Disable colliders:
268         foreach (var component in colliderComponents)
269             component.enabled = false;
270
271         // Disable canvas':
272         foreach (var component in canvasComponents)
273             component.enabled = false;
274     }
275     //Stop All Sounds if Target Lost
276     StopAllAudio();
277
278     // Stop All Animations if Target Lost
279     StopAllDirector();
280 }
281
282 #endregion // PROTECTED_METHODS
283
284 }
```

Figure 5.4.3.1.11 DefaultTrackableEventHandler.cs (6)

After complete create this C# script, drag into your Image Target or Scene. You can refer to Figure 5.4.3.9 to configure the audio name and scene name to match your resource. At this stage, the application can be play narration audio when the image target is being detected and stop when the image target is lost.

5.4.3.2 Part 2

In this session will cover timeline editing and animation. Before that, some minor configuration in 3D model is required. Select every humanoid avatar, go to 3D model import setting > Rig > Animation type > select Humanoid and click on apply.

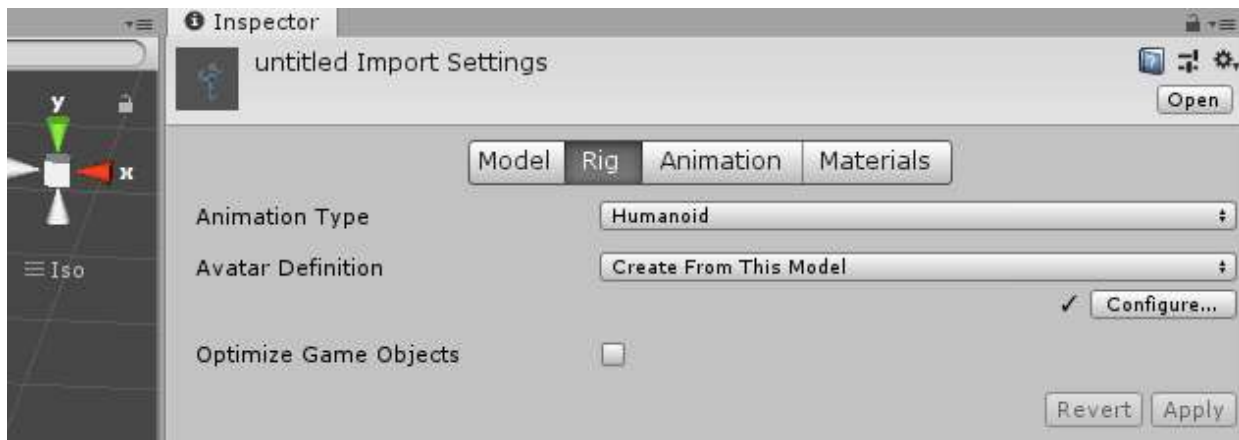


Figure 5.4.3.2.1 3D Humanoid Model Configuration

After finish rigging all 3D humanoid models, then it is good to go and proceed to timeline creation. First to create a timeline, Go to Window > Sequencing > Timeline. The timeline bar should appear at the bottom of Unity3D. Next, click Add > Animation Track and choose the preferred 3D model and drag into the animation track and right click to add the animation from animation clip.

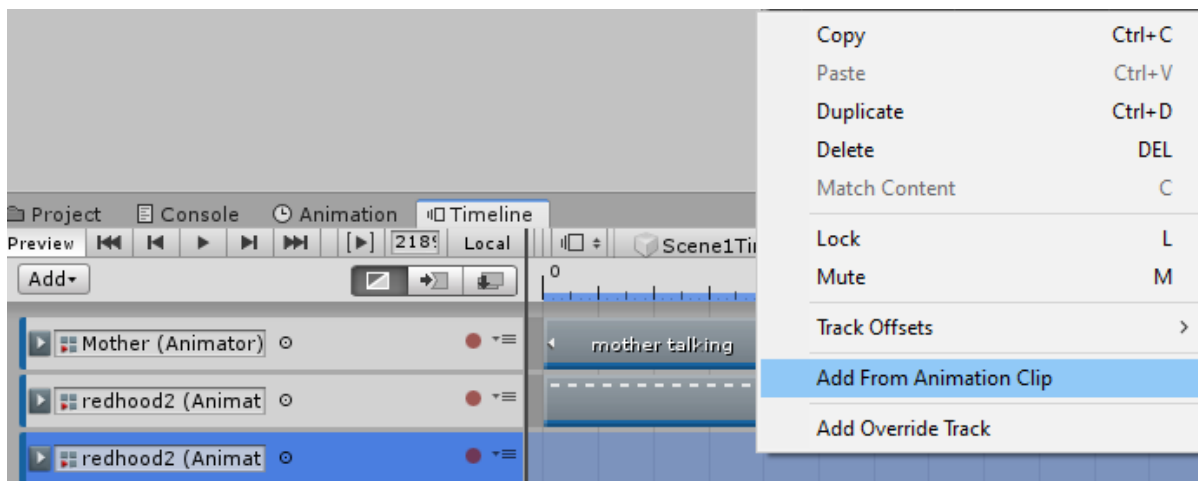


Figure 5.4.3.2.2 Add Animation Clip from Timeline

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Next, choose the imported animation clip that created using Blender 2.82 or you can import from some website such as <https://mixamo.com>. Adding 2 or more animation clip in a 3D model is possible, left click on the animation clip, then it is able to configure the clip transform offset for 3D models. Other than that, there is another way to do timeline, just merge them together. Go to the second animation clip > right click and choose match offset to previous clip. Follow the step if contain different and multiple animation clip. Also the speed of the animation clip can also be changed in clip timing > Speed Multiplier.

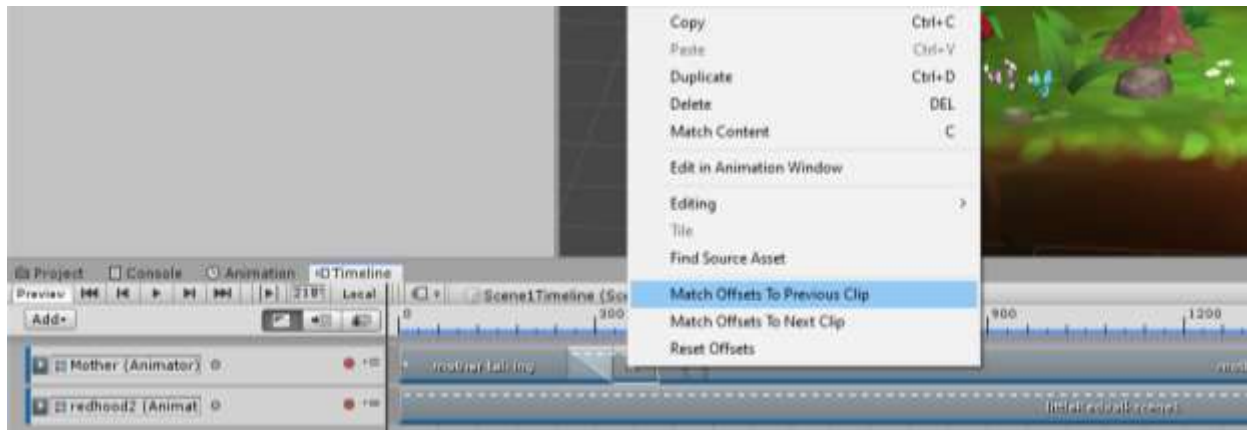


Figure 5.4.3.2.3 Merging Animation Clip

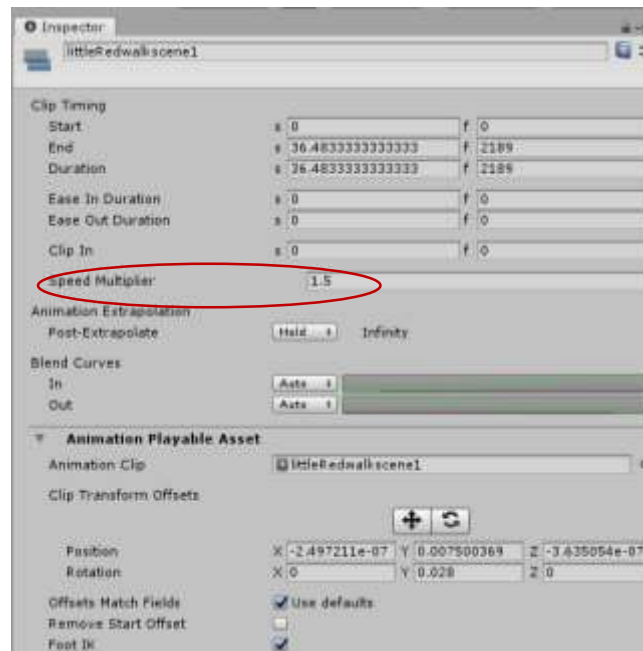


Figure 5.4.3.4.4 Adjust speed Multiplier

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Other than using timeline, we can use Unity3D build in animator system to do the animation. To do this, you will need to have bones in your 3D models. To add bones into 3D model, you will need blender to do that. After adding bones to 3D models, reimport it into Unity3D. Go to Window > Animation > Animation. In this section, you can edit the movement of the 3D models frame by frame.

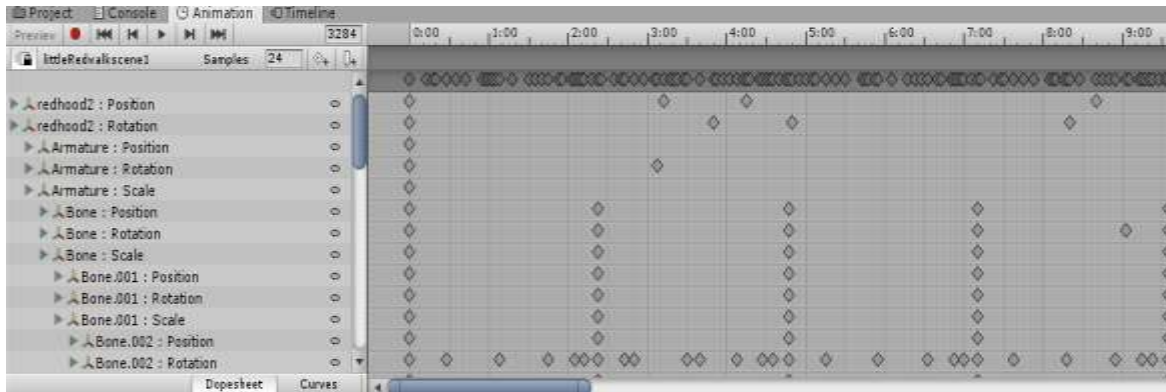


Figure 5.4.3.4.5 Animation Editor

Finally, while in AR mode we can add interaction between the application and the user. The user can rotate, zoom-in, zoom-out are one of the interactions can be done. How to do it is easy, go to Unity3D Asset Store > search Lean Touch > download and import it into your application. It is a free and useful asset, implement it into the application could have improve the user experience toward AR Storybook.



Figure 5.4.3.4.6 Unity3D Asset Store.

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Main component	Function
AR Camera	Vuforia Engine AR Camera to stimulate the AR scene
Canvas	Includes a hidden Guideline panel with a question mark button. A Home button leads the user go back to the main interface.
Main Menu	Includes scripts to every button in this page, when the user clicks the button will play click sound,
Scene	Contains Scene 0 to Scene 10 of the story
Lean Touch	Provide scale and rotate in AR Mode.

Table 5.4.3.2.1: Main Components in AR Mode

5.4.4 Mini Game Scene

In this section will discuss how to create a simple rotate image puzzle for user. As this application is mainly for children so the difficulties should not be too hard. Here is the sample of the puzzle Game.

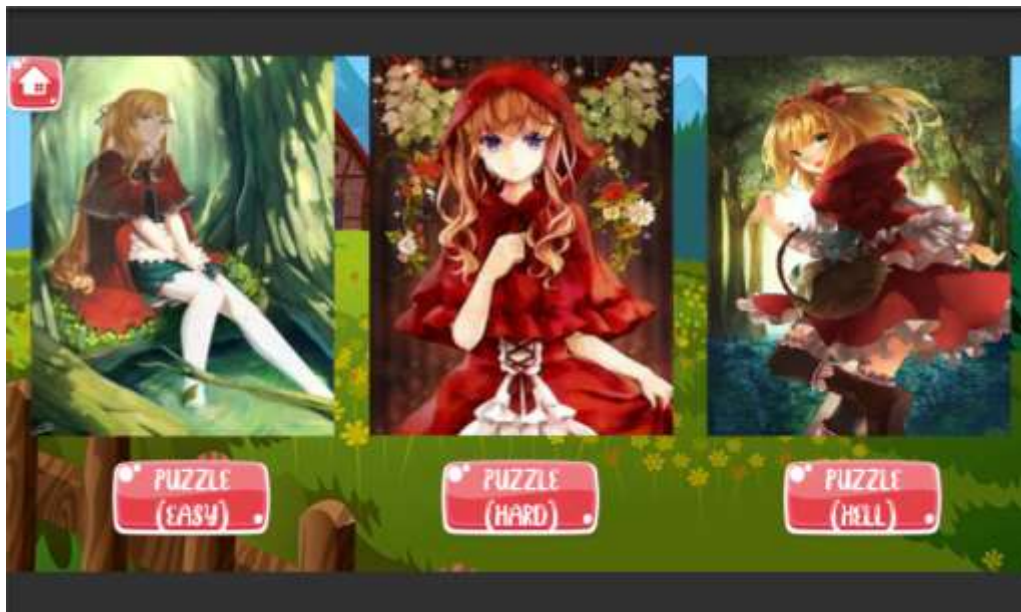


Figure 5.4.4.1 Puzzle Game Example (1)

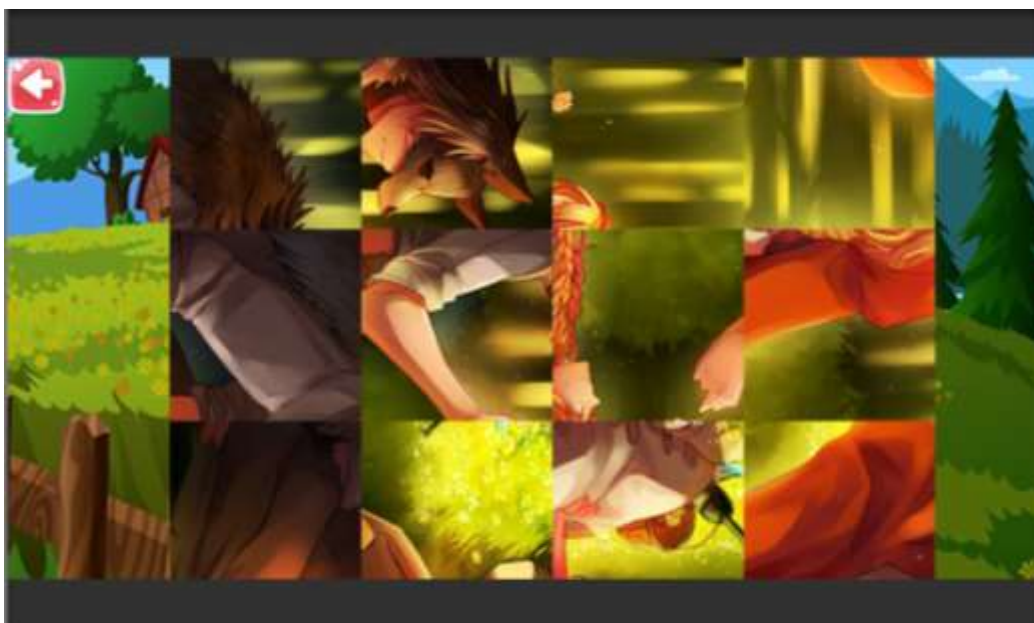


Figure 5.4.4.2 Puzzle Game Example (2)

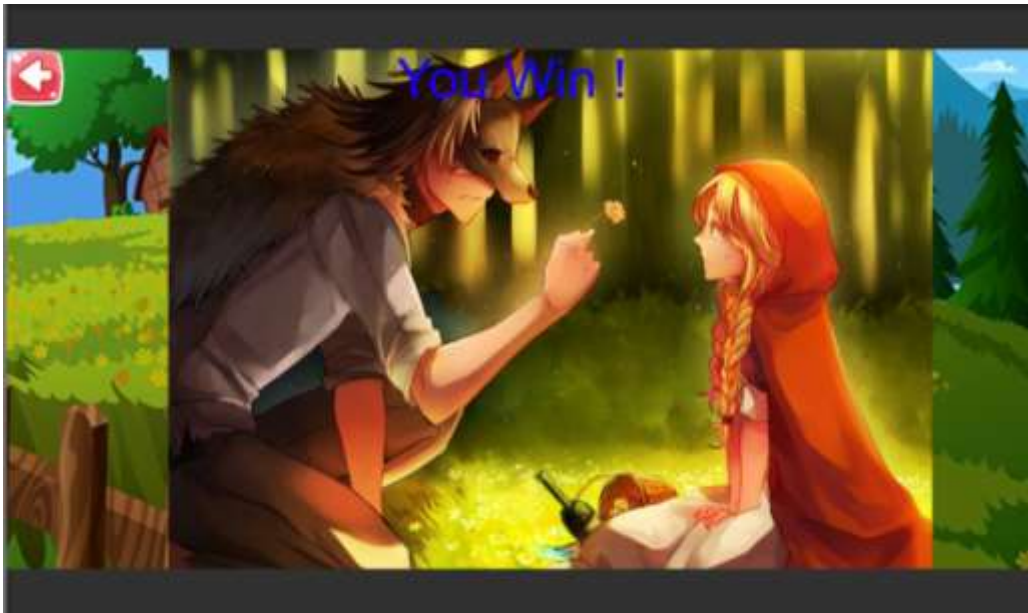


Figure 5.4.4.3 Puzzle Game Example (3).

To create this simple puzzle game, simply select one of the images in asset folder and make sure change the image format to sprite (2D and UI), then set Sprite Mode to Multiple and Pixels to Per Unit to 100. After that, click on Sprite Editor.

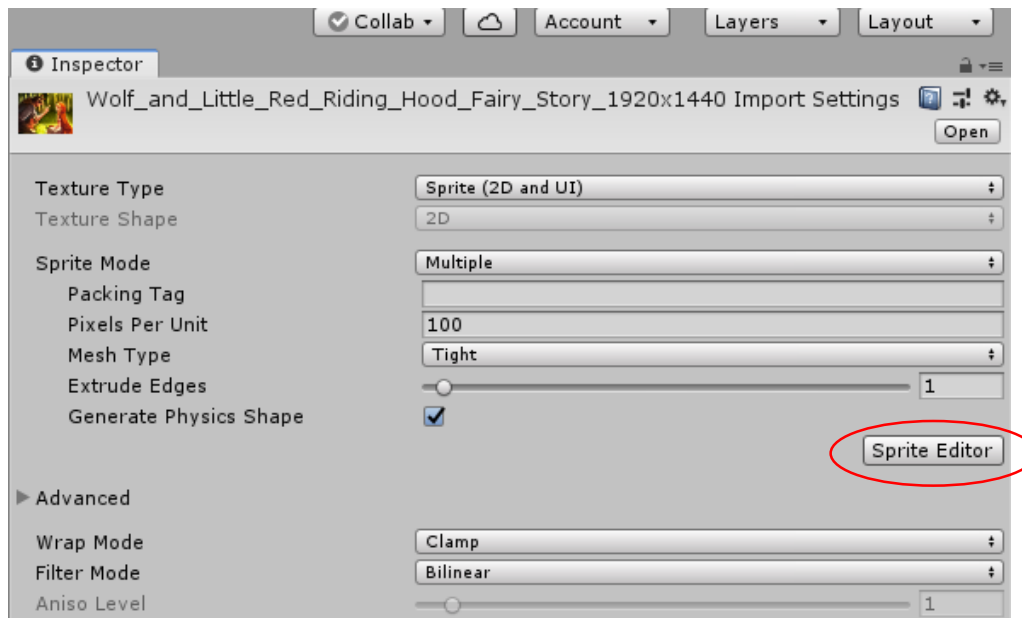


Figure 5.4.4.4 Import Setting of the Images.

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Next, In Slice tab > select Grid by Cell Count to choose your preferred difficulties for the game. After that, click Slice. For example, the author choose to slice at 4x3 which will generated 12 separate parts of this pictures.

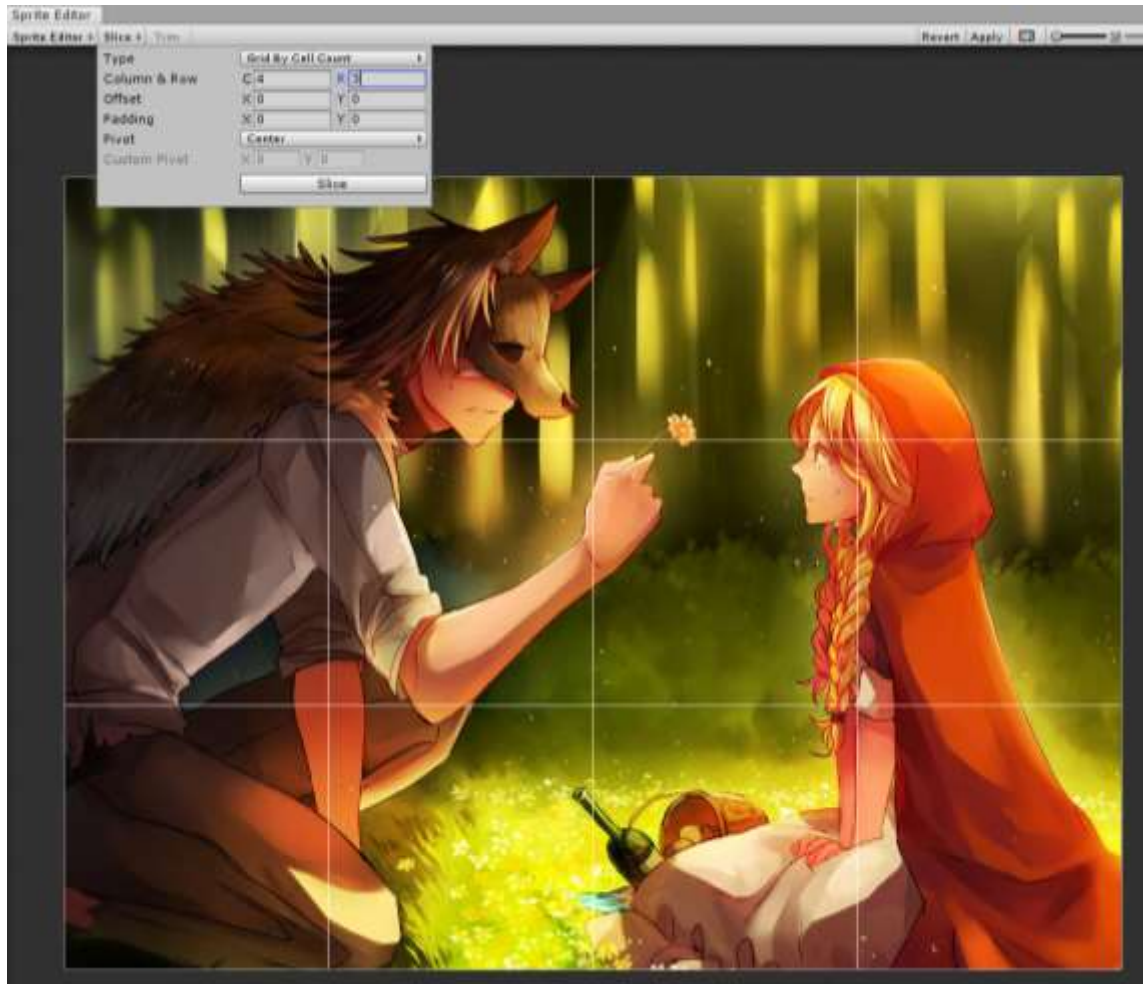


Figure 5.4.4.5 Slice Setting in Sprite Editor.

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After slicing the picture, drag all the picture fragments as a game object into scene. Arrange accordingly, hold V and connect each picture seamlessly.

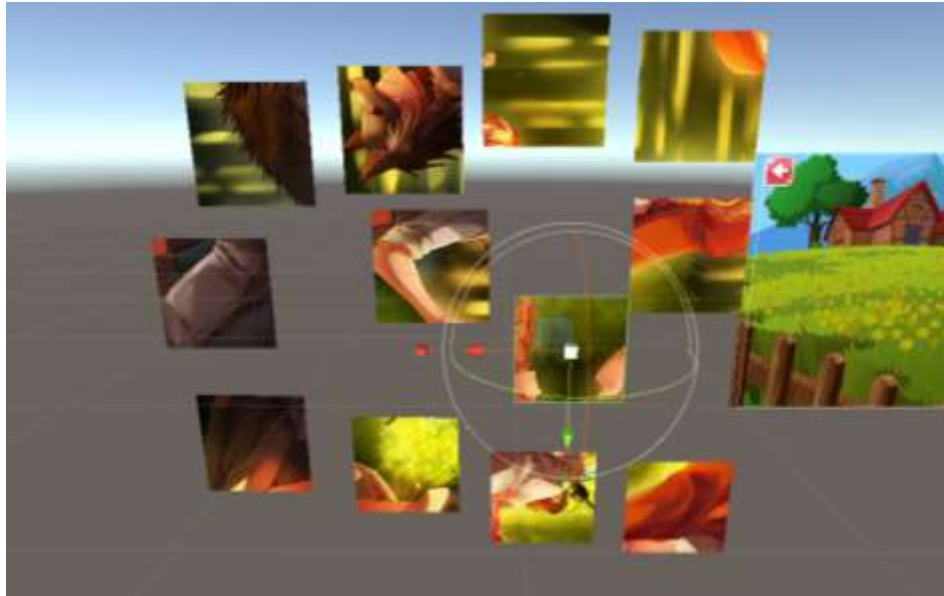


Figure 5.4.4.6 Arrange Picture Fragment (1).



Figure 5.4.4.7 Arrange Picture Fragment (2).

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Next, add all the picture fragment a “BoxCollider2D” component and additionally adding one C# script as shown in Figure 5.4.4.8 into the picture fragment. This script enables the picture puzzle rotate at a single side. Once all of the pictures are in the correct position and will show win message to the user.

```
1  using System.Collections;
2  using System.Collections.Generic;
3  using UnityEngine;
4
5  public class GameControlHard : MonoBehaviour
6  {
7      [SerializeField] private Transform[] pictures;
8
9      [SerializeField] private GameObject winText;
10
11     public static bool youWin;
12
13     void Start()
14     {
15         winText.SetActive(false);
16         youWin = false;
17     }
18
19     void Update()
20     {
21         if (pictures[0].rotation.z == 0 &&
22             pictures[1].rotation.z == 0 &&
23             pictures[2].rotation.z == 0 &&
24             pictures[3].rotation.z == 0 &&
25             pictures[4].rotation.z == 0 &&
26             pictures[5].rotation.z == 0 &&
27             pictures[6].rotation.z == 0 &&
28             pictures[7].rotation.z == 0 &&
29             pictures[8].rotation.z == 0 &&
30             pictures[9].rotation.z == 0 &&
31             pictures[10].rotation.z == 0 &&
32             pictures[11].rotation.z == 0
33
34         )
35     {
36         youWin = true;
37         winText.SetActive(true);
38     }
39 }
40 }
```

Figure 5.4.4.8 GameControl.cs.

Chapter 5: System Development and Implementation

Next create a game object and rename it as “GameControl”. Drag in the C# script shows in Figure 5.4.4.9, this script function as when the user clicks on the picture fragment, the picture will rotate in 90 degree and stop provide user to rotate when they win the game.

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

public class Rotate : MonoBehaviour
{
    // Start is called before the first frame update
    private void OnMouseDown()
    {
        if (!GameControl1.youWin)
            transform.Rotate(0f, 0f, 90f);
    }
}
```

Figure 5.4.4.9 Rotate.cs

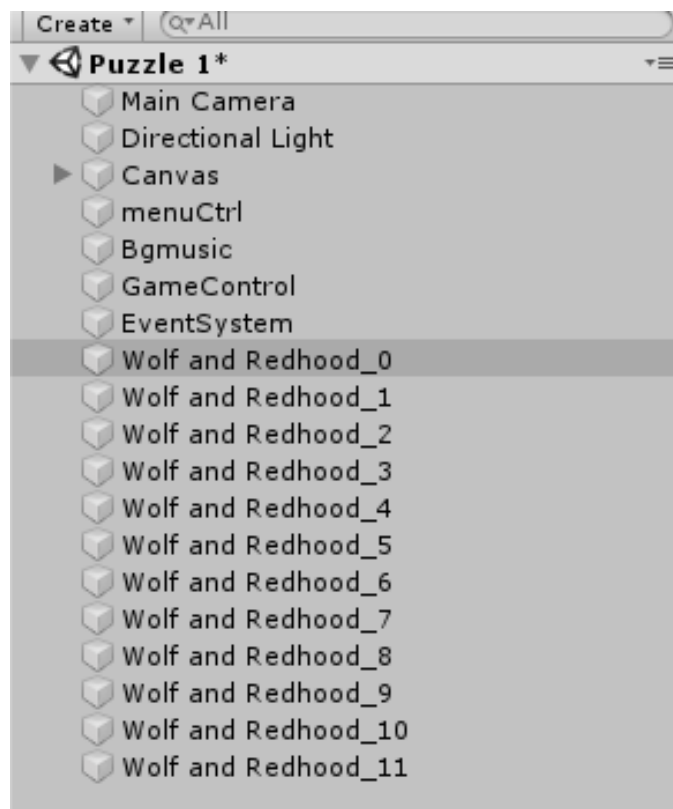


Figure 5.4.4.10 Hierarchy of Puzzle Game

Chapter 5: System Development and Implementation

Main Component	Function
Main Camera	Display the Puzzle Game scene
Canvas	Includes a back button that leads user back to mini game scene. A winText that appears while user win the puzzle game
menuCtrl	Used to make every button responsive and also have click sounds.
Bgmusic	Plays background music
GameControl	Includes a script shows in Figure 5.4.4.9

Table 5.4.4.1: Main Component of Mini Game Scene

5.4.5 Splash Screen

Lastly, creating a splash screen in Unity3D is simple. When every time the user launches the application, the splash screen will be shown at the first as figure below. The splash screen requires two images which is a logo and a background image. To create a splash screen in Unity3D, go to File > Build Setting > Player Setting > Splash Image and remember to select Android System, drag the images into “Logos” and “Background Image”. Setting the logo duration can makes the logo appears longer or shorter time to enter the application.

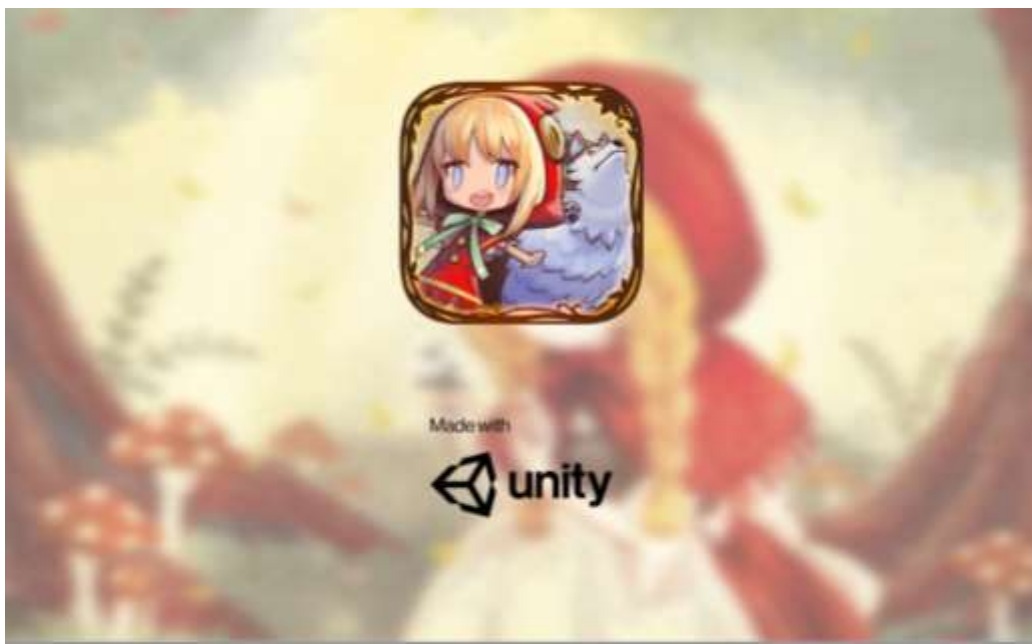


Figure 5.4.5.1 Splash Screen Demo

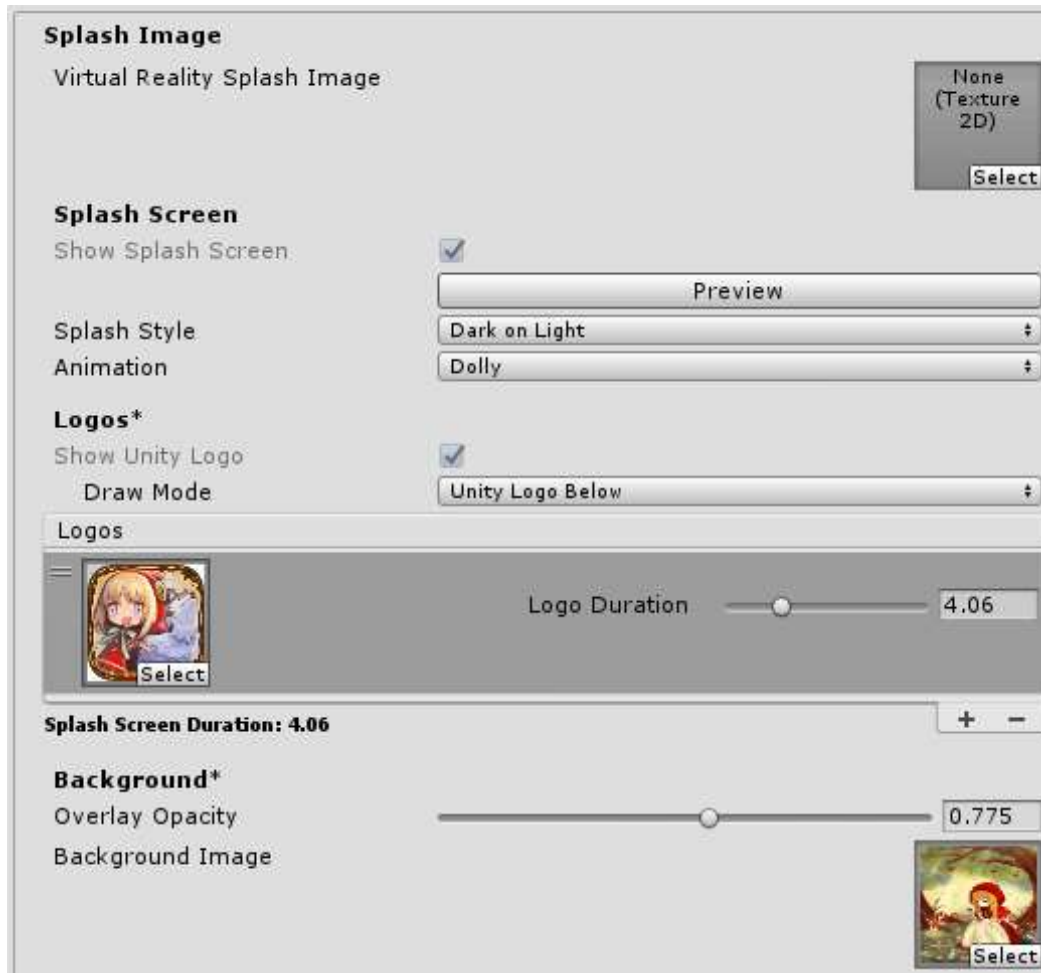


Figure 5.4.5.2 Splash Screen Configuration

5.4.6 Build Completed Application

Finally, the complete developed application using Unity3D has done. The last step is to build the proposed application. First go to File > Build Settings, include all the scene had done in previous session and clicks Build and Run. Unity3D will generate an APK file for testing. Import the APK file into Android Mobile Device and then it is all set to go.

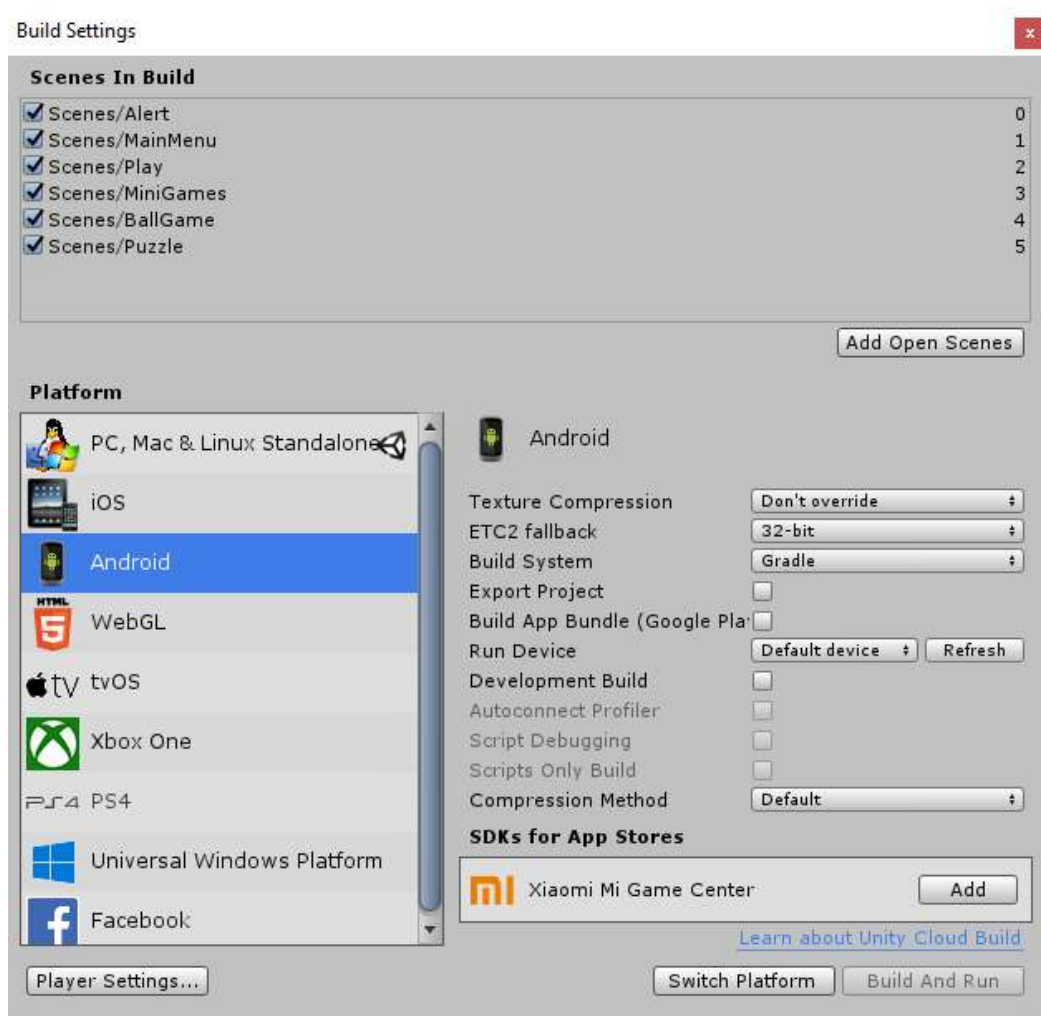


Figure 5.4.6.1 Build Configuration

Chapter 6: Evaluation

6.1 System Testing

The author had installed and tested the proposed application into different model of smart phone and android version from 6.0 or higher. The testing phases mainly focuses on the functionality of UI buttons, background music, proper 3D model visualization and accurate scene load while different marker is detected, mini game modules and audio can work, responsive in different devices.



Figure 6.1 AR Scene 1 Testing



Figure 6.1 AR Scene 2 Testing



Figure 6.3 AR Scene 3 Testing

Figure 6.1 to Figure 6.3 shows that 3 scenes tested in different mobile device and it is working as expected. After testing on different devices, the author concludes that all the function working fine, the application is able to be responsive in any screen resolution in android devices.

6.2 Evaluation of Project Objectives

According to project objectives stated in Chapter 1, the author had successfully achieved on:

1. Successfully developed a mobile storybook application intergrade with augmented reality technology and to show different visual representation compare to an ordinary storybook.
2. Successfully identify the reading habits among early-childhood students through analysing from the response of questionnaires.
3. Successfully developed a learning application that contains interaction between user and enhancing knowledge transfer towards user.
4. Successfully improve enjoyment during study by learning though augmented reality technology.

Chapter 7: Conclusion

7.1 Discussion

Augmented Reality technology trend is nowadays rapid evolution. Through reviewing some of the other existing AR storybook application, some of them does not aware and do not have one of the most important things which is safety alert message. As we know that AR provides interesting contents displays through our mobile devices, which meaning that the person who watching AR contents might not aware of their surroundings. These negligence about their surroundings can be deadly, any kind of accident might occur especially for children who using their parent's device to play. Therefore, in my opinion, safety alert message and confirming parental guidance for children under 12 years old is a must in every mobile AR application.

Other than that, the time constrain given to complete this task perfectly is difficult, as one weakness of this application is that the interactivity that supposed to have more than current version. Moreover, some of the other similar system contains built-in camera system. Sadly, the proposed system unable to have such features. There are many similar plugins that sells in Unity Asset Store however the price range is from 10 to 40 USD which is extreme costly for the author. The author tries to implement another methods and tutorials from any internet sources but unfortunately all of them failed. Thus, if the user wanted to have a screenshot of the 3D scene, they can only use screenshot method from the mobile device.

However, the strength of the proposed application is it provides interesting 3D models and animation that can easily attract to user. Nice and soft background music plays when the user using the application. Other than that, the proposed application contains full flow of story with narration. By reviewing some of the existing similar application, they either does not have full flow of story or not having a true 3D models in their AR scene. Therefore, this can also consider a strength of the proposed application. Moreover, the proposed application contains interactivity with users which some of the other application does not have this feature.

Chapter 7: Conclusion

7.2 Implement Issues and Challenges

The main issue and challenge that the author faced in this project is the author was lacked of knowledge and experience in developing the proposed project by using Unity 3D. Since Unity 3D has a lot of tools and functions, the author used few weeks for learning the usage of tools and functions for developing the proposed system.

Other than that, difficulty in designing of 3D model and objects is another major challenge faced by author. Drawing skills is highly required in order to construct a beautiful model, however the author is kind of weak in drawing. Thus, one of the solutions is to search similar 3D model to edit.

Besides that, although Blender 2.82 software is a flexible and not very user-friendly for beginners, it is seeming to be suitable for experiences 3D designer. Solution for this problem could be purchasing 3D models which is really hard to draw or seek for some friend who is good in drawing skill.

Moreover, create rig and bones into a constructed 3D model to do animation is also challenging and time consuming. This is because that the author needs to set and adjust the animation frame by frame so that the 3D model does not appears weird motion. Another thing is that the author needs to create a total 5 character and 10 scenes with animation in this story.

7.3 Future work

The current version of application is complete on basic requirement, there is many things can be improved. The author prepared a list that could possible to improve in future.

1. Increase interaction while user using AR Mode. The application might can be designed to have more interactivity with user.
2. Improve the 3D model animation to be smoother, therefore it will not seem to be awkward in some scene.
3. Have more Mini-Game to help learning in English in AR. For example, AR word finding game.
4. Possible to make it a marker-less Augmented Reality application.
5. Support in different language.

7.5 Conclusion

Augmented Reality technology are currently matured and by utilizing this technology, all the imaginary things can come true. As a conclusion for this project, the problem with loss of engagement in studies, loss of reading habits in youth, lack of enjoyment during studies can be identified. Therefore, the proposed mobile application is intended to solve these problems. These problems became strong motivation for the author to develop this project and wish to encourage children to cultivate reading since youth. Other than that, the author wishes to provide the students to have an interactive and interesting reading experience by implementing multimedia elements and augmented reality. Besides, as the children are interested in reading, language development can also be enhanced.

The objectives of this project are to develop an interactive mobile storybook application with augmented reality technology contains different visual representations compare to an ordinary storybook. Secondly, to analyse the reading habits among students. Lastly to verify the result after using the completed proposed application.

The author also encourages children to play and learn. Playing is also one of the study methods. Hence, the reading process will become more attractive and interesting by integrating interactive activities such as augmented reality during the story-telling. Developing an interactive mobile augmented reality storybook for learning English and cultivate reading habits is not to replace the traditional teaching-learning process in the classroom, but to aid the student and learner's learning experiences.

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Appendices A

FINAL YEAR PROJECT 2

WEEKLY REPORT

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: May 2020	Study week no.: 3
Student Name & ID: KUEK POH SENG 1502865	
Supervisor: MS. SAW SEOW HUI	
Project Title: INTERACTIVE AUGMENTED REALITY STORYBOOK FOR EARLY CHILDHOOD EDUCATION	

1. WORK DONE

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

- Refined previous FYP1 report
- Wolf 3D model construct complete

2. WORK TO BE DONE

- Construct more 3D character model in T-Shape

3. PROBLEMS ENCOUNTERED

- Time consume to draw the detailed of the 3D model

4. SELF EVALUATION OF THE PROGRESS

Need to spend more time on drawing 3D model



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Jan 2020	Study week no.: 5
Student Name & ID: KUEK POH SENG 1502865	
Supervisor: MS. SAW SEOW HUI	
Project Title: INTERACTIVE AUGMENTED REALITY STORYBOOK FOR EARLY CHILDHOOD EDUCATION	

1. WORK DONE

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

- Finished construct Little Red Riding Hood 3D models
- Created 2 basic AR scene in Unity3D

2. WORK TO BE DONE

- **Learn more on adding rig and bone to animate the 3D model**
- **Construct Grandma, hunter, scene background 3D model**

3. PROBLEMS ENCOUNTERED

- Rigging, creating 3D model animation are so time consuming!

4. SELF EVALUATION OF THE PROGRESS

Time left no more need to speed up.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Jan 2020	Study week no.: 7
Student Name & ID: KUEK POH SENG 1502865	
Supervisor: MS. SAW SEOW HUI	
Project Title: INTERACTIVE AUGMENTED REALITY STORYBOOK FOR EARLY CHILDHOOD EDUCATION	

1. WORK DONE

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

- Completed simple movement like walk around etc for Little Red Riding Hood and Big bad wolf.

2. WORK TO BE DONE

- **Construct Mother, Hunter, scene background 3D model**
- **Colouring 3D model, Create following scene.**

3. PROBLEMS ENCOUNTERED

- Hardware problem occurs, laptop hinge broken. Unable to open, hopefully have backup in my hard-drive and borrow laptop from my friend.

4. SELF EVALUATION OF THE PROGRESS



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Jan 2020	Study week no.: 9
Student Name & ID: KUEK POH SENG 1502865	
Supervisor: MS. SAW SEOW HUI	
Project Title: INTERACTIVE AUGMENTED REALITY STORYBOOK FOR EARLY CHILDHOOD EDUCATION	

1. WORK DONE

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

- Texturing created 3D models, background and etc.
- Extract and convert CD file format audio to MP3.

2. WORK TO BE DONE

- **Need edit the MP3 audio and create C# script, when the marker-based target is detected, the audio of the scene plays.**
- **Some character animation is not done.**

3. PROBLEMS ENCOUNTERED

- **Laptop comeback, but encountering some compatible problem because run on other version of unity and blender from my friend's laptop.**

4. SELF EVALUATION OF THE PROGRESS

Need to Speed up.



Supervisor's signature



Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project I / Project II)

Trimester, Year: Jan 2020	Study week no.: 11
Student Name & ID: KUEK POH SENG 1502865	
Supervisor: MS. SAW SEOW HUI	
Project Title: INTERACTIVE AUGMENTED REALITY STORYBOOK FOR EARLY CHILDHOOD EDUCATION	

1. WORK DONE

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

- Somehow created all 3D models, however animation is another thing to headache.

2. WORK TO BE DONE

- Need some idea on how can be interactive between users.
- **Try to do the report to become up to date.**

3. PROBLEMS ENCOUNTERED

- Time consuming Animation

4. SELF EVALUATION OF THE PROGRESS



Supervisor's signature



Student's signature

Appendices B

Survey Questionnaire

Interactive Augmented Reality(AR) Story Book for Early Childhood Education

This is a final year project questionnaire prepared by Kuek Poh Seng, a Bachelor of Information Systems (Hons) Information Systems Engineering student from Universiti Tunku Abdul Rahman (UTAR) Kampar Campus.

*Required

Consent Form

You are being invited to participate in a research study titled "Interactive Augmented Reality(AR) Story Book for Early Childhood Education". This study is being done by Kuek Poh Seng from University Tunku Abdul Rahman (UTAR) Kampar Campus.

If you agree to take part in this study, you will be asked to tick the box down below and complete the questionnaire on the following page. This questionnaire will take you approximately five minutes to complete. You may not directly benefit from this research; however, we hope that your participation in this study may contribute to further studies of Augmented Reality(AR) in education with the data collected and there will be no compensation to be claimed. To the best of our ability, your answers in this study will remain confidential to prevent exploitation by a third party. Your participation in this study is completely voluntary.

If you have questions about this project or additional information regarding this research, you may contact me with the information stated below. Your participation is much appreciated.

Thank you.

Name: Kuek Poh Seng
Email Address: pohseng08010@1utar.my

Please read the following statement and tick the box below if you agree. *

I fully understand that my participation in this study is completely voluntary and free to withdraw at any time. The use of data in research has been explained to me. I agree to take part in the research study.

Next

Interactive Augmented Reality(AR) Story Book for Early Childhood Education

*Required

Demographic Data

Gender: *

- Male
- Female

What is your age? *

- Less than 18
- 18 to 24
- 25 to 34
- 35 to 49
- 50 or above

Back

Next

Interactive Augmented Reality(AR) Story Book for Early Childhood Education

*Required

AR in Education

Augmented reality (AR) is a type of interactive, reality-based display environment that takes the capabilities of computer-generated display, sound, text, and effects to enhance the user's real-world experience.

Augmented reality combines real and computer-based scenes and images to deliver a unified but enhanced view of the world.

Do you think AR is suitable to implement in the early childhood education? *

- Yes
- No

Do you think children should cultivate reading habits in youth? *

- Yes
- No
- Not Sure

Do you think negative effects such as addiction to mobile devices will happen to children as if they spend too much time on digital technology? *

Yes

No

Do you think one-way communication teaching method in the traditional classroom is a lack of interaction between student and teacher? *

Yes

No

Instead of just studying, do you think that play and learn is more suitable for children? *

Yes

No

Do you think the multimedia elements such as video, audio, picture, text, and animation can attract children's attention effectively? *

Yes

No

Maybe

In general, how do you feel about AR implement in education? *

	1	2	3	4	5	
Dislike it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Love it

In general, how would you say the children will feel about AR implement in education? *

	1	2	3	4	5	
Dislike it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Love it

Do you think to implement AR in education can make a positive difference to the children's reading habits? *

- Yes
- No
- Maybe

Do you think the implementation of AR will help to motivate the children to read more? *

- Yes
- No
- Maybe

Do you think the implementation of AR will make a deep and lasting impression on the children when reading? *

- Yes
- No
- Maybe

Do you think which type of the storybook do you think children will have more motivation to read? *


- Traditional storybook
- AR storybook

What do you think AR could benefit children from ages 2 to 7 years old? *

- Language Development
- Raise Motivation Towards Reading
- Better Academic Performance
- Other: _____

If you as a parent, would you download a similar AR storybook for your children to play with? *

- Yes
- No




Interactive Augmented Reality (AR) Storybook For Early Childhood Education


*Children does not have learning habits?
Sick of does not understand the learning materials?
Bored toward Studies?*

Introduction


- PARTICIPATE IN THE STORY!
- STORY READING IN AN IMMERSIVE WAY!
- PROVIDE ENJOYMENT, ENGAGEMENT AND INTERATION IN STUDY!



Objectives




- PLAY AND LEARN
- ENCOURAGE TO READ INNOVATIVELY
- HELP CHILDREN IN CULTIVATE LEARNING HABITS
- ATTRACTIVE CONTENT
- INCREASE UNDERSTANDING IN CONTENTS LEARNING




Methodology



- AGILE MODEL
- UNITY3D
- VUFORIA ENGINE



Conclusion



- ATTRACT TO KIDS
- ACADEMIC AND PLAY IS BALANCED
- IMPROVE LANGUAGE SKILLS
- ENCOURAGE TO LEARN



**Bachelor of Information Systems (HONS)
Information System Engineering**

By : Kuek Poh Seng

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real for preschool children aged five to six?",
British Journal of Educational Technology, 2017

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Kuek Poh Seng
ID Number(s)	15ACB02865
Programme / Course	IA
Title of Final Year Project	Interactive Augmented Reality Storybook For Early Childhood Education

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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
 Name: SAW SEOW HUI
 Date: 11/09/2020

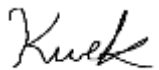

 Signature of Co-Supervisor
 Name: _____
 Date: _____

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(KAMPAR CAMPUS)****CHECKLIST FOR FYP2 THESIS SUBMISSION**

Student Id	15ACB02865
Student Name	Kuek Poh Seng
Supervisor Name	Ms. Saw Seow Hui

TICK (√)	DOCUMENT ITEMS
	Your report must include all the items below. Put a tick on the left column after you have checked your report with respect to the corresponding item.
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<p>I, the author, have checked and confirmed all the items listed in the table are included in my report.</p> <p></p> <p>_____ (Signature of Student) Date: 8 September 2020</p>	<p>Supervisor verification. Report with incorrect format can get 5 mark (1 grade) reduction.</p> <p></p> <p>_____ (Signature of Supervisor) Date: 11/09/2020</p>
---	--