### TECHNOLOGY-FACILITATED OF UNITY 3D COMPUTER BASED

#### INTERACTION WITH AUTISTIC SPECTRUM DISORDER

BY

#### TAN ZHONG QUAN

#### A REPORT

#### SUBMITTED TO

Universiti Tunku Abdul Rahman

in partial fulfillment of the requirements

for the degree of

BACHELOR OF INFORMATION SYSTEMS (HONS) INFORMATION SYSTEMS ENGINEERING

Faculty of Information and Communication Technology

(Kampar Campus)

MAY 2018

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# **DECLARATION OF ORIGINALITY**

I declare that this report entitled "TECHNOLOGY-FACILITATED OF UNITY 3D COMPUTER BASED INTERACTION WITH AUTISTIC SPECTRUM DISORDER" 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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# ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciation to my supervisors, **Mr.Kesavan a/l Krishnan** who has given me this bright opportunity to engage in an 3D Computer Game project. It is my first step to establish a career in 3D Computer Game field. A million thanks to you.

Finally, I must say thanks to my parents and my family for their love, support and continuous encouragement throughout the course.

### ABSTRACT

This project is a Computer 3D Game application for those children with Autism Spectrum Disorder. Moreover, those children who are suffering by the Autistic Spectrum Disorder will face a lot of problems. The problems can be poor eye contact, speech disorder issues, unusual visual spatial skills, no body language, keep performing the same thing, lack of emotion, no gesture and so on. In this project, it will only choose some of the problems to focus on. Therefore, project will try to help the children to get improving their some of the problems. Autism Children are usually lack of communication with others people, because they are facing speech disorder issues, they cannot even speaking a word clearly, Not only that, those children with Autism Spectrum Disorder also face the visual spatial issues, they are lack of this skill, so it make them are not be able to perform and complete a lot of things. Therefore, the methods used in this project are Speech Recognition function and given some task that are required user to use their visual spatial skill to do it. Firstly, Speech Recognition function is introduced in this project because in this project some of the task are actually required the user to speak in order to complete the task. In this case, they will try to speak clearly when they are playing the game because if the sound are not clearly enough, this game application will be detected the wrong word. So, they will keep trying, and this action will improve their speech disorder issue in the long run. Other than that, the task which required user to use their visual spatial skill to do it. It is to make sure that they can improve their visual spatial skill by playing this game.

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## **Chapter1: Introduction**

## Introduction

In this chapter, we will present the background and motivation of our research, the project scope and project objectives, and the last is impact, significance and our contributions to the field.

### **1.1 Problem Statement**

#### 1.1.1 Speech Disorder Issue

Speech Disorder is one of the problems that will be encounter by the majority of the Children with Autistic Spectrum Disorder. In fact, Those Autistic child can speak to others people with loud sounds, but majority of the people who are talking to them are not be able to get the meaning from them because the sound produce by the Autism Child is not intelligible. Moreover, the distortion of oral structure is the main reason of this problem. However, majority of the Autism child, they know how to pronounce correctly the words but because of this distortion problem, it makes them fail utter the words clearly and cannot even to produce articulate words. Therefore, they are not likely to talk or even the worst case is they will attempt to stop playing the game is just because of this speech disorder issue. This project is designed to help them to solve the speech disorder issue so that they can produce articulate words during conversation.

#### 1.1.2 Unusual Visual Spatial Skills Issue

Secondly, the other problem that will also encounter by the children with Autistic Spectrum Disorder is "Unusual Visual Spatial Skill". Due to this problem, the statistics show that, Autism Child cannot perform well in the task that required the user to use their visual spatial skill. Moreover, there are various types of Visual spatial

skills which include relating objects to self, other objects and other people, locating their own bodies in space and so on. Since, the Unusual Visual Spatial Skill are affecting those Autism child's performance, so naturally the task will also are not be able to completed, even they can do it but they also have to take a very longer time to complete it. However, this project is also design to help them solve this Unusual Visual Spatial Issues, so that those children can play this computer game to improve their Visual Spatial skill in the long run.

#### 1.1.3 Poor Vocabulary

Thirdly, Poor Vocabulary is also considering as one of the problems of Autism Child. However, some of the Autism Child will plagued by poor vocabulary problem when they are performing or conducting some task. Due to this type of issue, it may cause them are not likely to talk with others people. In addition, they also might fell lost in this game, and naturally they will also start to feel that this game is quite boring for them and they will attempt to quit the game. So, because of the issue of poor vocabulary, this project will be design to solve this problem, so that they can learn more vocabulary by playing this game.

### **1.2 Background and Motivation**

First of all, some of the aspects such as communication and social functioning that will be affected by the problem of Autism disorder. There are three impairments for the autism child, which include communication problem, Social problems and also imagination deficit. Sometimes Autism Child will only try to speak a little bit, but the worst case is most of the time, majority of them do not even communicate with others. However, a communication deficit is the main factors that cause the autism child are not likely to talk with others people. Besides that, Autism Spectrum disorder will not only cause them encounter the communication deficit issue, but also will affect their Facial gestures, body language and eye contact and so on. The wide variation in challenges and strengths possessed by each person with autism can be reflecting in a word called "spectrum".

One of the characteristic that can be found in the Autistic Spectrum Disorder is Impairment of communication. Moreover, delay in language acquisition and language development is the main issues of Autism Child. Children often have little or no speech. Where there is speech, idiosyncrasies such as immediate and delayed echolalia, pronoun reversal (substituting "I" for "you"), unusual intonation, and stereotyped speech can be observed (Lord & Paul, 1997). However, absence of desire to interact with others is one of the characteristic of the Autism child. Other than that, the characteristics of poor eye contact, lack of facial expression and gesture and some of the awkward body language will also be a problem of autism child, all of this can be consider as the characteristics of the communication impairment.

Moreover, the total numbers of Autism keep increasing year by year. On the other hand, there are different types of symptoms that can be found in the Autism Child. Moreover, the social and emotional understanding, all aspect of communication, and the flexibility in thinking and behaviour, all of this three is also the symptoms of Autism child. Children with Autistic Spectrum Disorder may often plagued by the symptoms and behaviours that are developed by themselves and it will disrupt the daily functioning. On the other hand, speech disorder is the main problems of the children with Autism Spectrum Disorder Speech disorder that included taking long time to respond just a question, or even worse is no response at all, use wrong words and answer the question incorrectly, they will feel difficulty to make a correct sentences and so on. In addition, Computer game is more popular to consumers than the past. Video games have become more important today. Video games have been used by majority of the school to teach the children. Therefore, Majority of the subject that are currently utilizing video game to teach the children, using it in teaching area can make more interesting in study. However, Video game can use to make the teaching more effectively for children.

Lastly, the four main characteristic of Autistic Spectrum Disorder are Socialinteraction difficulties, Communication challenges, Unusual Visual Spatial Skill and also the Tendency to engage in repetitive behaviours.

In addition, computer game are becoming more popular and the new mode of the interaction is also providing by the computer game, so the actual needs and interests of children can be easily meet by using computer games. Therefore suggesting the

computer games as valuable educational tools. If there is no one use the force method to force the children to learn. Then all of them are actually like to learn something new, just like all human. Nowadays, we can found many learning opportunities that are provided by Modern computer and video games Gee (2003) argues that "the real importance of good computer games is that they allow people to recreate themselves in new worlds and achieve recreation and deep learning at the same time". However, some educators consider a powerful instructional approach is on the game-based learning. Hence, computer education game can make the learning processes become easier, more interesting and more effectively, and the most important things is it makes the learner become the center of learning.

Lastly, 3D Computer game for the children with Autistic Spectrum Disorder will introduce in this project. However, for those children who are suffer from Autistic Spectrum Disorder can improve their speech, sound , responding time, and their visual spatial skill through this 3D Computer game. Due to this 3D Computer game, it will be provided sufficient word and use the Augmented Reality 3D model to display it to them, so children with autism can enrich their vocabulary through playing this Computer Game.

#### 1.3 Objective

- 1. To investigate the issues and the limitation of the Autistic Child, then select three out of many issues and limitation to solve it. Besides that, it is also to study how the game application is the most effective to improve their limitation and issues.
- 2. To design a 3D game by using located visual cues to improve the spatial awareness of autistic people, using Speech Recognition function to improve their speech disorder issue, and also using the quiz game method and Augmented Reality to improve their vocabulary.
- 3. To develop a 3D computer Based Interaction game to improve the spatial awareness, to improve the clarity of their speech, and also to improve their vocabulary.
- 4. To examine if this game helps the Autistic child to improve their problems.

### 1.4 Impact, Significances and Contribution

#### 1.4.1 Impact

In the education domain, those Autism children can improve their ability in the different aspect through playing this application.

Besides that, the end product forces the player to use their sound to perform the task. Those players are required to speak some words to complete the task. When they are trying to speak, they must ensure that their pronunciation should be clear enough to let the game be able to detect the words, otherwise, they will fail to complete the task. However, this application will design a function that can recognize their word. Due to this situation, the aim of this application is to train them to speak clearly. Therefore, it can help them to improving their pronunciation issue in the long run.

Secondly, this project will also provide the task that requires the player to utilize their visual spatial skill to play. This game will ask the user to take the specific things to the specific location. This kind of task will force them to use their visual spatial skill to complete it. By playing this application, they can actually get improving their "unusual visual spatial" issue. Since, this application will also provide a timer to ensure that our target audience can complete the task within a specific time. Therefore, they can get improving their responding time through this computer game.

Lastly, quiz game will also provide in this project. This game will require the user to answer the true and false question. Besides that, this game will use the Augmented Reality techniques to let the user to use the android application (Second mobile application) to scan the question in order to display the 3D model object in their mobile phone. Therefore, they can get improving their vocabulary through playing this computer game and can also attract and let them to concentrate to play this game by using the Augmented Reality technique.

#### 1.4.2 Significance

According to the Malaysia plan, the primary goal is to make our Country become a high income economy by 2050. However, in order to reach this goal, we have to ensure that the problems of Autistic Spectrum Disorder will be decrease as fast as possible. So, the main two problems of Autism Children are facing the speech disorder issue and unusual visual spatial skill. Therefore, by applying this project to those children who are suffer the Autistic spectrum disorder problems, the issue of speech disorder and unusual visual spatial skills can be improve. So the main significance of this project is focusing on help those Autism Child to solve their Social issue.

#### 1.4.3 Contribution

The innovation for this project is development of Speech Recognition tool, providing some task that required player to utilize their Visual Spatial skill to complete it and also providing attractive objects on Autistic child. The innovation can contribute to the education in order to help the children with Autistic Spectrum Disorder to enhancing their different types of ability. Those ability that include the ability of the speech, and the ability of the Visual Spatial Skill. With the help of tool, the Autistic child will find it effective way to overcome their problem which is cannot utter a word clearly and unusual Visual Spatial Skill. However, the children with Autistic Spectrum Disorder will be able to speak with other with the clarity sound in the long run and able to perform well in the task that are required the visual spatial skill.

Besides that, providing more attractive objects is also considered as an innovative for this project. This innovation can contribute to help the Autism children to learn some new vocabulary through the 3D attractive objects. Thus, by having a lot of vocabularies can indirect help the Autism children to embrace to speak with others.

Lastly, the Speech recognition can be used by Autism children's community to further improve the Autism speech skill and also their vocabulary.

### 1.5 Proposed Approach/study



Figure 1.5.1: Dataflow of This Project Application

### 1.6 Achievement

So far, this project has already achieved performing the Speech Recognition function to detect the words which is spoken by the children. The player is force to speak in order to perform the task. This project also achieves the function that allows the player to use our own android Virtual Reality application to scan and display the VR 3D object model in their mobile phone.

### 1.7 Report organization

This report has divided into six chapters. However, each chapter describes the following details:

### ✓ 1<sup>st</sup> Chapter: Introduction

• Elaborate the problem statement, background and motivation, project objectives, proposed approach, achievement I have done for this project.

### ✓ 2<sup>nd</sup> Chapter: Literature Review

• List out all the literature Review related to the sign and symptoms of the Autism Child, limitation communication, and also the Techniques and Contribution of the computer games.

### ✓ 3<sup>rd</sup> Chapter: Problem Analysis

• Show questionnaire analysis (Before user testing)

# ✓ 4<sup>th</sup> Chapter: System Design and Architecture

• List out all the UML Diagram, technology and methods involved in this project and prototype of this both computer game and android application.

### ✓ 5<sup>th</sup> Chapter: Methodology and Tools

• List the chosen methodology and tools, system requirement, implement and testing.

# ✓ 6<sup>th</sup> Chapter: System Testing

• Show the verification Plan for the whole application.

### ✓ 7<sup>th</sup> Chapter: Conclusion

• Elaborate the discussion of final application, achievements and problems encountered as well as the future works of this project.

### **Chapter2: Literature Review**

### 2.1 Understanding of Autism and Disorder

#### 2.1.1 Autistic Spectrum Disorder sign and Symptoms

First of all, due to the sign that may indicate that people should be evaluated for a diagnosis of autism. People can evaluate the children who are suffer from autism based on the different types of the sign. Thus, poor eye contact, appear deaf as well as abruptly stop talking with others is consider as the sign of Autism Spectrum Disorder. Moreover, Autistic Spectrum Disorder is a disease that can be resulting of abnormal and growth of cerebral neurons of human brains. Majority of the people who are encountering Autistic Spectrum Disorder, they will be faced some problems which is abnormal and irregular growth of cerebral neurons of human brains. However, there are many different types of sign and symptoms that can be found on Autistic Spectrum Disorder. Having a poor performance in the social interactions is one of the main symptoms in Autistic Spectrum Disorder, it normally called Communication deficit. it can make them have a difficulty in communicate with others. On the other hand, others people also difficult to communicate with them. When someone are talking with the people who are suffer from Autistic Spectrum Disorder, they will use different types of way to respond to you such as non-response, low sound response to others or unintelligible sounds, they are not be able to answering the question directly, it may cause delay in answering it, answering incorrectly with articulate words, and even form a correct sentences with words is also consider a difficult thing to make it. (Ferdous, 2010) Besides that, some of the behaviors can also diagnosis as symptoms of Autistic Spectrum Disorder. Moreover, behaviors of Autistic Spectrum Disorder are often encompassing, unusual interests and stereotype body movements. Furthermore, Autistic Spectrum Disorder will also bring them a variety of coexisting psychiatric symptoms. Feeling depression, hyperactivity, mania, specific phobias and generalized anxiety is considered as Coexisting psychiatric symptoms and the most common psychiatric symptoms on Autistic Spectrum Disorder is depressive.

#### 2.1.2 Limitation of Autistic Spectrum Disorder in terms of Communication

Firstly, there are many limitations of Autistic Spectrum Disorder, and communication is one of the limitation can be found on this symptom. However, the first limitations of communication is majority of autistic people are actually have the capabilities to form a full sentence but due to the communication issue, it cause them are not be able to utter a word or a sentences correctly and sometimes they will only repeat the same phrase over and over again. Therefore, whatever the sound or words they have heard, they will always trying to repeat the same things. It is consider as one types of communication issue because it will directly cause them fail to communication with others. Besides that, the people who are suffering from Autistic Spectrum Disorder may not express the body language during the communication. Facial expression, gesture and also the movements that may not match to what they are saying. It causes others people cannot understand what they are actually talking about. Besides that, the second limitation is called unusual responses. Autism people will feel very difficult to make the task that required the Processing and integrate the sensory information, so they will easily get experience some of the stimuli such as unpleasant and confusing. On the other hand, the third limitation is called Social Impairment, this limitation will also limit the people with Autistic Spectrum Disorder to communicate with others. They have a problem of difficulty to interact with others. In addition, Autistic Spectrum Disorder will cause them have a difficulty to making friends with others and also will make the person are not interested to do so. They seem to lack the intuition needed to recognize and understand how others are feeling or reacting, and they may not appear to react to others' feelings and actions. Therefore, all of this is a limitation of Autistic Spectrum Disorder to communicate.

#### 2.2 Interactive Computer Game Environment

#### 2.2.1 Computer Technology and platform

First of all, people with Autistic Spectrum Disorder can enhance their communication through Computer technologies, because the powerful new tools have been provided

by Computer technologies to improve the Autism child's communication issues. Therefore, Computer Technology is playing a very important role to enhance learning and also communication among the children with Autistic Spectrum Disorder. In the few past years, the use of computer technology is rarely. But nowadays, the trend of using computer technology has rapidly growth, at the same times the Computer Technology for the children with Autistic Spectrum Disorder is sharply increased. However, the reason of why they choose computer technology it is because Computer device has opened up immense possibilities for children with Autistic Spectrum Disorder. (Lehman, 1998; Michaud and The berge-Turmel, 2002; Pare s et al., 2005). Computer devices serve as an augmentative and alternative communication and had since gained popularity because of its flexible multimedia content and storage, portability, mobility and affordability. On the other hand, the potential of Computer technology on the children's progress have already identified by the Autistic associations. In addition, there are some advantages of Computer technologies that can be provided for the children with Autistic Disorder. For the Computer technology, the autistic child can access to the tools to play and communicate ubiquitously. By using the Computer technology, it makes them easy to access to the games. Besides that, Computer technology is also make it possible for the Autistic child to using one of the many applications available, the carer can help to manage social and also emotional skills and behavior management. (Liu, 2015) Lastly, there are plenty of the applications that are design for the people who are suffer from the Autistic Spectrum Disorder. Those applications have been developed for MacOS or Windows Platform.

#### 2.2.2 Contribution of Computer Game for Autistic Spectrum Disorder

Lastly, there are two main important contribution of Computer Game for Autistic Spectrum Disorder. Moreover, parents and teachers can assist by computer game to moving those children with Autistic Spectrum Disorder towards a potentially independent life, while providing tools to facilitate communication and this application itself.

#### 2.2.3 Techniques

Firstly, there are several types of techniques that are used to build the interactive Computer game environment for Autistic Spectrum Disorder.

- ✓ Speech Recognition engine is one of the techniques that are used to build the games. The main purpose of using Speech Recognition is to detect the desired word, the back-end for speech recognition is actually supported by this techniques that called Speech Recognition engine.
- ✓ XML grammar file, the comparison work is made by XML grammar file, such as if the word speaks by autistic children are not match to XML grammar file, and they will not be given any points.
- ✓ Graphic User Interface (GUI), it is used to support front-end for communication.



The idea of how the techniques works are shown below:

#### 2.2.4 Methods

Interactive Computer game environment for Autistic Spectrum Disorder can be built by several methods. Those people who face the issue of unable to speak with intelligible sounds is the main purpose of built the first interactive game. This kind of interactive game also called an interactive e-learning game. This game is developed for the autistic children who are facing unintelligible sounds problem, they will try their best to produce clear words to communicate to the device by using interactive elearning game. In order to help the Autistic children to eliminate their unintelligible sounds problems, there come out with an interactive game to solve it. The methods that is used by this game is there are different types of image that will appear one by one in the graphic user interface .If autistic children are successful to pronounce the name of the image clearly, then they will get the score and win the game. To avoid the problems of synonyms, the methods that are used to solve this they can set the words for each of the images which based on their familiarity. The second method is Pivotal Response Treatment (PRT), it is a naturalistic approach to behavioral intervention that is grounded in applied behavior analysis (ABA) method and developmental psychology, and this method is based on the practices of educating autistic children in order to teach the children with Autistic Spectrum Disorder.

### 2.2.5 Existing Application

"cMotion" is an existing Computer application. However, the visual characters are introduced and used to this game.

#### Advantages

- ✓ Reinforce emotion recognition by using Virtual Characters and also the logical problem solving to both normally developed children and high-functioning autistic children.
- ✓ It is also provide an interactive interface which focuses on the computer programming.

- ✓ To help Autism child to pay more attention, it provided a way that let the children to set the interface sound.
- ✓ It will gather the demographic information by letting them to talk with their virtual comrade.
- ✓ Those children with Autistic Spectrum Disorder can get improving their social interactions

### Limitation

✓ There are only few of gestures is available for Visual characters to perform.



Figure 2.2.5-1: cMotion Computer Application

"**Picaa**" is another type of existing Computer game application that are currently provide in the MacOS platform.

### Advantages

- ✓ This game successful to bring positive effects in the development of learning skills for the children who have special educational needs.
- ✓ Able to help autistic children to improve their basic skill such as language, social and so on.

By using **"Serious game"** to teach social interactions to individuals with autistics Spectrum Disorder is the purpose of the game. Currently there are 31 serious games, 16 of serious game is focus on emotion recognition or production and another 15 of them is focus on social skills.

### Advantages

- ✓ It is focus on providing feedback related to achieving long-term goals.
- Enhancing intrinsic motivation for learning by providing players with information about their progress toward incremental and primary learning goals

### Limitation

- ✓ Most of them all focusing on developed the game for High-Functioning individuals.
- $\checkmark$  Secondly, the game design is not usually described.
- $\checkmark$  Most of the cases the clinical validation and game design are not compatible.

"Visual-Spatial Concept Jigsaw Puzzles" is also other types of existing Computer game for Autistic Children.

### Andvantages

- ✓ helping autistic children to utilize their strong intelligences
- ✓ Intelligences that include visual-spatial intelligence, to enhance their communication and learning using a tablet computer game.

Levels	Level 1-Rails	Level 2-Pipes	Level 3-Snakes
Graphics			
Concept	Using route planner to train rationalization of spatial cognition.	Taking non- representational graphic design to train logistic concept.	Applying optical illusion to include spatial cognition, logistic thinking and virtual graphics for advanced training.

Figure 2.2.5-2: Jigsaw Puzzles concept



Figure 2.2.5-3: Jigsaw Puzzles game Interface

2.2.6 Similarities of games.



Above image is one type of the similarities game that is designed for the people with Autistics Spectrum Disorder. This game called "Build-a-train". By playing this game, On the left hand side, player are required repeating to choose the correct railroad in order to match with the model train



Another similarities game are show above and it is called "Wheels and Roads". According to the road marked to decide the direction of players' vehicles. All of this game is used to assist the ability to notice and respond to simultaneous multiple cues in early elementary autistic children or children with learning difficulties.

### 2.3 Project Comparison

Nowadays, there are plenty of the application is available for those children with Autism Spectrum Disorder. According to those similarity applications that are show above, there are also have some differences with this 3D Computer Game Project compare to those current applications. Below table show the differences:

	My Project	cMotion	Visual-Spatial Concept Jigsaw Puzzles	Picaa
Provide Virtual Character to improve emotional Recognition	×	✓	×	×
Provide Speech Recognition function to enhance their speak clarity	✓	✓	×	×
Provide some task to improve visual spatial skills	✓	×	✓	✓
Provide Augmented Reality techniques to show 3D object	~	×	×	×
Provide different word to enhanced vocabulary	✓	×	×	<b>~</b>
Provide 3D object	$\checkmark$	$\checkmark$	×	×
Provide Puzzle Task	×	×	✓	✓

Tuble 2.3.1. project comparison	Table	2.3.1:	project	comparison
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# **Chapter 3: Problem Analysis**

## 3.1 Questionnaire Analysis (Before User Testing)

### 3.1.1 Questionnaire analysis – Spatial Learning Test



Figure 3.1.1-1: unusual visual spatial skill problem (Question1)

Above figure 3.1.1-1 show the result of who are suffering the problems of unusual visual spatial skill. Moreover, above pie chart shows that there are 100% (Total 5 respondents) of the respondents are currently facing the problem of unusual visual spatial skill.



Figure 3.1.1-2: Look at the pointing location (Question2)

Above figure 3.1.1-2 show that, when you point to something, there are 60% of the respondents (3 people) will not look it, which means that they will not show any reaction. Besides that, there are only 40% of them (2 people out of 5) will look to the location which you are pointing at.



Figure 3.1.1-3: understand others people instruction (Question3)

Above figure 3.1.1-3 show that, when someone are trying to ask them to do something, there are 80% of them (4 people out of 5) do not understand what other people are asking for. On the other hand, there are only 20% (only 1 people) are understand the other people's instruction.



Figure 3.1.1-4: Paring the number to corresponding image (Question4)

Above figure 3.1.1-4 is a question that ask the user to base on the instruction and write down the corresponding number next to the image. There are 9 images there, but there are just have 3 numbers (number 1 to 3) for user to write. This figure shows that, there are 2 respondents are successfully to write correctly a number to the corresponding image, but another 2 numbers are not be able to do correctly. On the other hand, other 3 respondents' answers are totally wrong.



Figure 3.1.1-5: Draw line to point to the third object (Question5)

Above figure 3.1.1-5 is a question that ask the user to draw a line to point to the third object which is specify in the question. In this question, there is only one respondent's answer the one question correctly out of 3. Moreover, 4 respondents fail to answer the question correctly.



Figure 3.1.1-6: Draw line to connect one object to the other (Question6)

Above figure 3.1.1-6 is a question that ask the user to draw a line to connect one object to the other. Since, this question is more easier compare to the question 5, so the figure show that there are 3 respondents are able to draw a line correctly, but another two line still connect to the wrong place. On the other hand, the line draws by the other two respondents are totally wrong.

#### 3.1.2 Questionnaire analysis - Interaction Test



Figure 3.1.2-1: Interact (Question 1)

From the above figure 3.1.2-1 show that, the percentage of the people who are often interact with an object are lesser than the percentage of the people who are no often interact with it. However, 80% (4 people out of 5) of their answer is "No". On the other hand, the "Yes" answer only has one respondent (20%) to choose it.



Figure 3.1.2-2: Repeat to do same things (Question 2)

In this question 2, there are 60% of them (3 people out of 5) will always do the same things over and over again in the same way. Fortunately, not all the respondents have this kind of problem, from the figure4.4.2-2, we can see that they are still have 40% of the respondents (2 people) are not facing this kind of problems.



Figure 3.1.2-3: Interaction to an object (Question 3)

From above figure 3.1.2-3 show that all of the respondents (100%) are not able to done the interaction task correctly.



Figure 3.1.2-4: Time to solve interaction task (Question 4)

Figure 3.1.2-4 show that the percentage of the people who choose the answer of "unable to solve it" is the same as the percentage of the people who answer is "within 16 -30 minutes". Both of them occupy 40% for each, which mean that each of the answer have 2 respondents to choose. On the other hand, the answer of "within 6 - 15 minutes" only have 1 respondents choose this answer and no respondent are able to solve the interaction task correctly within 5 minutes.


Figure 3.1.2-5: Move burger ingredients to correct place (Question 5)

In question 5, the job of the respondents is to draw a specific object to put on the specific location. This purpose of this question is to test their interaction with the objects. Above bar chart show that there are 4 respondents' answers are totally wrong. There is only one respondents at least can do one correctly the question.



Figure 3.1.2-6: Move football to correct place (Question 6)

The solving method of this question is same as the previous question (Question 5) but we can see that the result of this question is slightly better than question 5. Moreover, there are 2 respondents can draw correctly one of the object to the specific location which is specify in the question. Another 3 respondents still cannot do correctly one of the questions.

3.1.3 Questionnaire analysis – 3D Computer Game environment Test



Figure 3.1.3-1: Experience of 3D computer game (Question 1)

Figure 3.1.3-1 show that there are 60% of them do not have any experience about playing the 3D computer game and the percentage of the people who have experience it before are only 40%.



Figure 3.1.3-2: play computer game (Question 2)

Above figure 3.1.3-2 is a pie chart statistic of investigate how often does the respondent play computer game. As we can see that, 60% of them are never play the computer game and 40% of them are playing it monthly.





From the figure 3.1.3-3, we can see that most of the respondents think that they have learned nothing from gaming and the percentage of this group of people is up to 80% (4 people). Only one respondent choose the "Yes" answer and they have learn something from gaming.



Figure 3.1.3-4: Level of like to play computer game (Question 4)

From above figure 3.1.3-4, we know that 60% of the respondents (3 people) are currently do not like to play on the computer, but still have 40% of the respondents (2 people) like to play on the computer.





Based on the figure 3.1.3-5, we can see that all of the respondents think that computer game have provided an appropriate level of customization concerning different aspects.



Figure 3.1.3-6: The level of the skills in playing computer game (Question 6)

Lastly, in this question 6 is to test and see how good does the respondent feel they are at playing computer game. Moreover, it shows that, 60% of the respondents are no skill in playing computer game, and 40% of them think that they are not very skilled in playing the game.

# **Chapter 4: System Design and Architecture**

# 4.1 Technologies and Methods Involved

Firstly, C# language is a programming language that will be used to develop the 3D Computer game application. C# language is an appropriate and better language for computer game developer to develop their own computer games. Hence, this language is the most suitable language for developer to use to developing the games application. Besides that, the primary scripting language of the game engine is C# language.

In this computer game application should include 3D graphic objects, countdown timer, Voice recognition and Augmented Reality. 3D graphic objects introduce in this project is used to avoid "boring mood" occur, so 3D can used to attract those autism child, to make sure that they will concentrated and they will also become more likely to implement them to playing this game. There have a relation between 3D graphic objects and Voice recognition. Firstly, the purpose of Voice recognition is used in this project is to training those autism children to speak more clarity. Due to the children with Autistic Spectrum Disorder, they are do not like to speak with others, so we use the attractive and cuties 3D graphic object to motivate them to speak with clarity. So in this project they have a part that it can let the children to speak by using voice recognition to detect the voice. There are also provide timers in this project, the purpose of this timer is ensuring that they can improve their responding time for answering the question. However, the more question they have answered and perform correctly, the more points they can earn, if they are fail to performing some task they will not get any points, and they will keep trying to make it correctly, so by playing this computer game they can feel challenges and get more motivate to do it. Besides that, This application also have designed a quiz game for them to play in order to improve their vocabulary, However, this game will introduce Augmented reality to attract those children and help them to pay more attention when they are answering the question.

Lastly, "Technology-Facilitated of Unity 3D Computer Based Interaction with Autistic Spectrum Disorder" application will be work on the windows10 platform.

All of the technologies and Methods involved in this project is shown below:

✓	Programming Language	: C#
√	Software	: Unity, SketchUp, Blender
✓	Database	: Firebase
✓	Technologies	: 3D object, Augmented Reality

There are two applications for this final project, the first application is a 3D computer game, and this is an online application. It required the user to connect to the internet in order to perform the Speech Recognition function. In this game application, there is one "quiz game" which required the player to use the second application to answer the question. Moreover, the second application is an android application, this application using the Augmented Reality techniques to show the 3D model object. The player just need to use this application scans the "quiz game" to show the AR 3D object.

# 4.2 System Architecture



Figure 4.2 -1: Text-to-Speech Architecture



Figure 4.2 -2: System Architecture for Computer Game Application

Above figure 3.2-2 is show the architecture for this 3D Computer Game application. Player are only be able to access to the High score database with the internet connection. When the player are trying to get the History score from the database, then this application will start communicating with the server. Moreover, the flow of the data between request and response will be control by the server. After that, the server will retrieve the data from the database and then response and display the data to the player. For this 3D computer game application, there is one level called 'Level2'which required user to use the speech recognition function to perform the task. Therefore, in this case, the player can only be using this function with the internet connection. When the user are trying to speak something and then this application will response back to the player and show the detected word on the screen.



Figure 4.2 -3: System Architecture for Android Application

Above figure 3.2-3 is show the architecture for this AR Camera Android Application. In this application, there is one function called "Text-To-Speech" are allow the player to use it. This function can only be use with the internet connection. Moreover, when the player wishes to learn how to pronounce a word, then they can type in a word and get the speech back through this application with the internet connection.



### 4.3 Block Diagram

First of all, user can select either they want to start playing Level1 or quiz game. If their selection is start playing Level1, then they have to complete all of the tasks that are state in this level. They can only proceed to the Second Level when they successful to done all of the tasks in Level1. Level1 is trying to improve their Visual Spatial Skill, and Level2 is trying to improve their Speech Disorder issue. Besides that, if the user selects the quiz game to play, they must use the android application to scan the question, after scan it, the Augmented Reality 3D model will display in their mobile phone. They can answer the question either true or false depending on the 3D model. This game is design to improve their vocabulary. Text-to-Speech function can also be found in this android application. This function allows the user to type in a word and then it will pronounce the specific word.

### 4.4 Game Application Design / Overview

Firstly, the entire of this game application will be using different types of diagrams to describe it in details. Diagrams that will be use to describe this application that includes use-case diagram, sequences diagram, activity diagram, and description of the use case. All of the functions and features and also the entire work flow of "Technology-Facilitated of Unity 3D Computer Based Interaction with Autistic Spectrum Disorder" will be explain by using diagrams.

Moreover, "Technology-Facilitated of Unity 3D Computer Based Interaction with Autistic Spectrum Disorder" is a 3D computer game application which required the final user to use their sound and visual spatial skill, therefore, the main important thing for this project is to provide the Speech Recognition function for the user to perform the task.

Furthermore, presentation storyboard will use to show the real interface, in order to provide the idea of how the application will looks like. Presentation storyboard is useful, it can let the developer to use the presentation storyboard present it, so that the audience can get the clear idea of this application.

### 4.4.1 Use Case Diagram



Figure 4.4.1: Use Case Diagram

# 4.4.2 Use Case Description

Name of Use Case : Start Game		ID : 1	Important Level : High				
Actor : Player	Тур	pe of Use Case :					
	Essential, Detail						
Stakeholders + Interests:							
Player – desire to Start Game so that c	an pl	ay and exper	ience the game.				
Description :							
It is describes how the player starts the	e gan	ne.					
Trigger: Player desire to Start the Gam	e in d	order to play	and experience it.				
Type : External							
Association : Player							
Include : Select Level							
Extend : Exit Game							
Event Flow (Normal) :	Event Flow (Normal) :						
1. Player wants to Start Game in	1. Player wants to Start Game in order to play and experience it.						
2. Player click Start Game button	•						
4. The game application Load the	gam	ne.					
5. The game application display s	select	ed Level scer	ne.				

# Table 4.4.2.1: Start Game Use Case Description

Name of Use Case : Option		ID : 2	Important Level : High			
Actor : Player	Typ Ess	e of Use Case sential, Detail	2:			
Stakeholders + Interests: Player – desire to go to Option panel in order to adjust the volume of background music and also adjust the quality of the graphic.						
Description: It is describes how Player adjusts the volume and the quality of the graphic.						
Trigger: Player want to go to Option panel to adjust volume and graphic level. Type : External						
Association : Player Extend : Adjust volume, Mute background music, Adjust graphic quality						
Event Flow (Normal) :	Event Flow (Normal) :					
<ol> <li>Player wants to adjust volume or graphic quality.</li> <li>Player click Option button.</li> <li>The game application shows the Option panel.</li> <li>Player adjusts the volume of graphic.</li> </ol>						

#### Table 4.4.2.2: Option Use Case Description

lame of Use Case : Help Panel		ID : 3	Important Level : High				
Actor : Player	Тур	e of Use Case	2:				
	Essential, Detail						
Stakeholders + Interests:							
Player – desire to go to Help Panel in c game.	order	to get some	idea of how to control the				
Description :	Description :						
It is describes how the Player can get t	he ic	lea of how to	control and play the game.				
Trigger : Player wants to get the idea c	of ho	w to control a	and play the game				
Type : External							
Association : Player							
Event Flow (Normal) :							
<ol> <li>Player wants to go to the Help game.</li> </ol>	pan	el to get the i	dea of how to control the				
2. Player click Help button.							
3. The game application shows the	he He	elp panel.					
4. Player gets the idea of how to control the game from the Help panel.							

#### Table 4.4.2.3: Help Panel Use Case Description

Name of Use Case :		ID : 4	Important Level : High				
Interaction and Manipulation							
Actor : Player	Тур	Гуре of Use Case :					
	ESS	ential, Detail					
Stakeholders + Interests:							
Player – desire to Control Character in	orde	er to perform	the given task.				
Description :							
This use case describes how the Playe	r Con	trol the Char	acter to perform the task.				
Trigger : Player want to Control the Ch	naract	ter					
Type : External							
Association : Player							
Extend : Move, Grab Object							
Event Flow (Normal) :							
1. Player wants to control the Ch	1. Player wants to control the Character.						
<ol> <li>User press "W or 个" to move forward, "S or ↓" to move backward, "A or ←" to move to the left, "D or →" to move to the right. Player can also grab or place the chiest</li> </ol>							
<ol> <li>The game application keeps updating the position and shows the real-time position to the player.</li> </ol>							

#### Table 4.4.2.4: Interaction and Manipulation Use Case Description

Name of Use Case : Speech Recognition		ID : 5	Important Level : High			
Actor : Player	Typ Ess	e of Use Case ential, Detail	e :			
Stakeholders + Interests: Player – desire to use Speech Recognition function to perform some specific given task.						
Description : It is describes how the Player uses Speech Recognition function to perform the specific task.						
Trigger: Player wants to use Speech Recognition function to do some tasks Type : External						
Association : Player						
Event Flow (Normal) :						
<ol> <li>Player wants to use the Speech Recognition function to do a specific task.</li> <li>Player press Numeric Keypad Enter to start the Speech Recognition Function.</li> <li>Player speaks to the game application.</li> <li>The game application starts detecting the word.</li> <li>The game application displays the detected word to the screen.</li> </ol>						

# Table 4.4.2.5: Speech Recognition Use Case Description

lame of Use Case : Restart Game		ID : 6	Important Level : High			
Actor : Player	Typ Ess	e of Use Case ential, Detail	2:			
Stakeholders + Interests: Player – desire to restart the game in order to continue play the game						
Description : It is to describe how the Player restart the game						
Trigger : User want to restart the game Type : External						
Association : Player						
Event Flow (Normal) :						
<ol> <li>Player wants to restart the game in order to continue play the game.</li> <li>The game application is time's up, it will display the time's up panel and restart button.</li> <li>User click restart button to restart the current level of the game.</li> </ol>						

#### Table 4.4.2.6: Restart Game Use Case Description

Name of Use Case : Task Dialogue		ID : 7	Important Level : High		
Actor : Player	Type of Use Case Essential, Detail		e :		
Stakeholders + Interests: Player – desire to see the Task Dialogue, so that they can perform the task					
Description : It is to describes how the Player see the Task Dialogue.					
Trigger : Player wants to see the Task Dialogue Type : External					
Association : Player					
<ol> <li>Event Flow (Normal) :</li> <li>Player wants to see the Task Dialogue.</li> <li>Player clicks a specific object.</li> </ol>					
<ol> <li>The game application pop up a Task Dialogue to the player.</li> <li>Player performs the task base on the task that is written in the Task Dialogue.</li> </ol>					

#### Table 4.4.2.7: Task Dialogue Use Case Description

Name of Use Case : Achievement Task		ID : 8	Important Level : High			
Actor : Player	Type of Use Case : Essential, Detail					
Stakeholders + Interests: Player – desire to see the Achievement task, so that they can get to know which task has already performed.						
Description : It is to describe how the Player sees the Achievement Task.						
Trigger: Player wants to see the Achievement Task. Type : External						
Association : Player						
Event Flow (Normal) :						
<ol> <li>Player wants to see the Achievement Task.</li> <li>Player press "m" key to show the Achievement Task board.</li> <li>The game application pop up an Achievement Task board to the player.</li> <li>Player performs the uncompleted task which is display in Grey colour in Achievement Task board.</li> </ol>						

#### Table 4.4.2.8: Achievement Task Use Case Description

Name of Use Case : Text-To-Speech		ID : 9	Important Level : High		
Actor : Player	Typ Ess	Type of Use Case : Essential, Detail			
Stakeholders + Interests: Player – desire to type a word, so that the word.	they	can play and	get to know how to pronounce		
Description : It is to describe how the Player performs Text-To-Speech Function.					
Trigger: Player wants to type a word and get to know how to pronounce the word. Type : External					
Association : Player					
Event Flow (Normal) :					
<ol> <li>Player wants to learn to pronounce a specific word.</li> <li>Player type in a word.</li> <li>The game application pronounces the word.</li> </ol>					

## Table 4.4.2.9: Text-To-Speech Use Case Description

Name of Use Case : Display AR model		ID : 10	Important Level : High			
Actor : Player	Typ Ess	Type of Use Case : Essential, Detail				
Stakeholders + Interests: Player – desire to see the 3D model, so that they can answer the question based on the 3D model.						
Description : It is to describe how the Player display the 3D model.						
Trigger: Player wants to see the 3D model, in order to answer the question. Type : External						
Association : Player						
Event Flow (Normal) :						
<ol> <li>Player wants to see the 3D model.</li> <li>Player use android application to scan the question.</li> <li>The android application displays the AR 3D model.</li> <li>Player base on the specific AR 3D model to answer the question.</li> </ol>						

# Table 4.4.2.10: Display AR model Use Case Description

a of						
Description : It is to describe how the Player to display the Top 20 High Score Record.						
Trigger: Player wants to see the High Score Record, in order to know which area of the skills they are facing problems. Type : External						
Association : Player						
rs.						

# Table 4.4.2.11: Display High Score Record Use Case Description

#### 4.4.3 System Functionalities

According to the use case diagram, there are several functions in this application:

- Start Game
  - ✓ This function is to let the user to start playing the game. In this function, user are allow to select the game to play before they start playing the game, they can either select level1 or quiz game to play it.
- Option
  - ✓ The function of "Option" is to let the user to adjust the game. In this function, user are allow to adjust the volume level of the background music, mute the background music, and also can adjust the graphic level of the game.
- Interaction and Manipulation
  - ✓ The function of "Interaction and Manipulation" is to let the user to move, grab and place an object to a specific location. In this function, the user can move forward, backward, left and right to control the character. Besides that, it is also allow the user to grab and place an object to a specific location.
- Speech Recognition
  - ✓ This function is to force the user to speak to complete a task. In this function, the user can speak a specific word or sentence to perform the task.

- Display Augmented Reality (AR) model
  - ✓ This function is to let the user to scan the question of the game. In this function user are required to use our android phone application to scan the game question to display the AR 3D model, so the user must base on the model to answer the true and false question.
- Text-To-Speech
  - ✓ The function of the "Text-To-Speech" can pronounce the words entered by the user. In this function, user can type in a word, and then this android application will pronounce the words entered by the user so that the user can improve their vocabulary and also get to know how to pronounce it.
- Display High Score Record
  - ✓ This function are able to show the Top 20 Historical high score database to the user, so the user can base on the top 20 historical score data to strengthen their barriers.

# 4.4.4 Activity Diagram



Figure 4.4.4.1: Activity Diagram for Starting the game



Figure 4.4.4.2: Activity Diagram for the Option Panel



Figure 4.4.4.3: Activity Diagram for the Help Panel



Figure 4.4.4.4: Activity Diagram for Exit the Game (during game start)



Figure 4.4.4.5: Activity Diagram for Restart the Game



Figure 4.4.4.6: Activity Diagram for Interaction and Manipulation



Figure 4.4.4.7: Activity Diagram for Speech Recognition



Figure 4.4.4.8: Activity Diagram for Text-To-Speech



Figure 4.4.4.9: Activity Diagram for Display AR 3D model



Figure 4.4.4.10: Activity Diagram for Display High Score Record

# 4.5 User Interface Design

## 4.5.1 3D Computer Game – Windows



Figure 4.5.1-1: Main Menu Page

First of all, this is the first scene that will be show to the player when they open the Game application. Due to the target player is for those Autism Spectrum Disorder children, so the main menu will show the simple design layout to them, so that they can easily get the idea of how to use and control it. When the Main Menu is opened, and the background music will also be play at the same time. However, there are four simple different choices are allow the player to choose. The four choices that include:

- ✓ START-GAME
- ✓ OPTION (adjust the background music volume)
- ✓ HELP (show the instruction of how to play the game)
- ✓ EXIT



# Figure 4.5.1-2: OPTION

Figure 4.5.1-2 show the Option design layout. When the user click on the Option button, the game application will show the Option panel to the user, inside the Option panel they can adjust the level of the volume, they are also allowed to MUTE the background music directly. Lastly, the Graphics adjustment is only give the user to choose the clarity of the background. If they choose "VERY LOW" the background will become very blur.


Figure 4.5.1-3: Help

Figure 4.5.1-3 shows the Help scene design layout. When the user click on the 'Help' button, the game application will show the Help panel to the user, inside the Help panel they can get to know the idea of this game about which button are required to use for what purpose. Besides that, for the 'right' button, user can click it (show in Figure 4.5.1-4) to see what is the function of this button are provided. After click it, it will show the sample to demo to the player, the purpose is to help the player to get a idea how its work.



Figure 4.5.1-4: button clicked



## Figure 4.5.1-5: Historical Score Data

Above figure 4.5.1-5 show the Top 20 Historical data. When the user click the database icon that are shown in the main menu, this application will retrieve the data from the database and display the Top 20 history score data to the user. So, they can get to know that which area or Level they are facing, then they can depend on this result data to improve their barriers.





This is the scene that will show to the user when they click the Start Game button. There are two different types of game. However, different level will help to improve different skills. For level 1 (this level is trying to improve their visual spatial skill), it is the level that will ask the user to take some object to put to the specific location. After the user has done all of the task in Level 1, they can proceed to next Level which is Level 2. Level 2 (this level is trying to improve their speech skill, so that they are able to speak more clearly), this level will show some task to the user and the task are required the user to speak to perform the task such as "ask the user to change the object colour" and so on. Besides that, for the "Quiz" game, it is design to help the children to improve their vocabulary by using the Augmented Reality Techniques and also provide the true and false question for them to answer.



Figure 4.5.1-8: Item (grabbed)

This scene will show to the user when the user chooses the Level 1 to play. From the level 1, the user is allowed to grab and place the object to a specific location. All the item that already grabbed by the user will store in the 5 small boxes, then user can drag and drop the object to place it to a specific location. Figure 3.5.1-8 shows the items have already collected by the user. Besides that, in this level, there is a timer starting to countdown, so user has to ensure that they can solve the given task within the time. If the time's up, then the screen will show the restart button to user, if the user clicks the restart button they have to redo the entire task. The restart screen is show below (Figure 4.5.1-9):



Figure 4.5.1-9: Level 1 (Time's Up screen)



Figure 4.5.1-10: Task Achievement

Above Figure 4.5.1-10 show that user can get to know what they want to do in this Level. When they have achieved and done one of the tasks, this achievement board will automatically change the colour from Grey to Yellow colour. The main purpose of changing this colour is easier for them to check which task haven't done yet, so they can go to complete the task which is still in grey colour mode.



Figure 4.5.1-11: Notification

Besides that, when the user have done a task, this application will direct display it to notify the user, so user can easily to get to know whether they have completed the task. The notification will display on the Top Center side. Above figure 3.5.1-10 show the notification.



Figure 4.5.1-12: Level 2

This is the scene will show to the user when they come to Level 2. When the Level 2 is start, it will fist pop up the "welcome panel" to the user. Left-top hand size they have a coin icon, the number of coin number will increase when the user is done the given task. The detected word will show on the bottom (inside the white box), so that user can know whether they speak correctly or not. There is also having the timer in all Level. In this game, it is also apply the shadow to show the better visual for the user.



Figure 4.5.1-13: Level 2 (show the task)

Figures 4.5.1-13 shows that if the user clicks on the specific object, it will pop up the task, and the user has to perform the task correctly in order to earn the coin.



Figure 4.5.1-14: Level 2 (coin earned)

Figure 4.5.1-14 show that, when the sound which is produced by the user is clear enough to detect by the game application, user will automatically earn the coin.

Above figure also show that, when the user speaks "Yellow Color" the colour of the object will be change from Green colour to Yellow colour. When this application have successful to detect the word, then user will also direct receive and display the notification to the user.

Lastly, when the Time is countdown at "0", it will also show the Restart button to the user to restart again the game, otherwise, the user are consider as "Game Over".



Figure 4.5.1-15: Level 2 (2<sup>nd</sup> environment)



## Figure 4.5.1-16: Quiz Game

This is another game called "Quiz" game, this game are allow the user to choose either TRUE or FALSE to answer the question. If the answer is correct, then it will show the correct word, but if it is a wrong answer then user will see the wrong word display on the screen. The main purpose of this game is to improving their vocabulary. Moreover, this game are required the user to use another application (android mobile application – Augmented Reality) to scan the white box in order to see the VR 3D model. User can only answer it after they scan the question, otherwise they are not be able to answer it.

## 4.5.2 Augmented Reality camera mobile application - Android



## Figure 4.5.2-1: AR camera

Above Figure 4.5.2-1 is an android application that has a function called Augmented Reality Camera. This function is typically design for the quiz game. User has to use this AR camera to scan the white colour box which is display in the Quiz game. After scan it, this mobile application will display the 3D model, so the user have to answer the question depending on this 3D model.



Figure 4.5.2-2: Speech function

This application not only provides the AR camera for user to scan the question, it also has provided the Text-To-Speech function for the user to learn how to pronounce a word. Besides that, although the quiz game is design to help them to improve their vocabulary, but sometimes the user may face the problem to pronounce the word, so they can direct to use this android application to type in a word and then this application will pronounce the specific word for them. It is easier and convenience for them to learn a new word. Therefore, this can ensure that the user are not only learn a new vocabulary but also can pronounce it correctly.

# **Chapter 5: System Methodology and Proposed System**

# **5.1 Methodology and Tools**

## 5.1.1 Agile Model



Figure 5.1.1-1 Agile Approach

First of all, the software development model that I have chosen to use in this project is Agile Approach. Agile model is a type of methodology. This approach is normally used by the game developer to develop their game. Agile model is a term used to describe approaches to software development emphasizing incremental delivery, team collaboration, continual planning, and also continual learning. Therefore, the most suitable methodology can be used for this project is Agile development, it is because the entire array of the tasks is actually divided into multiple sub-tasks. The basic concept of agile model is show below figure 5.1.1.



Figure 5.1.1-2 Concept of Agile

There are 6 phases in agile model which is show below:

- Planning
  - Planning is an initial phase of this methodology, the features will be break down into a few task. Moreover, the objective and goals of the development of this game application will be identified in this phase.
- Design
  - Design is a second phase in agile methodology. In the design phase, this computer game will start to design by the game developer. Therefore, the game design will be based on the user requirement to build the architectural of the game, and it is also include the User Interface (UI) design of the project.

- Develop
  - Develop is a third phase, after the design phase have done, the development work will start doing on this stage. However, due to the agile approach, the feature of this project will spread in to different small part to ensure that it is easily to make any changes for this project. Each part on this stage will start to develop their features.
- Testing
  - After the develop stage, will come to Testing phase. In this stage, different types of testing will be test on this game application. The four types of testing will conduct in this stage in order to make sure that the features is actually solving the needs. Testing which includes black box testing, functional testing, performance testing and beta testing.
- Evaluate
  - In this stage the models obtained are more thoroughly evaluated and the steps executed to construct the model are reviewed to be certain it properly achieves the business objectives.
- Meet
  - Meet is the last phase of this methodology, it is a last stage for each part of the features, In this stage, game developer have to ensure that all of the features have already fulfilled and fully meet the feature which is required by our target user.

#### 5.1.2 Unity - Development Tools

• The functionality of providing an awesome 2D or 3D games is offered by the game Unity Technology. This Technology is also a game development platform. Unity is able to let their customer to realize their creative vision fast, and deliver their content to virtually any media or device. Obviously, Unity is a very powerful graphics engine and full-featured editor. Due to the unity is a cross-platform software, naturally, it is allow the user to connecting to audiences on PCs, mobile devices embedded system and so on, so because of this it make the displays can be easily achieved. Besides that, Unity also have provided their own Asset Store, Unity Cloud Build, Unity Analytics, Unity Ads, Unity Everyplay, and Unity Certification is a tools and resources that are provided by Unity. It is a specific tool to use for develops 3D games. After finished the process of building object in SketchUp and blender, Unity is a tool to blend the entire object together and started to build the complete computer game to support for the windows10 platform.

#### 5.1.3 SketchUp - Development Tool

First of all, SketchUp is a 3D modelling tools for a wide range of drawing applications that including game design. SketchUp is a powerful 3D modelling program and it is design to make it easy for developer to use. Online library of free model assemblies is also have provided by SketchUp. Due to this project is a 3D Computer Game application, so SketchUp will be used to build the 3D modelling object such as building and so on. By using SketchUp, It makes it easier to develop a fantastic 3D modelling object in this Computer game application.

## 5.1.4 Blender – Development Tool

Blender is a free and open-source 3D graphics software toolset that can be downloaded from the internet. Blender provide the functionality that allow the user to creating animated films, visual effects, 3D printed models, and so on. Hence, Developer are allow to use the Blender to create Interactive 3D application and video game. It is also include the 3D modelling, texturing, soft body simulation, motion graphic, rendering and so on. Since the functionality of the blender is to build the 3D animation graphics, so in this project, the computer game application will be used it to build the animation on the character or objects, so that the object will looks nature.

# 5.2 Game application - System Requirement

Operating System	Windows 10
Speed of Processor	At least Intel® Core™ i5-4200U CPU @ 1.60GHz 2.30Ghz
Type of the System	64-bit Operating System

#### 5.2.1 Windows game application

#### Table 5.2.1: System Requirement – Windows application

#### 5.2.2 Android AR application

Operating System

Android

Android version

Android 5.0 above

(Android 6.0 is recommended)

#### Table 5.2.2: System Requirement – Android application

BIS (Hons) Information Systems Engineering Faculty of Information and Communication Technology (Perak Campus), UTAR

## 5.3 Questionnaire

First of all, Questionnaire is a method that is used to do a research which includes different types of question in order to collect the information from respondents and it will be conducted in this project in order to retrieve the latest requirement of the user. However, the requirement of the user should be included in the proposed application. There are two types of Questionnaire are show below:

#### **5.3.1 Open-Ended Question**

For the Open-ended Questions, respondents can respond it in the form of a sentences, speech, or even essay. The aim of the open-ended question is to encourage those respondents to come out with their opinion in order to get more information and requirement from them.

#### 5.3.2 Closed-End Question

On the other hand, for the Close-ended Question, the Close-ended Question is easier for respondents to answer with it, compare to the open-ended question. This type of question, it has limited the respondents to answer with it. This is not like open-ended Question, the answer will not be a paragraph or not even a sentences. Thus, it can make it easier to do comparison from the different respondents.

# 5.5 Questionnaire Analysis (After User Testing)



## 5.5.1 Spatial Learning Test

Figure 5.5.1-1: visual spatial skills improved (Question 1)

After we have let all the users to test playing this project's game, the figure 5.5.1-1 show that, after play it all of the respondents agree their visual spatial skills have improved.



Figure 5.5.1-2: look at the pointing location (Question 2)

Based on the figure 5.5.1-2, we can clearly see that all of the respondents will respond to you when point something across the room and they will look at it.



Figure 5.5.1-3: understand instruction (Question 3)

In this situation, there still 20% of the respondents (1 people) sometimes they do not understand others people instruction but most of the respondents understand it. The percentage of the people who understand others people instruction is up to 80% (4 people).



Figure 5.5.1-4: paring number to the corresponding image (Question 4)

Based on above figure 5.5.1-4, we can clearly to know that, 3 respondents can answer correctly all of the questions, 1 respondent answer correctly 2 questions out of 3, and

the last respondent may face some problems that only answer correctly one question and another 2 answers are wrong.



Figure 5.5.1-5: Draw line point to third object (Question 5)

Above figure 5.5.1-5 show that, there are 4 respondents are successful to answer the two questions correct which is question 1 and question 2. The answer of the respondent 2 only 1 answer is correct. Since the question 3 is more difficult than question 1 and question 2, so all of the respondents' answers are wrong in the last question.



Figure 5.5.1-6: Connect one object to the other (Question 6)

Based on the figure 5.5.1-6, we can see that all of the respondents are not facing any bigger problems in this question. All the answer of the first four respondents has made it correctly. Moreover, there is only one answer is wrongly made by the last respondent.

## **5.5.2 Interaction Testing**



Figure 5.5.2-1: Interaction (Question 1)

From the above figure 5.5.2-1 show that, 100% of the respondents said that they often interact with objects.



Figure 5.5.2-1: Keep doing the same thing (Question 2)

In this question 2, there are 80% of them (4 people out of 5) will not do the same things over and over again in the same way. Unfortunately, they are still have one respondent sometimes will do the things over and over again.



Figure 5.5.2-3: Interaction to an Object (Question 3)

From above figure 5.5.2-3 show that all of the respondents (100%) are able to done the interaction task correctly.



Figure 5.5.2-4: Total time to solve interaction task (Question 4)

Figure 5.5.2-4 show that the percentage of the people who choose the answer of "within 16 -30 minutes" is the same as the percentage of the people who answer is

"within 6 -15 minutes". Both of them occupy 40% for each, which mean that each of the answer have 2 respondents to choose. On the other hand, the answer of "within 5 minutes" only have 1 respondents are able to do it.



Figure 5.5.2-5: Place ingredients on the burger-Interact (Question 5)

In question 5, the job of the respondents is to draw a specific object to put on the specific location. This purpose of this question is to test their interaction with the objects. Above bar chart show that there are 4 respondents are able to answer all the questions correctly. On the other hand, the last respondent answer is 1 correct and 1 wrong.



Figure 5.5.2-6: Put the object to specific location (Question 6)

The solving method of this question is same as the previous question (Question 5) but we can see that the result of this question is better than question 5. However, the figure 5.5.2-6 show that, all the respondents have successful to answer correctly all of the questions in question 6.

## 5.5.3 3D Game environment Test



Figure 5.5.3-1: Experience of playing 3D computer game (Question 1)

Figure 5.5.3-1 show that all of them have the experience about playing the 3D computer game before.



Figure 5.5.3-2: play computer game (Question 2)

Above figure 5.5.3-2 is a pie chart statistic of investigate how often does the respondent play computer game. As we can see that, 80% (4 people) of them are play the computer game weekly and only 20% of them (1 people) are playing it Daily.



Figure 5.5.3-3: Learned from gaming (Question 3)

From the figure 5.5.3-3, we can see that most of the respondents think that they have learned anything from gaming and the percentage of this group of people is 100% (5 people). The answer of "No" is 0%.



Figure 5.5.3-4: Likely to play on the computer (Question 4)

From above figure 5.5.3-4, we know that 20% of the respondents (1 people) are currently do not like to play on the computer, but still have 80% of the respondents (4 people) like to play on the computer.



Figure 5.5.3-5: appropriate level to concern in different aspects (Question 5)

Based on the figure 5.5.3-5, we can see that all of the respondents think that computer game have provided an appropriate level of customization concerning different aspects.



Figure 5.5.3-6: Skills of playing computer game (Question 6)

Lastly, in this question 6 is to test and see how good does the respondent feel they are at playing computer game. Moreover, it shows that, 60% of the respondents (3 people) think that they are not very skilled in playing computer game, and 40% of them (2 people) think that they are Moderately Good in playing the game.

# 5.6 Questionnaire - Result and Discussion

First of all, questionnaire is a method that is used to do a research which includes different types of question in order to collect the information from respondents. In this project, I have already conducted the questionnaire for our target user to test it. Besides that, there are total 5 set of the questionnaires that we have collected for this project. Therefore, I will using this information that students have filled in for statistical analysis. Each set of the questionnaire will divide into 3 parts which include Spatial Learning Test, Interaction Test, and also the 3D computer game environment Test. For this questionnaire, we have conducted two testing, one is the before user testing, another testing is called after user testing.

"Before user testing" will be conducted to our target user before they start playing the 3D Computer Game of this project. This testing is important because it can be used to measure the level of our target users' abilities. On the other hand, "After user testing" will be given to user after they have played the 3D Computer Game. By using both of this user testing information, we can compare and see the before and after result.

Below statistic is show the before and after the Spatial Learning Test result (Question5):



Figure 5.6.1: Q5 Visual Learning (Before playing the game)



Figure 5.6.2: Q5 Visual Learning (After playing the game)

Based on the Figure 5.6.1 and Figure 5.6.2, we can easily to see the differences between these two graphs. Obviously, their visual spatial skills have improved after they played the game and their ability is very similar to each other.

Below statistic is show the before and after the Spatial Learning Test result (Question6):



Figure 5.6.3: Q6 Visual Learning (Before playing the game)



Figure 5.6.4: Q6 Visual Learning (After playing the game)

Based on the Figure 5.6.3 and Figure 5.6.4, we can see that there are very bigger gap between these two graphs. Obviously, most of them are not facing any problems on this kind of question. The result show in the figure 5.6.4 is better than the result show in figure 5.6.2, it is because the question 5 (Q5) are more challenging than question 6 (Q6).

Based on the above figure, we can see that this 3D game can help them to improve slightly their visual spatial skills in the long run. On the other hand, the other testing that have included in this questionnaire is called Interaction Testing.



Below statistic is show the before and after the Interaction Test result (Question5):

Figure 5.6.5: Q5 Interaction (Before playing the game)



Figure 5.6.6: Q5 Interaction (After playing the game)

Since, inside this 3D computer game there are many interaction task that required the user to perform, so based on the figure 5.6.5 and figure 5.6.6, we know that their interaction can get improved through playing this computer game. They can get to improve their skills is because when they play the game they will keep trying to solve the task until they successful to complete it. The more you practice, the faster you progress.

## 5.7 Baseline, Treatment and Maintaining Stage.

In this project I have chosen one target user out of 5 to testing. This testing will be divided into 3 different stages. These 3 stages which include 'Baseline stage', "Treatment stage" and also the "Maintaining stage".

The first stage of this testing is a Baseline stage. In this stage I have to make sure that the guy haven't trained before. In this case, the skills or the ability is on the minimum level.

Secondly, the second stage will come to Treatment stage. In this stage, the user have to start playing and training their skills. In this maintaining stage must record his/her performance, so it will take some time in order to get record the progress.

Lastly, it will come to the Maintaining stage. Since this is a last stage, so I will test the user to move from one Level to the other in order to record and see how well their skills.



#### 5.7.1 Baseline Stage

Figure 5.7.1-1: Graph of Baseline stage

First of all, I have spent 3 Days to conduct Baseline stage. Since this is a first stage, the ability of the player is on the minimum level. For this 3D Computer Game, the maximum Point of this level is 100 points. Based on the figure 5.7.1-1, the best record of the player can only reach up to 50 points for 3 days. The lowest record is only 20 points. Moreover we can see that the record from 50 points drop to 35 points in day 3. This means that his skills/ability are not stable enough, the points will drop or increase irregularly.

#### 5.7.2 Treatment Stage



Figure 5.7.2-1: Graph of Treatment stage

Firstly, I have spent 6 Days to conduct Treatment Stage. Since this is a "treatment", so I spent more time to conduct it, compare to the Baseline stage. Based on the graph show in figure 5.7.2-1, we can see that the highest record can go to 75 points and the lowest record is 25points. The trend of this graph also shows that the skills of the player will increase steadily in the long run. When it comes to the certain points, sometimes the points will keep maintaining, even if the points drop also will not drop much. At that time, this situation can called "skills stability". After that, the skills will slowly increase or even can reach the highest point in this level which is 100 points.

#### 5.7.3 Maintaining Stage



#### Figure 5.7.3-1: Graph of Maintaining stage

Firstly, I have spent 9 Days to conduct Maintaining Stage. Since in this stage, the player will move from Level 1 to Level 2. However, the trend of the graph might cause some fluctuations, so it will spend more time to see the trend. For Level 2, the minimum point is 100 rather than 0 and the highest point can go to 200 points. In maintaining Stage, the performance of the player in the first few days is quiet poor. It is a normal situation, this problem will happened because of they still unfamiliar with the new game style. After few days the skills of the player will become steadily. At the end, the trend will become steady.

#### 5.8 Testing Method

#### 5.8.1 Black-Box Testing

• **Black-Box Testing**, It is one of the method that are used to test the software. This testing that actually do not required tester to know how the interior works of this application. During the testing process, it does not touch and access to the application source code, it is just need to providing the inputs and examine the output without knowing how the inputs are

worked upon. Since, it is Black-Box Testing, the most important thing is just need to interact with the user interface and examine the output.

## **5.8.2 Functional Testing**

• **Functional Testing**, it is another type of the method that are used to test the software. Moreover, the specification of this application will be test by Functional testing. The result of Functional Testing is examined that need to conform to the functionality it was intended for by providing the input to test it. This testing of this application is conducted on a complete, integrated system to evaluate the application's compliance with its specified requirements.

## **5.8.3 Performance Testing**

• **Performance Testing**, the application bugs is not testing by performance testing, majority of people are use it to test the application performance issues. Application performance in terms of speed of this computer game, capacity, stability and also the scalability of this computer game.

#### 5.8.4 Beta Testing

• **Beta Testing**, this is another testing can be used to test this application. This testing is providing to our target audience to perform testing on this application. It can be test by providing the application installation to the target audience, after they have done to test and play this computer game application, and then they can send their feedback to us.

# **Chapter 6: System Testing**

# **6.1 Verification Plan**

## Test Plan 1: Top 20 Historical score data

Input	Expected output	Actual output
Player access to the database with the internet connection to see the Top 20 historical score data.		The Top 20 High score data will directly display to the user.
Main Menu START-GAME HELP OPTION EXIT		History TOP 20 Scores 200 score 200 score 200 score 200 score 120
Player access to the database without connect to the internet.		Historical score data are not be able to display on the screen.
Main Menu START-GAME OPT-ION EXIT		History TOP 20 Scores 0 - 100 score> Level 1 101- 200 score> Level 2
Input	Expected output	Actual output
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------	--------------------------------------------------------------------------------------
Try to click the 'Right' button that is display on the screen.		It will directly display what is the function of up, down, left, right keypad.
1 12 13 14 15 16 17 18 19 Function (Level 2)   Close 7 8 9 1 2 3 Image: Speech and a state of the state o		1 1 1 2 3

Test plan 2: Click Right button (display on the 'Help' screen)

#### Test plan 3: Grab and Place an Object

Input	Expected	Actual output
Player walkthrough to grab the object.		The objects that have been grabbed by the player will directly show in the box list (bottom).
Remaining Time: 1287		20 Remaining Time: 1759
Player can place the object using mouse to drag and drop the object to the specific location.		Object will also disappear in the box list when the player drags the object out.
20 Remaining Time: 1759		20 Remaining Time : 1765

#### Test plan 4: Earn Points and Deducted Points

Input	Expected	Actual output
	output	
Player successful to place an object		Points will directly add on the top
b the specific location to earli		left side.
Points.		
20 Remaining the 1758 Y		30 Remaining the state of the s
The marks will be deducted when		Points will also be deducted
the player move the object to		directly on the top left side
another location instead of the		ancedy on the top fort side.
specific location.		
Remaining		Remainer Taxa 720 V

#### Test plan 5: Speech Recognition Function

Input	Expected output	Actual output
Player able to use Speech recognition Function with the internet connection.		If the specific word is detected, the object will be change directly.
120 Remaining The data	X	130 Remaining The state ×   130 Remaining The st

Test plan 6: AR Camera (Android Application) and Text-to-Speech Function

Input	Expected output	Actual output
Try to use AR camera to scan the question.		The android application will show the 3D object on the mobile screen. Besides that, Some of the 3D object will play the sound at the same time.



#### **Chapter 7: Conclusion**

#### 7.1 Project Achievement

In this chapter 6, the result was prove that this project has been fits the three objectives. Firstly, this 3D Game application have already design 3 types of game for the player. Player can either choose to start playing from Level1 or choose to play the quiz game. Moreover, Level2 can only be play by the player when they are successful to complete all of the tasks which are state in the Level 1. The first Level (Level 1), is trying to improve their unusual visual spatial skill. It will provide the tasks which required them to place a specific object to a specific location in order to earn the Points. Besides that, after they have done all of the tasks in the Level1, then they can proceed to play the Level2. In Level2, it is trying to 'cure' their speech disorder issue. All of the tasks in this level are required the player to Speak to perform the task. If this application is not be able to detect the correct word which is speak by the player, and then they will keep trying to speak the word. Practice makes perfect, it can improve their speech disorder issue in the long run. Besides that, quiz game are design to fits the last objective which is improve the Autism Child's vocabulary. This game will provide different words to let the player to learn. Other than the 3 main Objectives, this project also has added some of the different function such as Text-To-Speech and AR Camera. Player can find these two functions in the Android mobile application. AR Camera allows the player to scan the question when they are playing the quiz game. After scan it, the 3D object will directly show on the mobile screen, it also will play the sound effect at the same time to make it more fun. This project are not only aim to improve their vocabulary, but also have to ensure that they can learn a new word and also can get to know how to pronounce it at the same time. In order to achieve it, the Text-to-Speech function will be introduced in this mobile application. Therefore, they can type in a word in the text field and then press the play button to learn how to pronounce the word. Lastly, there is one database created in the 3D computer game application, this database is used to store the TOP20 historical score data. By using this data, we can get to know the current situation of the child and also know which area they are facing difficulty (either Level1 or Level2).

#### 7.2 Problems Encountered

The first problem encountered in this project is the difficulty of making different types of the animation on the game character. Moreover, it is very time consuming to make a character with many types of animation. For this project, I have just made two animation for the character, the first one is called Idle animation, it will be invoked when the character is do nothing, another animation is a walking animation, when the player are trying to move the character, then the walking animation will be invoke at that time.

The second problem encountered in this project is the sensitivity of the Speech recognition function. Sometimes, this function will not easily detect correctly what the player is talking about. So, in this situation the player need to keep trying and practices again and again until this function is successful to detect correctly the specific word.

#### 7.3 Future work

This application can be improved by including other techniques such as emotional expression recognition and also provide a Virtual Reality environment. Autistic Spectrum Disorder children also encounter a problem called 'Lack of emotion expression'. For the future work, this 3D computer game can include emotional expression recognition function to let the children play it. By playing this function, it can help them to make more funny emotional expression, so when they can trying to communicate with others people, they can speak with emotions expression rather than just speak and end the conversation.

Another thing that can be including in this project is Virtual Reality Techniques. This technique can include in this project to make it more fun and more real. Player can grab and place the object by using Oculus equipment to experiences it.

#### 7.4 Conclusion

In conclusion, a game called "Technology-Facilitated of Unity 3D Computer Based Interaction with Autistic Spectrum Disorder" and one android mobile application will be developed in this project. This project is developed to target for those children who are facing the problems of Autistic Spectrum Disorder. First of all, there are 3 main problems in this project. However, three problems that include Speech disorder issue, Unusual Visual Spatial Skill issue, and having a poor vocabulary problem. On the other hand, there are several solution have been proposed in this project. Speech Recognition function will introduced in this project, this function is used to ensure that it can help to improve those Autism Children's speech disorder issue. This game will also ask the user to find and take the specific objects to put on the specific location, this kind of task designed in this project is to ensure that it can help them to improve their unusual visual spatial skills problems. On the other hand, there is one game called quiz game, it have many question are design for the children to answer. Before they answer the question, they have to use the mobile application to scan the question, and then the 3D object will appear on the mobile screen, so they can based on this object to answer the question correctly. The purpose of this task is helping them to enrich their vocabulary. Moreover, this game can divided into 3 types, different types will help our target user to improve their different skills, such as visual spatial, speech, and so on.

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# Appendix

# **Spatial Learning Test**

The purpose of this test is to collect the information about the visual spatial skills from our target user in terms of spatial learning. In order to protect our target users' secret, we will keep all the information in private. It will not disclose to the public.

## PART A

You should circle the answer in part A.

## **Sample Question 1 to 3**:

1. Do you think your Visual Spatial Skills is good enough? (yes  $\sqrt{n0}$ )

## PART B

## **Sample Question 4:**

First of all, below is a sample question 4, which is design to test you and see how well you can use your ability to differentiate the characteristic of an object. It will provide you an image and this image contains different types of objects. In this case, you are required to see carefully the shape and also the color of the objects. Therefore, you have to find the specific object and write down their corresponding number next to the object. You have to complete all the questions within 6 minutes.

Please make sure that you are following the instruction correctly. However, you are NOT allowed to rotate the paper when you are trying to solve the question 5.

#### **Example:**



## **Sample Question 5:**

Secondly, below is a sample question 5. It is trying to test and see how well you can use your ability to imagine different perspective or orientation in space. It will provide you a picture that contains different types of objects and also an arrow circle with a question about the direction between some of the objects. For this question, you are required to imagine that you are currently standing at one object and facing to other object, So, the question will ask you to draw an RED arrow from the center object and show the direction to the third object.

#### Noted:

- The Object of the location which you are standing at will named in the center of the circle.
- The Object name that you are facing will named at the top of the circle.

#### **Example:**



## **Sample Question 6:**

Lastly, sample question 6 is a last question for this Spatial Learning test. It is trying to test your ability to move yourself to the designation location/object. In this question, it will provide you an image and this image there is one people there, so your task is draw a line to guide the guy to the specific location in order to get the object which is specify in the question.

#### Noted:

• Your line CANNOT cross to the wall.

#### **Example:**

Draw a PURPLE line to guide Chris goes to take an apple.



# PART A

1. Are you facing the problem of unusual visual spatial skill? (yes / no)

2. If I point at something across the room, will you look at it? (yes / no)

3. Do you understand when someone tells you to do something? (For example open the door...) (yes / no)

## PART B

4. Write the corresponding number next to the picture.

Red Circle-[1], Yellow Square-[2], Green Triangle-[3]







6. Go to take the object which is place on your left, center and right hand side.

-- Draw a RED line to guide Chris goes to take the basketball which is place on your right hand side.

-- Draw a BLUE line to guide Chris goes to take a football.

-- Draw a BLACK line to guide Chris goes to take the football which is place on your left hand side.

# \*\*Your line cannot cross the wall



# **Interaction Test**

The purpose of this test is to collect the information about the skills of interaction with object from our target user in terms of interaction test. In order to protect our target users' secret, we will keep all the information in private. It will not disclose to the public.

# PART A

You should circle the answer in question 1 to 3 and tick the answer in question 4.

## **Sample Question 1 to 3**:

2. Do you think your interaction is good enough? (yes  $\frac{1}{2}$  no)

## **Sample Question 4:**

- 1. How long will you take to solve the interaction task?
  - Half an hour

  - o 5 minutes

## PART B

## Sample Question 5 and 6:

First of all, below sample question 5 and 6 is design to test you and see how well your interaction with an object. In both of this question, it will provide you at least 2 objects and your job is to place (Draw) one object on the other objects which is specify in the question. Therefore, whatever the thing that you want to take and place to the other place you just need to DRAW it on that place.

You have to complete all the questions within 4 minutes

Appendix A

#### Example:

Planting the flower on the soil





# PART A

- 1. Do you often interact with objects? (yes / no)
- 2. Will you do things over and over again, in the same way all the time? (yes / no)
- 3. Are you able to done the interaction to an object correctly? (yes / no)
- 4. How long will you spend to solve a interaction task?
  - o Unable to solve it
  - Within 16 30minutes
  - $\circ$  Within 6 15 minutes
  - Within 5 minutes

## PART B

5. Let us make a burger, please put the sausage and Black sesame on/in the Bread. (Draw the sausage and Black sesame on the bread image)



- 6. Please take and put the football and chair on/beside the table.
- Draw (put) the ball on the table.
- Draw (put) the chair beside the table.



← Football





# **3D Computer Game Environment Test**

The purpose of this test is to collect the information about the knowledge of 3D computer game environment from our target user. In order to protect our target users' secret, we will keep all the information in private. It will not disclose to the public.

# PART A

You should circle the answer in question 1, 3, 4 and 5. Tick the answer in question 2 and 6.

## Sample Question 1, 3, 4 and 5:

3. Do you think computer game is good to play? (yesy no)

## Sample Question 2 and 6:

- 1. How many games you have played before?
  - Series Less than 5
  - $\circ$  Within 6 to 10
  - $\circ$  More than 10

First of all, the purpose of this test is just to know more about your knowledge or experiences about the 3D computer game environment.

You have to complete all the questions within 3 minutes.

#### Noted:

• Please tick the answer if you see this symbol " ° " in the question.

# PART A

- Do you have any experience about playing 3D computer game? (yes / no)
- 2. How often do you play computer games?
  - o Daily
  - $\circ \ \text{Weekly}$
  - $\circ$  Monthly
  - $\circ$  Yearly
  - o Never
- 3. Have you learned anything from gaming? (yes / no)
- 4. Do you like to play on the computer? (yes / no)
- 5. Do you think that computer game have provided an appropriate level of customisation concerning different aspects? (yes / no)
- 6. How good do you feel you are at playing computer games?
  - $\circ$  very good
  - $\circ$  moderately good
  - o not very skilled
  - o no skill