SERIOUS GAME FOR INTERNAL MEDICAL PRACTICE
(CROWD SIMULATION)

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I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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First and foremost praise is to GOD for all his blessings for giving me patience and good health throughout the duration of this Bachelor research.

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ABSTRACT

Crowd simulation is now being widely used in various virtual environment applications such as entertainment, games and virtual environment. With the existing of crowd simulation in those applications can provide an immersive feeling into static scenes therefore elevate the realistic of the systems. The collision avoidance is important for a large number of characters in a same area, it used to prevent or avoid any collisions among character. Collision avoidance is one of the important elements that needed for construct crowd simulation. Besides that, steering is another important element for the simulation crowd system. By utilize this two elements, the application can produce higher level of realism of crowd simulation as well as make the applications more realistic and interesting. The comparison among different technique has been presented here.

ABSTRAK

Simulasi orang ramai kini sedang digunakan secara meluas dalam pelbagai aplikasi persekitaran maya seperti hiburan, permainan dan persekitaran maya. Dengan yang sedia ada simulasi ramai dalam permohonan mereka boleh memberi perasaan mendalam ke dalam adegan statik itu meningkatkan realistik sistem. Mengelakkan perlanggaran adalah penting bagi sebilangan besar watak-watak dalam kawasan yang sama, ia digunakan untuk mencegah atau mengelakkan sebarang pertembungan antara watak. Mengelakkan perlanggaran adalah salah satu elemen penting yang diperlukan untuk membina simulasi orang ramai. Selain itu, pemandu adalah satu lagi elemen penting untuk orang ramai sistem simulasi. Dengan menggunakan dua elemen ini, aplikasi ini boleh menghasilkan tahap yang lebih tinggi realisme simulasi orang ramai serta membuat permohonan yang lebih realistik dan menarik. Perbandingan antara teknik yang berbeza telah dibentangkan di sini

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Crowd simulation is about simulating the movement of a large number of characters which also consider as virtual environment. Crowds have been study as scientific interest since the end of 19th century. Crowd can do anything superior difficult motion that which is over the maximum ability of human. Nowadays, games is not only designed for entertainment but have been created for some field to undergo some simulation, such as medical field.

Crowd simulations have become more and more significant in the computer game industry no matter is entertainment game or serious game. This project is about to create a serious game for those medical student to let them learn more knowledge and simulate through games. Mostly they do not have enough time and opportunities to get contact with patient. In order to let medical student and medic to have a real experience from the game, one of the important factors is the environment in the game. In the actual environment of hospital, there is full of visitor in morning section, hence we implement crowd simulation into this serious game to make the virtual environment of the serious game be like actual hospital.

A perfect designed game with a well game environment can be easily lead player enter the situation inside the game, and then player can easily grasp the environment of the game. For example , when a virtual patient in the game have an emergency state, medical students can apply their medical knowledge into the game, and see whether the virtual patient get recovery or their state back to stable as previous.

1.2 PROBLEM STATEMENT

Most of the time, medical students does not have the enough opportunities to treat patients during their study because most of the patient lack of trust on them, and feel that medical students does not have enough experiment on treat patient. Due to lack of opportunities on treat patient so medical students cannot get to know the real situation in hospital. Therefore they may be scare of the crowd in the real situation. Through the crowd simulation of the serious game, medical students can get to know the situation and environment in hospital and suit themselves into the situation and environment.

1.3 OBJECTIVES

The objective of this project is:

(i) To simulate the hospital crowd as an obstacle for medical students to find the shortest path to reach therir patient

(ii) To simulate the hospital crowd taht moving around without colliding with each other and the static object.

(iii) To contribute in the development of crowd simulation this serious game.

1.4 SCOPE

The scope for develop this project is:

(i) Develop an actual human crowd for hospital simulation which contain these character, doctor, patients, and visitors to he hospital.

(ii) The numbers of crowd in the hospital will be change according to the visit time hour in hospital. For example, during day time the numbers of crowd will be more than the crowd at night time.

(iii) The movement of crowd in the game is random which mean they are not moving to same position and change same direction at the same time .

1.5 THESIS ORGANIZATION

This thesis consists of 5 chapters. However chapter 1 is discuss about the introduction on the study of crowd simulation in serious game. There are few of the elements that have to focus and various techniques is required will be talk over in this chapter.

CHAPTER TWO

LITERATURE REVIEW

2.1 Literature Review

A crowd is not only a group of various kind of person that occupying a common area but them also will give appropriate response to the change of the environment, having interaction among each other. The past few years, crowd simulation on computer has been widely used in various fields such as safety modelling, entertainment software, architecture and so on. Recently, serious game with crowd simulation has been putting on an important position in medical field. Heiko Aydt, Michael Lees, Linbo Luo(2011) state that one of the great motivation to simulate virtual crowd is to build believable characters in the movie and computer games [1]. Ramy Taher Makram Wassef and Awad Khalil (2011) pointed out: “Since past decade, crowded scenes had been an important territory of research.” And find out that researchers focused on randomizing thee movement and the appearance of those characters in such scenes. The technique that required to generate the randomize movement of the 3D crowd in real-time using inexpensive pixel shader operations.

There are numerous of article and journal we found from network to find out that crowd simulation is done based on actual environment in real world. Frederic D. McKenzie, Mikel D. Petty and Paul A. Kruszewski (2007) state that to develop a crowd-modelling capability for military simulation is required analysis to the identify military simulation crowd- modelling requirements, need to examine psychological research relevant to crowd modelling. To produce not only a highly realistic simulation but also an easily reconfigurable game AI behaviours this research is been drove an assembly of the military simulation technology with gaming simulation technology.

Branislav Ulicny and Daniel Thalmann (n.d.) pointed out goal of simulation is to reproduce realistic screenplays for those conditions develop in real-time which involve large amount of virtual human agents. In this paper, they conclude that multi-agent architecture allowed virtual human crowd to be execute autonomous behaviour in a virtual environment. In the system created by them, those crowd is being create as collection of humans which able to response to the environment.

Noralizatul Azma Bt, Abdullah Bin Bade and Sarudin Kari (2009) pointed out that without collision avoidance the crowd simulation will be does not look realistic. Collision avoidance technique which mean that to avoid collision of two or more object, include static object and dynamic object. Implement crowd simulation can make the player or user trapped in situation. Besides that, a realistic crowd simulation will occurred if there is collision avoidance implemented.

Ramy Taher Makram Wassef and Awad Khalil (2011) said that there is a major problem faced by game designer which is character repetition. They have undergo several study involved few test on human subjects; the repetition in appearance is more easy to get notice than repetition in animation. They are used the colour modulation technique to create different character of crowd. A model can have many characters by changing its texture and colour of clothes.

N. Pelechano, B. Spanlang and A. Beacco (n.d.) found that an animation planning mediator (APM) will select the most appropriate and will modified the skeletal configuration of each character of crowd. The APM allow us to accelerate the crowd motion and increase the number of locomotion types.

Heiko Aydt, Michael Lees, Linbo Luo, Wentong Cai, Malcolm Yoke Hean Low, and Sornum Kabilen Kadirvelen (2011) state that they use emotion engine which can realise emotional and reflect pacifying soldier response. Those of the effect from different character will be reflected into the crowd behaviour. Their emotion engine is able to manage general emotions but there is one emotion they have to concern is anger.

Christian Gloor(2012) state that for PEDSIM need to maintain in individual particle. Besides that, each pedestrian are able to make own decision (route choice). It control in two layers which is physical and mental. However for physical layer is take care of the movement of pedestrian, interaction between pedestrians and interaction between pedestrian and environments. For mental layer consist two mental strategy which is Look Ahead and Route Generator. Look Ahead Mental Strategy tells each pedestrian to looks for other pedestrian who in front of them and count the pedestrian on the left and right, walk to the area which have less pedestrians. Therefore, collision avoidance among pedestrian and building have to avoid by pedestrian itself. Route Generator says each of the pedestrian have own routes. Technique transportation is to generate all day long activity for pedestrian and destination of each activity.

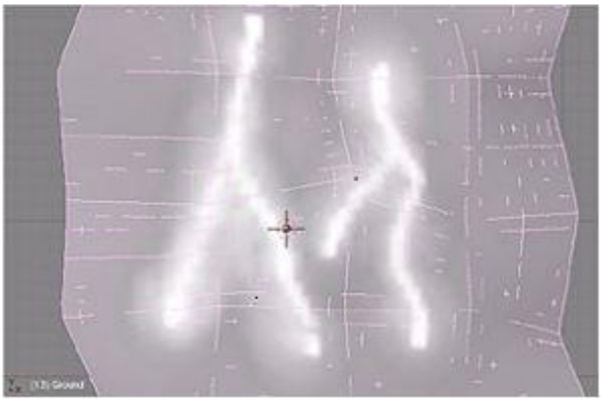


Figure 2.1: Pedestrian will gravitate toward the brighter painted pathways

Roland Hess (2005) states that BlenderPeople support character animation. It is combination of Blender 3D, Python programming, MySQL database which can generate and track motion and interaction of actors within a simulated environment. For best result, gradate the painting away from barrier, allow agents to sense “something”, they may route around it. Besides that, it requires to create a white path across a field which is dark color; attract actors toward it by graduate the brightness of path.

Nicolas Brodu (2004) pointed that Crogai introduce AI in crowd behavior scenarios. In Crogai will be use Collision avoidance and detection. Collision avoidance is to find a steering force to prevent the collision. However Collision detection is determine whether two agents are occupying the same space or not. Besides that, the collision avoidance of Crogai needs only be applied at AI frequency, to produce a steering force. Next, for the collision detection is assumed that the AI frequency is enough to capture changes in the neighbourhood are allows using only the current list of neighbours for distance comparisons. If there is an agent far away in less than an AI cycle it will not be detected.

Arges Systems Inc (2009) state that collision avoidance and steering can be done in UnitySteer. UnitySteer contain few classes which can help in game characters or object maneuver around the scene such as How to accelerate and for how long? How to act when avoiding from obstacles or neighbors? How to keep distance from other agents? UnitySteer are built upon OpenSteer and OpenSteerDotNet. Besides that, dynamic object will keep distance with the obstacles since it can sense the distance between obstacles.

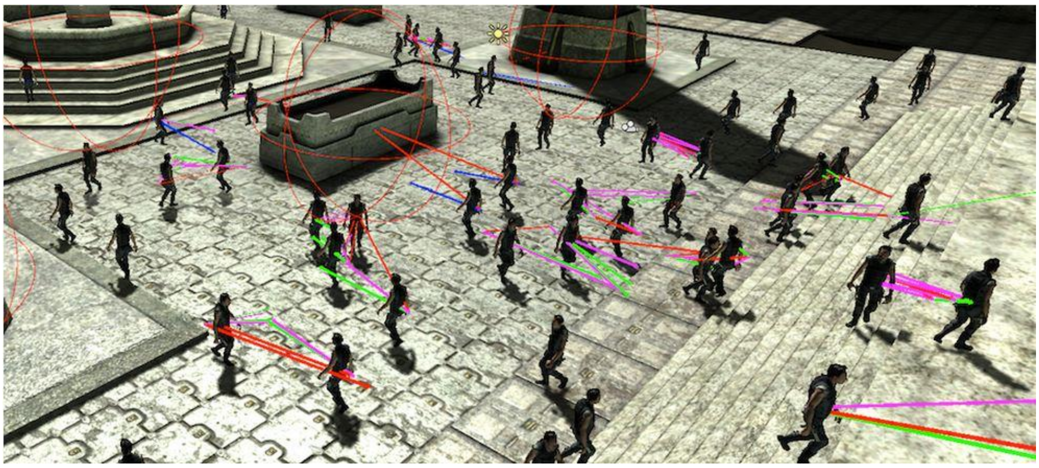


Figure 2.2: UnitySteer update to spherical obstacles avoidance

In short I can summarized that create a serious game based on the real environment is the only way to be successfully complete the game. Previously, game developer just focus on the main character of the game. Nowadays, they realized that the realism of game is important. To make the game more realistic have to observe and study the real environment in the hospital and the crowd behavior in hospital. The crowd will have different reaction among each other with the change of the environment. There are many different techniques and methods can be used to developed crowd simulation based on the few review. Each of the technique can bring different effect in the virtual environment to user.

Chapter 3

METHODOLOGY

3.1 Introduction

This project is a serious game in internal medicine. This project will be constructing step by step based on the software development methodology that I had chosen. There is few activity have to have to be consider during the research development.

First of all, I will study on previous work that how are they going to create crowd simulation. I will look on the requirement regarding what type of crowd is needed and study on the different among each technique such as what effect can those different technique present in the game, choose the most suitable technique that use for crowd simulation .

For the next step will be prepare the content which means the crowd model that suitable to be used in hospital environment and animate those crowd with the technique or classes that I choose to apply on the crowd model. After applied technique on crowd model, we can test for the movement and reaction between crowds, crowd with obstacles. Therefore, check for any unnatural movement, any collision and intersection among them, the reaction of crowds when they are near to each of them and the amount crowd will change according to the visiting time of actual hospital.

Therefore, deploy it into actual scene and combine with my part with other partners who in charge in different part of this project. After we done the combination, we will test and check for any error or bug. If there is no error or bug, we will user which is medical student to test for it, let them comment on this system.

Lastly, if there is any good opinion and logic suggestion from user (medical students) we will improve our system based on their comment.

3.2 Methodology

3.2.1 Development Plan

The methodology that I have chose to use for the development of this project was ADDIE model. ADDIE model is basically a generic, systematic, step-by-step framework. ADDIE model is a instructional design model that comprising five phases: Analysis, Design, Development, Implementation, and Evaluation. The diagram at below show the ADDIE model.

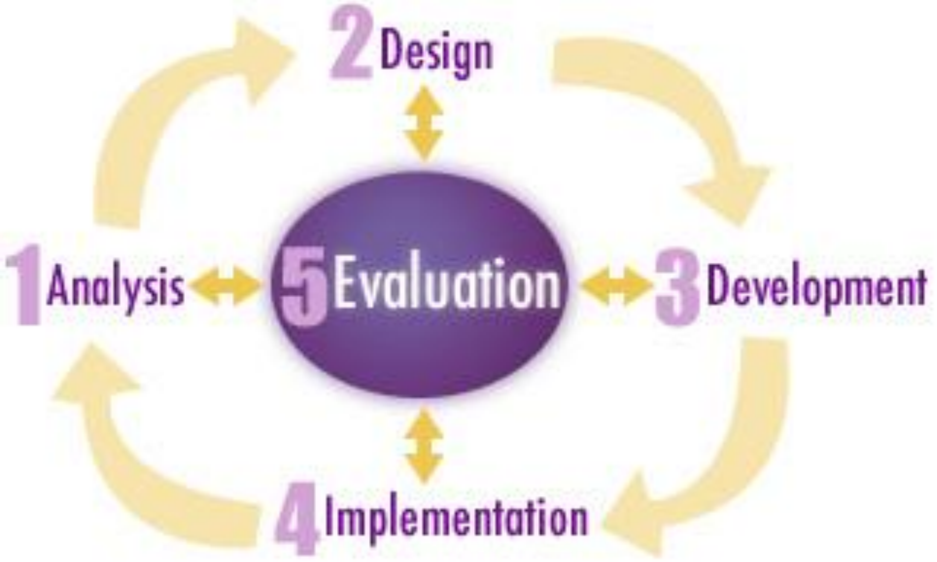


Figure 3.1: ADDIE Model

Step 1 : Analysis

- Analyse the problem from previous work
- Anayse the goals and objectives of our system.
- Analyse the technique have been use in previous study.
- Analyse the actual environment of hospital(Hospital Tengku Ampuan Afzan).
- Analyse the movement of crowd in hospital(Hospital Tengku Ampuan Afzan).
-

Step 2:Design

- Design the 3D crowd simulation of hospital
- Design the collision detected between crowds, crowds with obstacles.
- Design the reaction for crowd when there is a threat of collision happen
- Design the reaction for crowd when there is a pontential collision happen
- Design the coding for system flow.
- Design the flowchart of this system.

Step 3: Development

- Develop the 3D crowd simulation of hospital
- Develop the collision detected between crowds, crowds with obstacles.
- Develop the reaction for crowd when there is a threat of collision happen
- Develop the reaction for crowd when there is a pontential collision happen
- Develop the coding for system flow.

Step 4: Implementation

- Test the system and check for any error or bugs.
- Test by user.
- Feedback from user on this Serious Game.

Step 5: Evaluation

- Review and evaluate each phase to ensure it is accomplishing what it is supposed to do
- Observe the tasks that were trained by the learners and its implication
- Revise the system to make it better and to meet future challenges

3.2.2 Chosen Technique

This project is about a serious game for internal medicine which develops for medical students. It was not an easy task to let medical students integrate into game environment, a well design for virtual environment of game is necessary and important. After the comparisons between four open source have been used in crowd simulation, UnitySteer is the most suitable open source being use in develop this project. For my part crowd simulation, after done the development will be integrated into Unity game so must use UnitySteer to generate it. Some of the opensource such as Crogai is use (Artificial Intelligence) AI for their crowd simulation. Refer to our implementation of those crowd did not need or require any advanced or specific AI. AI require a lot of coding, and a lot of code will cause the processing became slow, we are not consider about it, this project will be implemented through internet which require fast connection.

	UnitySteer	PEDSIM	Crogai	BlenderPeople
Obstacle avoidance & Steering	✓	X	✓	X
Collision avoidance & detection	✓	✓	✓	✓
Generate and track motion and interaction	X	X	X	✓
Collision avoidance & transportation	X	✓	X	X

Table 1: The comparison between different tools.

The crowd is form by visitors, doctors and nurses. For this game, we are focusing on how the doctor gives treatment to patients. The crowd simulations in this serious game no need interaction among crowd itself and they does not need any extra motion other than walking. For the technique collision avoidance and transportation, does not needed in this serious game. Transportation is kind technique that generate activity for each pedestrian, however, the crowd in this project just have to walk around the hospital to create the realistic of the environment where they does not have to have own task or activity.

3.3 Hardware and Software

To develop this project, I have use laptop which the brand of Toshiba Satellite L840 Series. This processor for this laptop is 2nd generation Intel Core^{TM} i5-2450M , the clock speed is 2.50 GHz. This laptop is using Windows 7 Home Premium 64-bit Operating System. The installed memory (RAM) for this laptop is 4GB besides that the hard disk capacity is 640GB. Build in graphic card for this laptop is AMD Radeon ^{TM} 7670M (1GB dedicated memory).

However, for the software that I have choose to develop this project was Unity 3D.Unity 3D is a powerful rendering engine fully integrated with acomplete set of intuitive tools andrapid workflows to create interactive. The project can be program in C++, JavaScript, Boo. This Unity 4.0 have added some new features and some improvements which include HDR rendering, linear space lighting, multi-threaded rendering and so on.The code in Unity 3D is more stable compare to written in other languages. Therefore it had reduce a lot of errors that developers will do normally.

3.4 Gantt chart

Gantt chart is a type of planning and control chart, designed to show graphically the relationship between planned performanceand actual performance over time.[Refer to Appendix A]

Chapter 4

DESIGN AND IMPLEMENTATION

This paper proposes crowd simulation in virtual hospital environment. This project is focusing on simulate the crowd in virtual hospital environment. This chapter discuss about the framework, approach and process of data gathering on this research.

4.1 DESIGN

This research is about the simulation on crowd in a hospital; how the crowd will be react on when they have any collision between other character and obstacles. Therefore the model of this research must contain human character and some obstacles.

Before any model has been design or draft, I had a general hospital in Kuantan named Hospital Tengku Ampuan Afzan visited under the lead of my project supervisor. The purpose to visit the hospital is to analyze the environment of an actual hospital and the movement of crowd in hospital. Figure 4.1, 4.2 and 4.3 shows the environment which is the lobby of hospital and the movement of crowd in hospital.

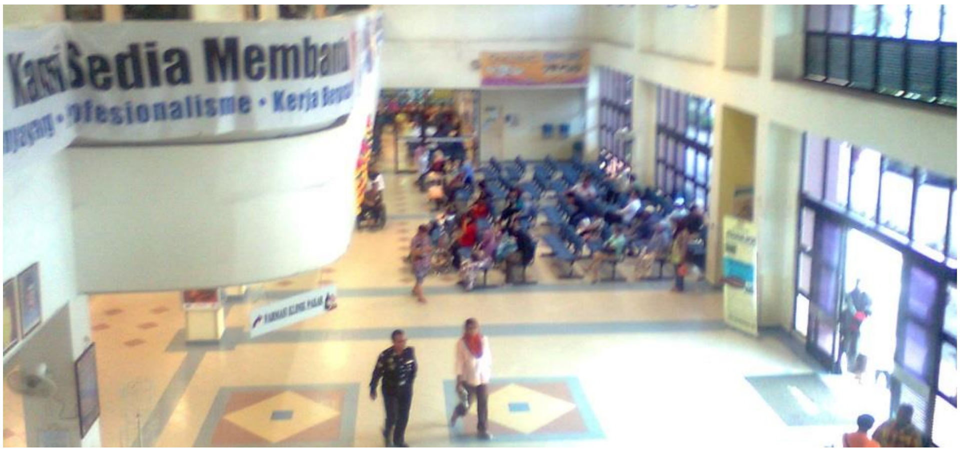


Figure 4.1 Crowd in lobby of hospital

Figure 4.2 Crowd in lobby of hospital

Figure 4.3 Crowd in lobby of hospital

The initial model of the research is designed based on the analysis and data I get from visit Hospital Tengku Ampuan Afzan. There are some human characters in the scene and with some sphere shape object as the obstacle in hospital, th human character will wander around in planar and avoid to collide with each other and also the obstacles. Figure 4.4 is the initial model designed based on analysis.

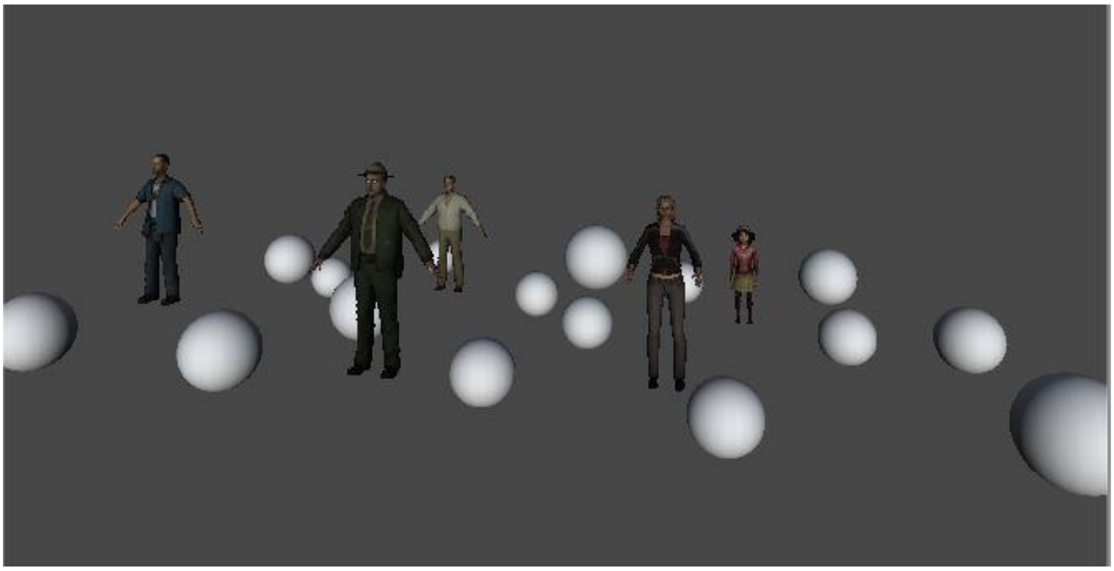


Figure 4.4 Initial model of project

Before I visit the hospital, I had made some research on what kind of information I needed and help me on the development of the project. Therefore, I had discuss with my supervisor on where and when to collect the information that I needed to be used on the development of this project. In the hospital, I have to observe on the reaction and movement of visitor, doctor and nurse, the flow of visitor to visit hospital based on the visiting hour and the environment of the hospital.

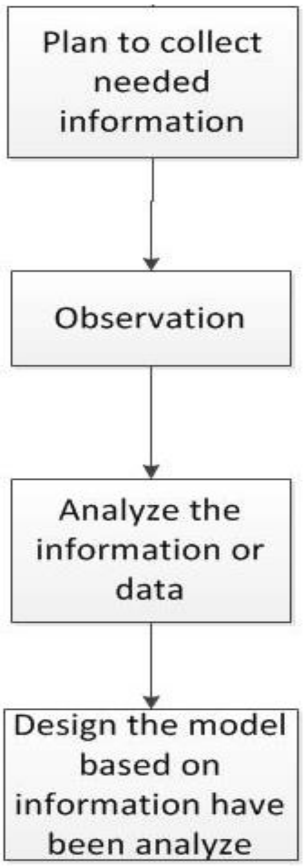

Plan to collect needed information
Observation
Analyze the information or data
Design the model based on information have been analyze

Figure 4.5 work flow

Before start my to develop my project, I need to collect the needed information to be used in my project through observation of the hospital environment. After that, analyse the information I got through the observation in hospital. Therefore, start to design the model based on the information I have been collected.

4.2 IMPLEMENTATION

Figure 4.6 is another prototype of my model. First of all, the sphere shape objects created to play the role as the obstacle in hospital environment however the bullet shape object is created as the visitors which include doctor and nurse in hospital. The bullet object will be wander around on the plane have been created without collide with any obstacles. The movement and the direction changing of the bullet shape object will be based on the script have been written on it.

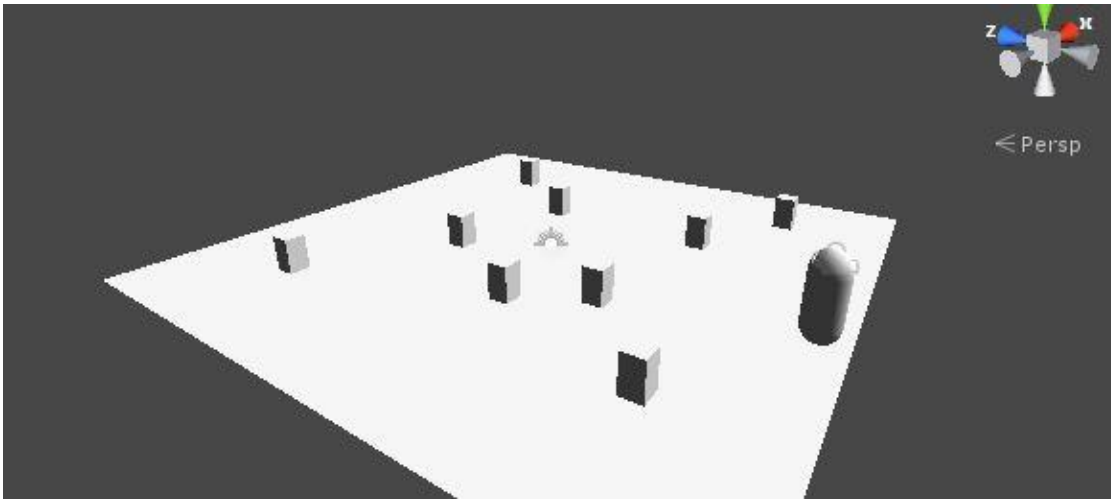


Figure 4.6 Second model

Besides that, the amount of visitor will be change based on the visiting hour of hospital. When there is visiting hour, the numbers of visitor will be increased more than usual through the control of spawning time of visitor. However, when there is not visiting hour the numbers of visitor will decrease.

4.2.1 Development Material

There are some materials that needed for this development:

a) Character model and obstacle object

b) Spawn point

c) script

a) Character model and obstacle object

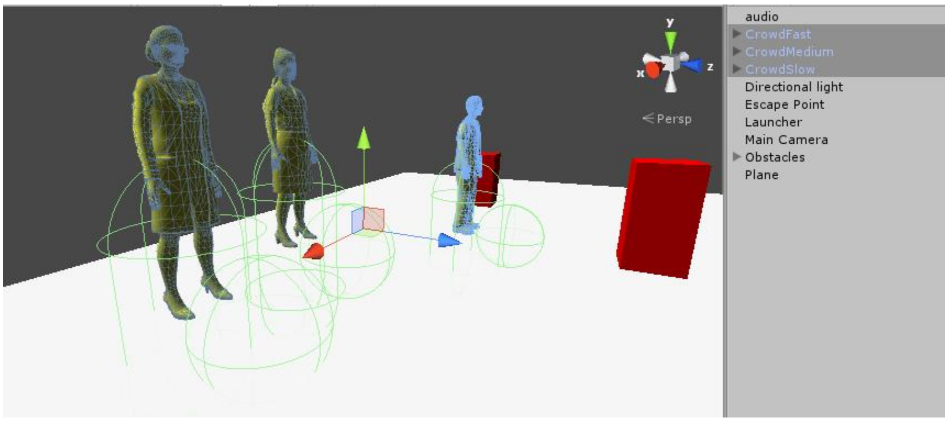


Figure 4.7 Character types with collider

There are three different types of crowds which catergorize based on their moving speed will be used in this project which is fast moving speed, medium moving speed and slow moving speed of crowd. All of them are created as prefadb in project window.

The fast moving speed of character represent to the doctor, mostly the doctor are rushing time on giving treatment to their patient. However, the medum moving speed represented the nurse which always assist and give support to doctor while they giving treatment to patient. At last, the visitor to the hospital are represented by the slow moving speed character.

Figure 4.7 shown three types of character that used in this project and each of them contain two collider on it, one of it is external collider which attach manually at the front of the character. The character's own collider are in capsule shape,however the external collider is in sphere shape. The function of the extra collider is to detect any collision with others collider before they are too near to each other.

The sphere shape collider allow charater to make a rotation smoothly due to the sphere shape contain the same diameter, therefore it can always detect any collison happen no matter in which side of the sphere shape collider. The character will keep on rotate until there is no collision have detected from the external collider. Figure 4.8 shown there is a collider as children of the character model.

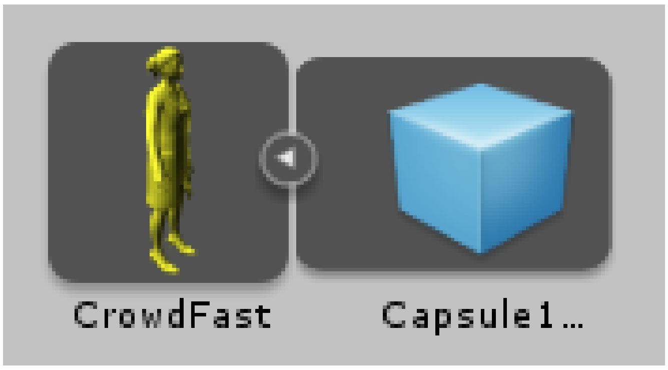
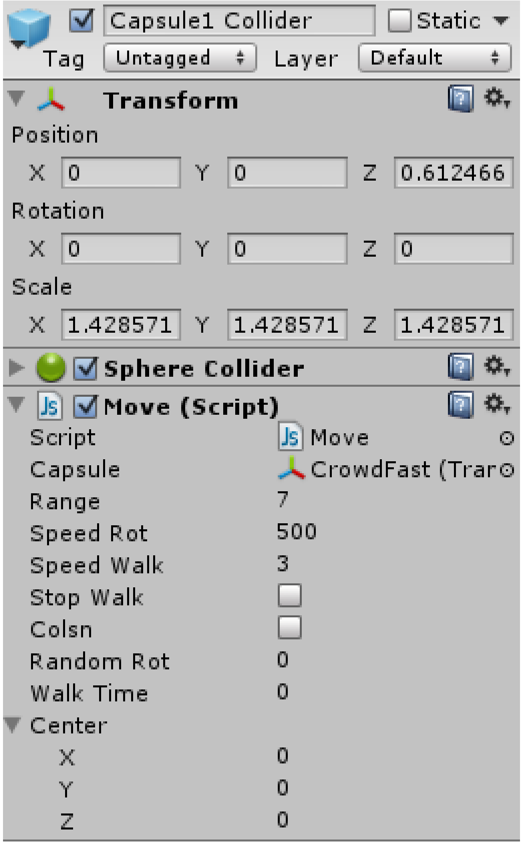


Figure 4.8 Extend collider atach to character

Move script will be added under the external collider of the character which is use to control the movement of a character by dragging the character into the capsule column. With this all the setting is just apply on selected character only. Figure 4.9 which is the setting of move script under external collider of each type of character.



☑ Capsule1 Collider □ Static

Tag Untagged Layer Default

Transform

Position

X 0 Y 0 Z 0.612466

Rotation

X 0 Y 0 Z 0

Scale

X 1.428571 Y 1.428571 Z 1.428571

☑ Sphere Collider

☑ Move (Script)

Script	Move
Capsule	CrowdFast (Trar
Range	7
Speed Rot	500
Speed Walk	3
Stop Walk	□
Colsn	□
Random Rot	0
Walk Time	0
Center	
X	0
Y	0
Z	0

Figure 4.9 Setting of move script

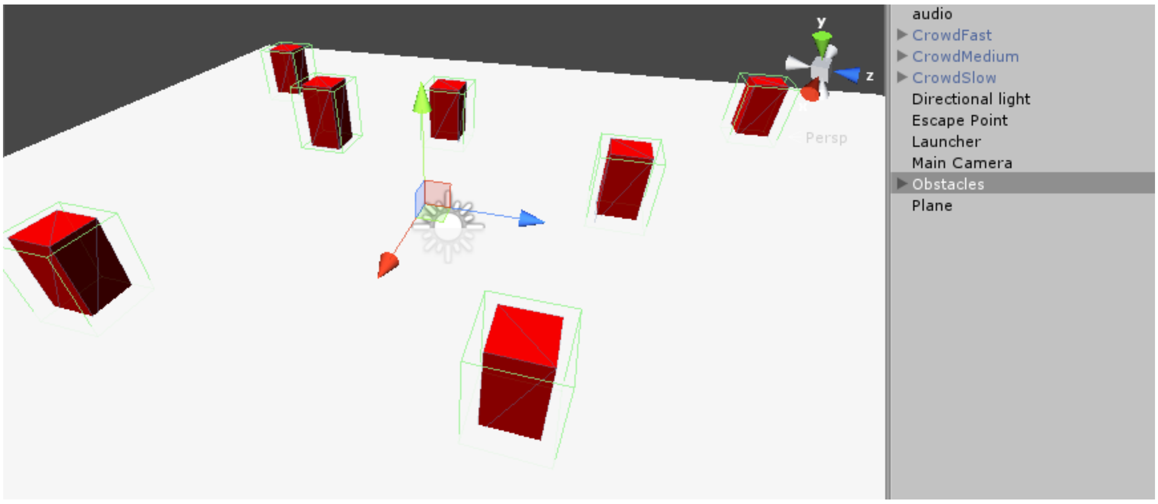


Figure 4.10 Obstacles object

All of the red cubes in figure 4.8 are playing a role as obstacle in the project. Each of them have a collider which are be seen clearly with green line covered the red cube. All of the collider of the red cube are bigger than the red cube is to prevent character come too near when collide with the obstacle.

b) Spawn point

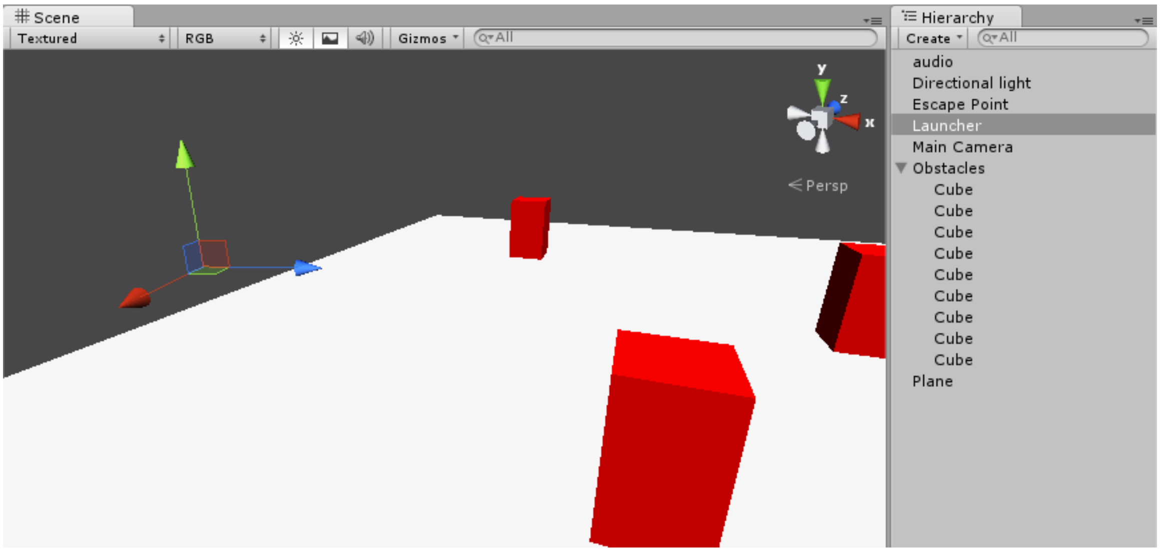
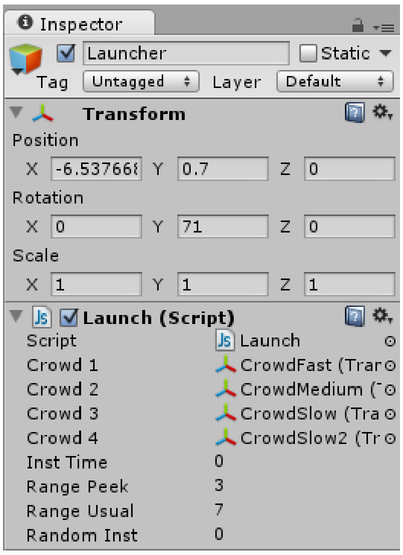


Figure 4.11 launch point

The spawn point have been creaed by create an empty game object, and set the coordinate of the empty game object for character to generate and spawn. To make sure character will successfully spawn out from the point, have to set the y-axis of the point more higher than zero. Launcher script is needed to be added into the empty object which is use to call the character to generate. Figure 4.11 shows the location of the spawn point my project.



☑ Launcher □ Static

Tag Untagged Layer Default

Transform

Position

X -6.53766(Y 0.7 Z 0

Rotation

X 0 Y 71 Z 0

Scale

X 1 Y 1 Z 1

☑ Launch (Script)

Script Launch

Crowd 1 CrowdFast (Tran

Crowd 2 CrowdMedium ("

Crowd 3 CrowdSlow (Tra

Crowd 4 CrowdSlow2 (Tr

Inst Time 0

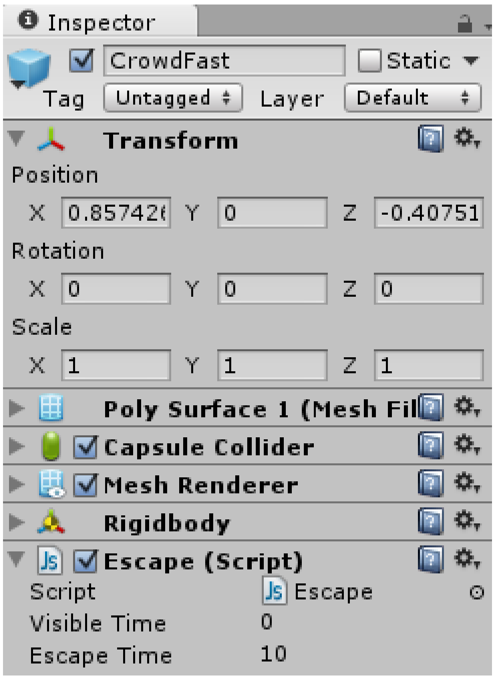
Range Peek 3

Range Usual 7

Random Inst 0

Figure 4.12 Setting of launch script

Figure 4.12 shown launch character is required to put in the spawn point. Character that will be spawn in the point are need to be add into the setting part of the the launch point. Which can be seen there is a list crowd1,crowd2,crowd3 and crowd4.



Inspector

☑ CrowdFast □ Static

Tag Untagged Layer Default

Transform

Position

X 0.857426 Y 0 Z -0.40751

Rotation

X 0 Y 0 Z 0

Scale

X 1 Y 1 Z 1

Poly Surface 1 (Mesh Fil

☑ Capsule Collider

☑ Mesh Renderer

Rigidbody

☑ Escape (Script)

Script Escape

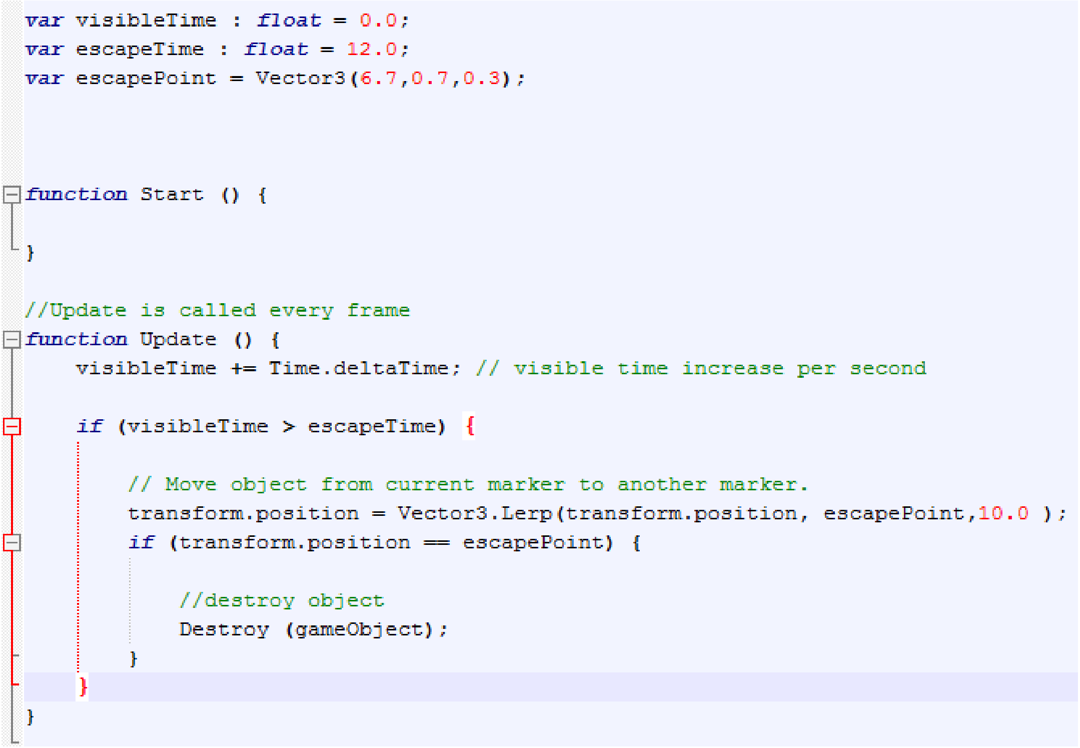
Visible Time 0

Escape Time 10

Figure 4.13 Setting on escape script

An escape code is added into the characer model. The use of the script is to destroy the game object when the visible time of game object is greater, we gonna destroy object to prevent hopital looks like too full and packed especially when is not the visiting hour in hospital. Figure 13 shown the script is added on one of the character.

c) Script



```
var visibleTime : float = 0.0;
var escapeTime : float = 12.0;
var escapePoint = Vector3(6.7,0.7,0.3);


function Start () {

}

//Update is called every frame
function Update () {
    visibleTime += Time.deltaTime; // visible time increase per second

    if (visibleTime > escapeTime) {

        // Move object from current marker to another marker.
        transform.position = Vector3.Lerp(transform.position, escapePoint,10.0 );
        if (transform.position == escapePoint) {

            //destroy object
            Destroy (gameObject);
        }
    }
}
```

Figure 4.14 Escape script (destroy character by themselves)

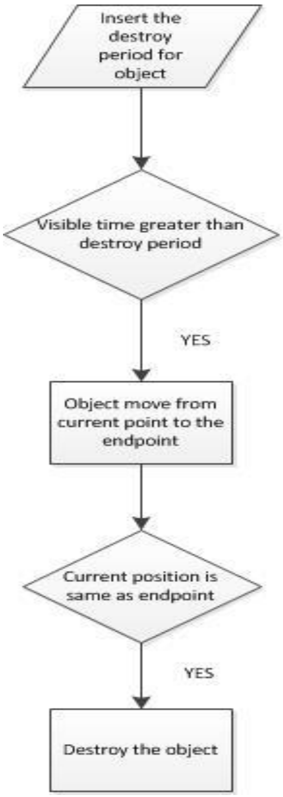
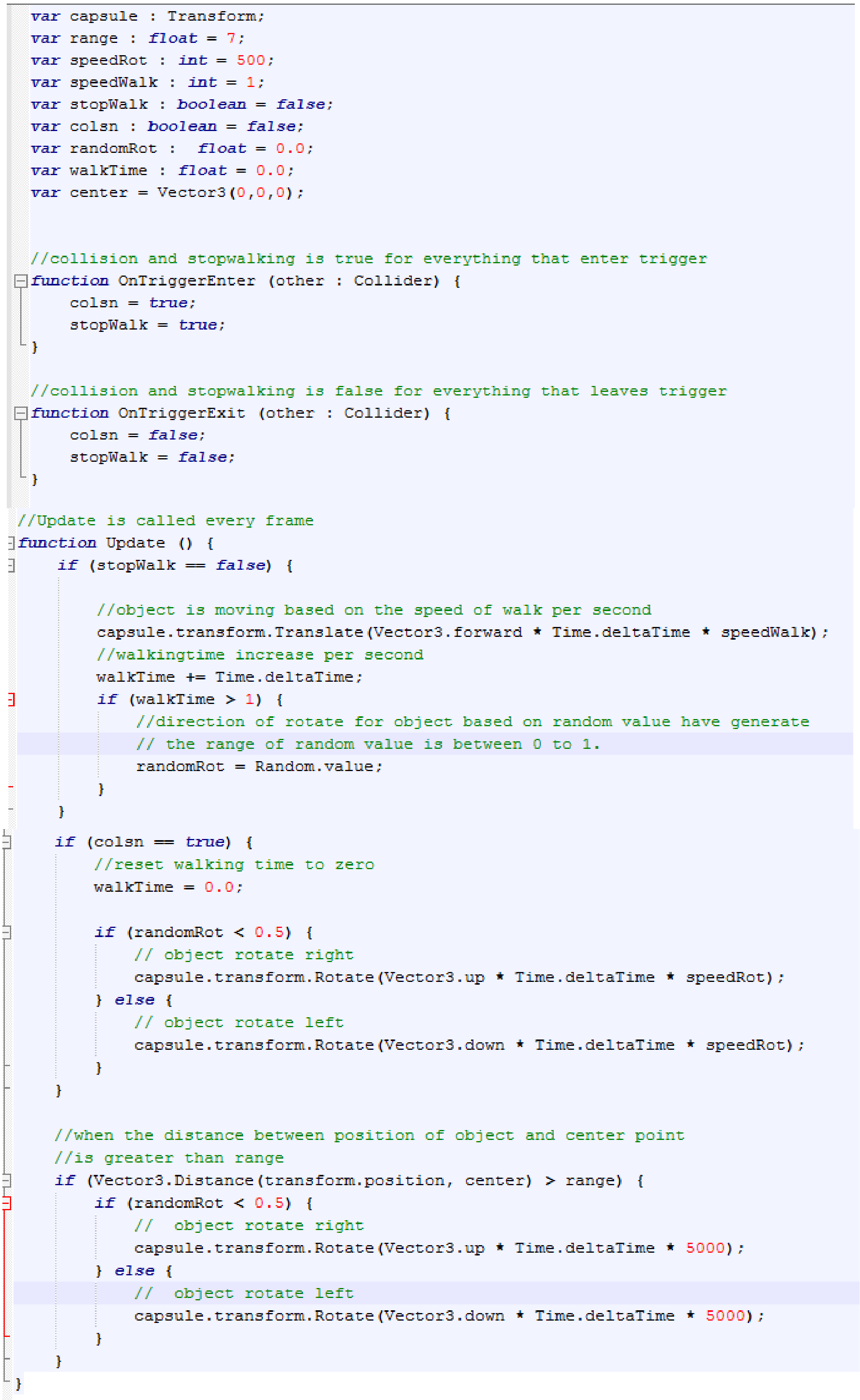

Insert the destroy period for object
Visible time greater than destroy period
YES
Object move from current point to the endpoint
Current position is same as endpoint
YES
Destroy the object

Figure 4.15 Flow of Escape script



```
var capsule : Transform;
var range : float = 7;
var speedRot : int = 500;
var speedWalk : int = 1;
var stopWalk : boolean = false;
var colsn : boolean = false;
var randomRot :  float = 0.0;
var walkTime : float = 0.0;
var center = Vector3(0,0,0);


//collision and stopwalking is true for everything that enter trigger
function OnTriggerEnter (other : Collider) {
    colsn = true;
    stopWalk = true;
}

//collision and stopwalking is false for everything that leaves trigger
function OnTriggerExit (other : Collider) {
    colsn = false;
    stopWalk = false;
}
//Update is called every frame
function Update () {
    if (stopWalk == false) {

        //object is moving based on the speed of walk per second
        capsule.transform.Translate(Vector3.forward * Time.deltaTime * speedWalk);
        //walkingtime increase per second
        walkTime += Time.deltaTime;
        if (walkTime > 1) {
            //direction of rotate for object based on random value have generate
            // the range of random value is between 0 to 1.
            randomRot = Random.value;
        }
    }
    if (colsn == true) {
        //reset walking time to zero
        walkTime = 0.0;

        if (randomRot < 0.5) {
            // object rotate right
            capsule.transform.Rotate(Vector3.up * Time.deltaTime * speedRot);
        } else {
            // object rotate left
            capsule.transform.Rotate(Vector3.down * Time.deltaTime * speedRot);
        }
    }

    //when the distance between position of object and center point
    //is greater than range
    if (Vector3.Distance(transform.position, center) > range) {
        if (randomRot < 0.5) {
            //  object rotate right
            capsule.transform.Rotate(Vector3.up * Time.deltaTime * 5000);
        } else {
            //  object rotate left
            capsule.transform.Rotate(Vector3.down * Time.deltaTime * 5000);
        }
    }
}
```

Figure 4.16 Move script(to allow character or crowd to move)

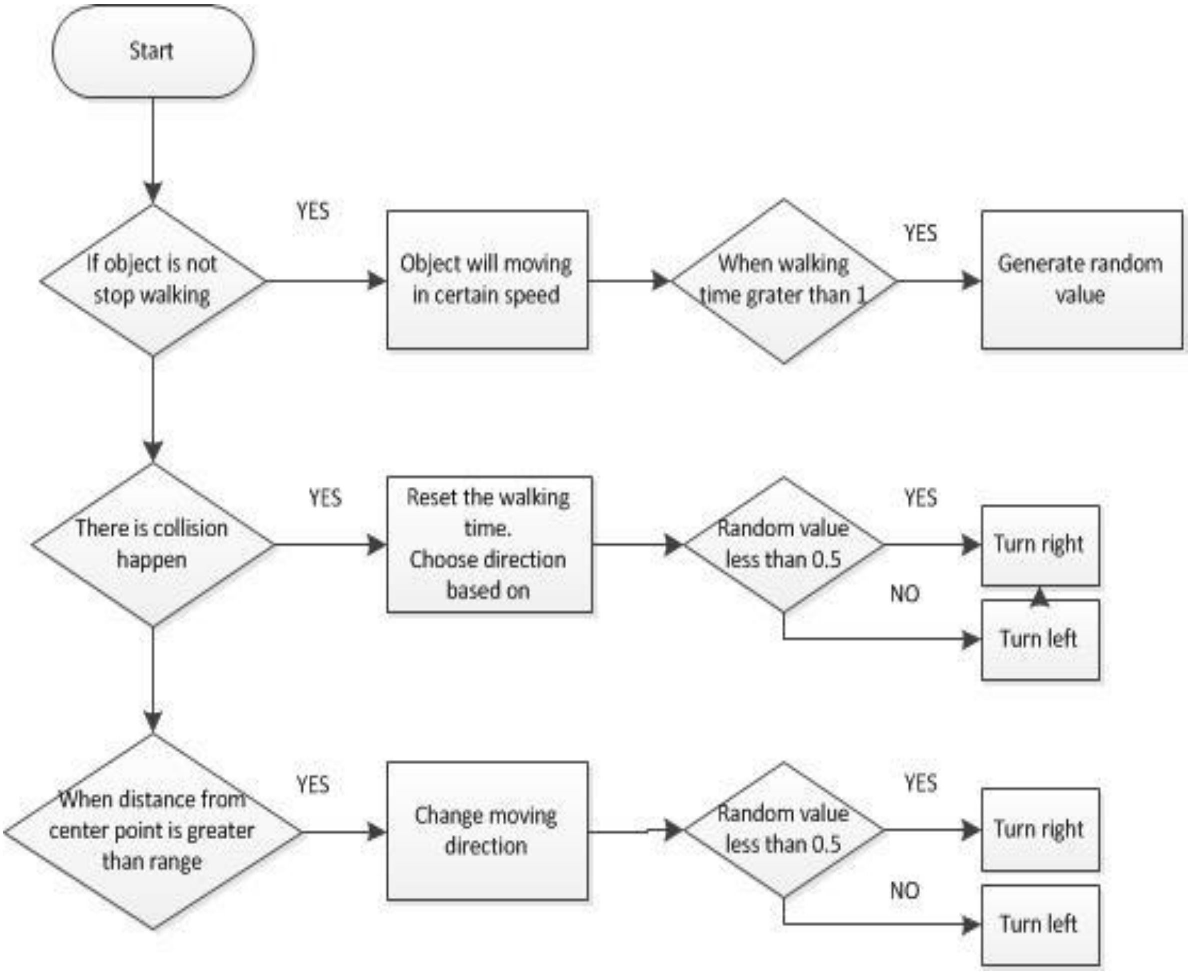
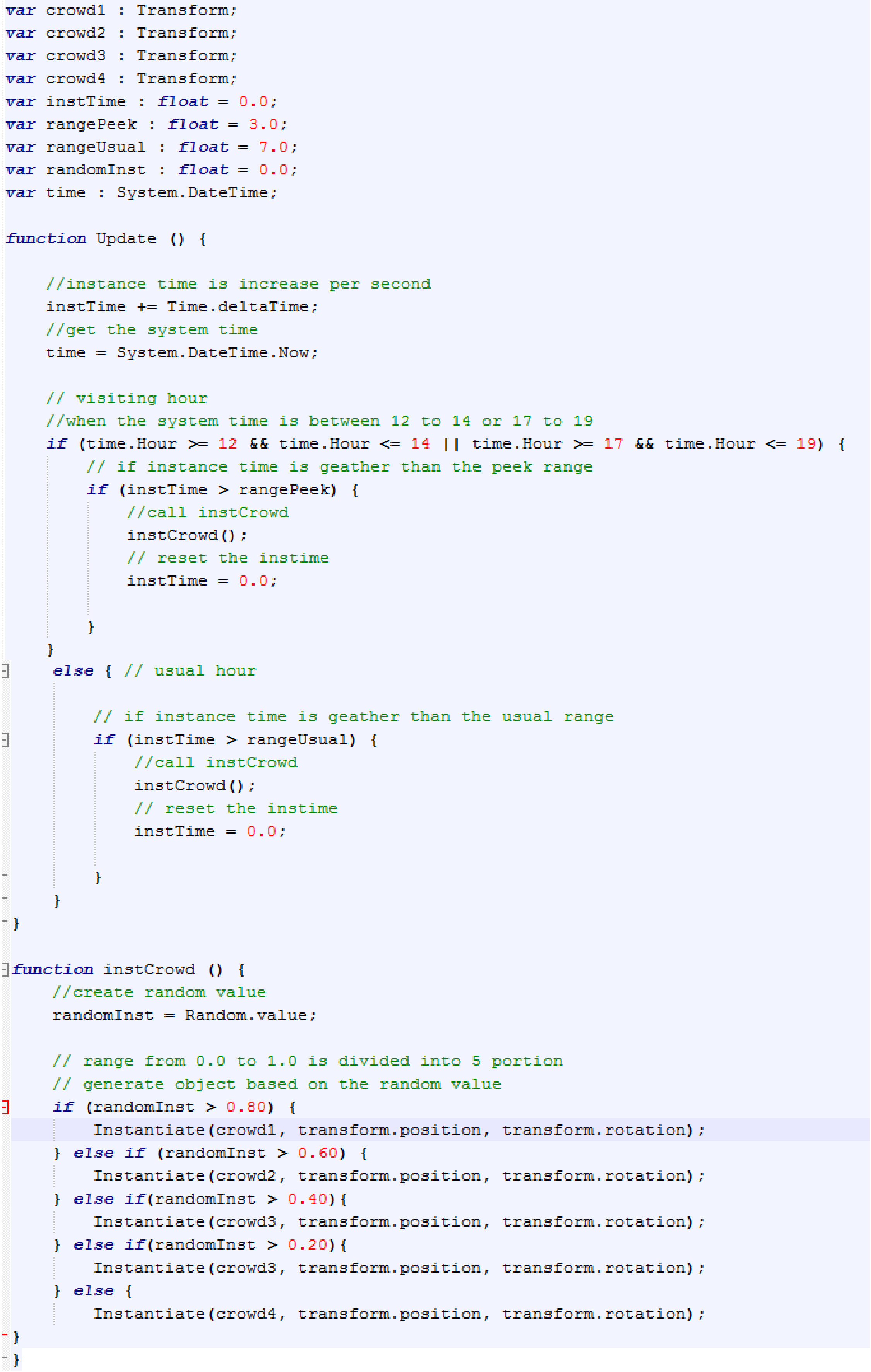

Start
If object is not stop walking
YES
Object will moving in certain speed
When walking time grater than 1
YES
Generate random value
There is collision happen
YES
Reset the walking time.
Choose direction based on
Random value less than 0.5
YES
Turn right
NO
Turn left
When distance from center point is greater than range
YES
Change moving direction
Random value less than 0.5
YES
Turn right
NO
Turn left

Figure 4.17 Flow of the Move script



```
var crowd1 : Transform;
var crowd2 : Transform;
var crowd3 : Transform;
var crowd4 : Transform;
var instTime : float = 0.0;
var rangePeek : float = 3.0;
var rangeUsual : float = 7.0;
var randomInst : float = 0.0;
var time : System.DateTime;

function Update () {

    //instance time is increase per second
    instTime += Time.deltaTime;
    //get the system time
    time = System.DateTime.Now;

    // visiting hour
    //when the system time is between 12 to 14 or 17 to 19
    if (time.Hour >= 12 && time.Hour <= 14 || time.Hour >= 17 && time.Hour <= 19) {
        // if instance time is geather than the peek range
        if (instTime > rangePeek) {
            //call instCrowd
            instCrowd();
            // reset the instime
            instTime = 0.0;

        }
    }
     else { // usual hour

         // if instance time is geather than the usual range
         if (instTime > rangeUsual) {
             //call instCrowd
             instCrowd();
             // reset the instime
             instTime = 0.0;

         }
     }
}

function instCrowd () {
     //create random value
     randomInst = Random.value;

     // range from 0.0 to 1.0 is divided into 5 portion
     // generate object based on the random value
     if (randomInst > 0.80) {
         Instantiate(crowd1, transform.position, transform.rotation);
     } else if (randomInst > 0.60) {
         Instantiate(crowd2, transform.position, transform.rotation);
     } else if(randomInst > 0.40){
         Instantiate(crowd3, transform.position, transform.rotation);
     } else if(randomInst > 0.20){
         Instantiate(crowd3, transform.position, transform.rotation);
     } else {
         Instantiate(crowd4, transform.position, transform.rotation);
}
}
```

Figure 4.18 Launch script(generate crowd)

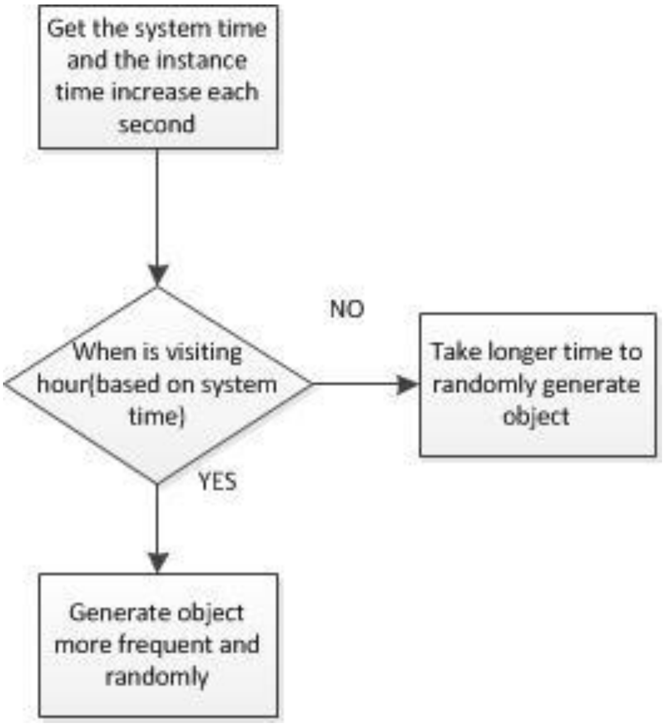

Get the system time and the instance time increase each second
When is visiting hour(based on system time)
NO
Take longer time to randomly generate object
YES
Generate object more frequent and randomly

Figure 4.19 Flow of Launch script

There are some variable in the script is adjustable, such as the destroy time of the character which is named as escape time in the Escape script.

Besides that, the generate time of a character to form a crowd is aso adjustable, a character will be spawn after few second of the system time. The shortest the time taken to generate a character , the more frequent the character will be generated and appear in the scene.

The different of each character are on their moving speed, each of the character have their moving where the fastest character have the highest speed among the character. However, the range of moving for crowd can be adjust to more bg or small. Refer to the figure 4.9, 4.12 and 4.13.

4.3 TESTING

To ensure the development of this project is smooth going must have testing section on the model. There are few types of testing :

- Code-Based Testing (run or execute all the code at least once)

  Everytime complete a full code, will try to run them once.
- Debugging (finding and reducing the number of bugs or defects)

  Test for any bugs in while debugging the project and try to reduce the numbers of bugs if found out any from the project.
- Regression testing (perform once see whether broke something when bug is fixed)

  After the bug issue have been fixed, see anything had broken while fixing the issue.
- Code Inspection (analyzing the program logic and its compliance with coding standards)

  For the crowd simulation, collision among crowd has been tested .Example:

  1)

```
function OnTriggerEnter (other : Collider) {
        colsn = true;
        stopWalk = true;
}
…
if (colsn == true) {
        //reset walking time to zero
        walkTime = 0.0;
        if (randomRot < 0.5) {
        // object rotate right
        capsule.transform.Rotate(Vector3.up*Time.deltaTime*speedRot);
                } else {
        // object rotate left
        capsule.transform.Rotate(Vector3.down * Time.deltaTime * speedRot);
                }}
if (Vector3.Distance(transform.position, center) > range) {
        if (randomRot < 0.5) {
        //  object rotate right
        capsule.transform.Rotate(Vector3.up * Time.deltaTime * 5000);
```

```
    } else {
    //  object rotate left
    capsule.transform.Rotate(Vector3.down * Time.deltaTime * 5000);
    }} }
```

To observe whether any avoidance happen between crowd and the obstacles and observe the angle rotation and the direction of rotation of the character when they are trying to avoid to collide with each other and obstacles, see whether they are successfully to avoidance collision and changing direction of move.

2)

```
function instCrowd () {
    //create random value
    randomInst = Random.value;

    // range from 0.0 to 1.0 is divided into 5 portion
    // generate object based on the random value
    if (randomInst > 0.80) {
        Instantiate(crowd1, transform.position, transform.rotation);
    } else if (randomInst > 0.60) {
        Instantiate(crowd2, transform.position, transform.rotation);
    } else if(randomInst > 0.40){
        Instantiate(crowd3, transform.position, transform.rotation);
    } else if(randomInst > 0.20){
        Instantiate(crowd3, transform.position, transform.rotation);
    } else {
        Instantiate(crowd4, transform.position, transform.rotation);
}}
```

Observe whether the crowd are randomly chosen for generate and appear in the scene based on the random value have been produce in the system.

3)

```
var visibleTime : float = 0.0;
var escapeTime : float = 12.0;
function Update () {
visibleTime += Time.deltaTime; // visible time increase per second
if (visibleTime > escapeTime) {
// Move object from current marker to another marker.
transform.position = Vector3.Lerp(transform.position, escapePoint,10.0 );
if (transform.position == escapePoint) {
//destroy object
Destroy (gameObject);
}}}
```

Observation on will the character destroy themselves when their appearing time is same as the destroy time that have been adjusted before test to run.

- Dynamic testing

where this is to test whether the code must actually be compiled and run. This can test on giving the input values and check if the output is an expected result. The generate time of crowd will be based on the spawn time that have been declare as range peek and range usual. For the value of range peek is mean the character will be spawn after one second of the system time. Example:

```
var rangePeek : float = 1.0;
var rangeUsual : float = 4.0;
…
if (time.Hour >= 12 && time.Hour <= 14 || time.Hour >= 17 && time.Hour <= 19) {
            // if instance time is geather than the peek range
            if (instTime > rangePeek) {
                  //call instCrowd
                  instCrowd();
                  // reset the instime
                  instTime = 0.0;
            }     }
      else { // usual hour
            // if instance time is geather than the usual range
            if (instTime > rangeUsual) {
```

```
//call instCrowd
instCrowd();
// reset the instime
instTime = 0.0;}
```

CHAPTER 5

RESULTS AND DISCUSSION

5.1 RESULTS

The developed application, serious game for internal practice (crowd simulation) has met the objective of this project, which are

a) To help user use shortest time to reach the patient by avoid the crowd in the virtual hospital.

b) To avoid any collision happen between crowd and obstacles.

With existing of crowd in this game, user is required to avoid crowd and find the shortest path to reach their patient and give treatment to them. The crowds in this game are created with random movements which mean they will wander around randomly and user cannot forecast where is path that crowd want to move to. Therefore user are required avoid those crowd will skill and speed to choose the shortest path reach patient.

From Figure 5.1 shows that the crowd randomly wander around, and the capsule shape object play a role as player who need to cross over the crowd to reach the blue cube in the scene. A camera is attached on the capsule object which is to let player view the game through the camera of capsule. Figure 5.2 shows the player view in the game.

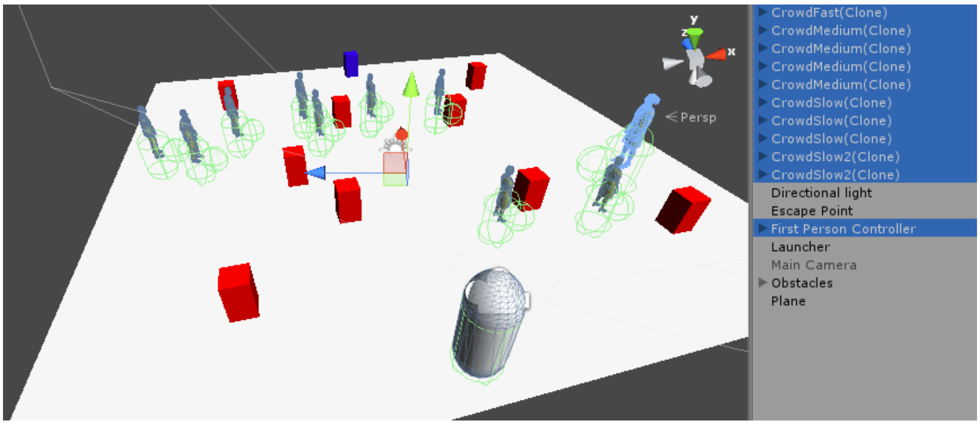


Figure 5.1 Scene view

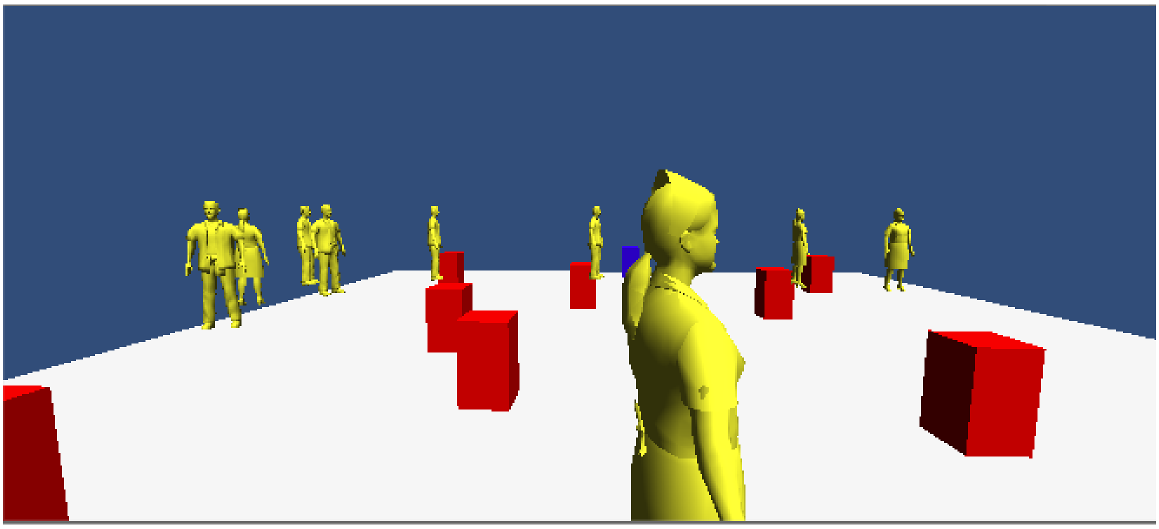


Figure 5.2 Player view

In the actual environment, human crowd will not collide with each other unless there is too pack and any emergency incident happen; if here is collision happen they will change their moving direction. Based on my visit to Hospital Tengku Ampuan Afzan can say that, there is merely chance for collision happen. Therefore, the visitor will be able to avoid collide with each other and obstacle in hospital. In this system, the crowd are required and able to avoid collide with each other and obstacles.

Figure 4.3 shows that the character are move with the extend collider which is used to detect the collider of obstacle. Figure 4.4 shows the avoid collision among crowd which also use collider to detect the nearby crowd.

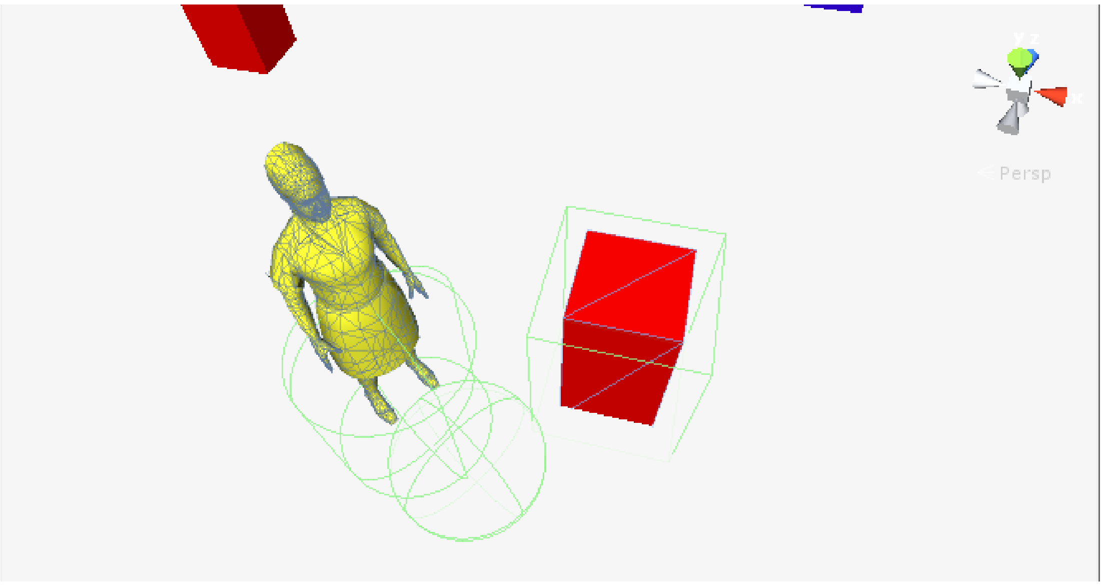


Figure 5.3 Crowd avoid to collide with obstacle

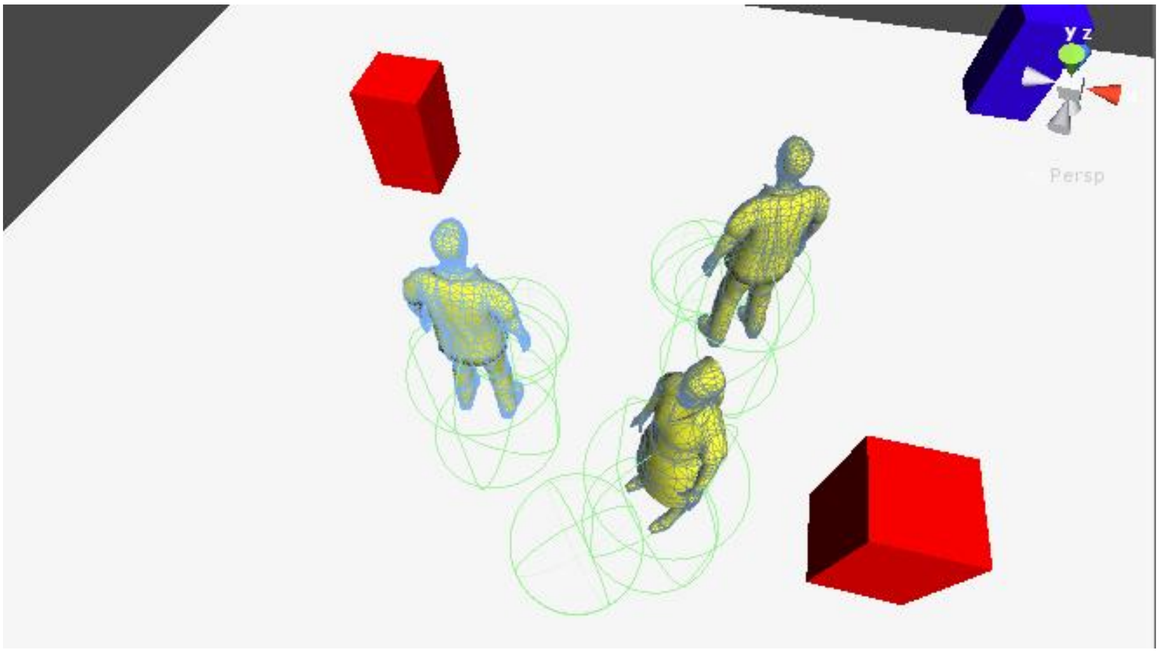
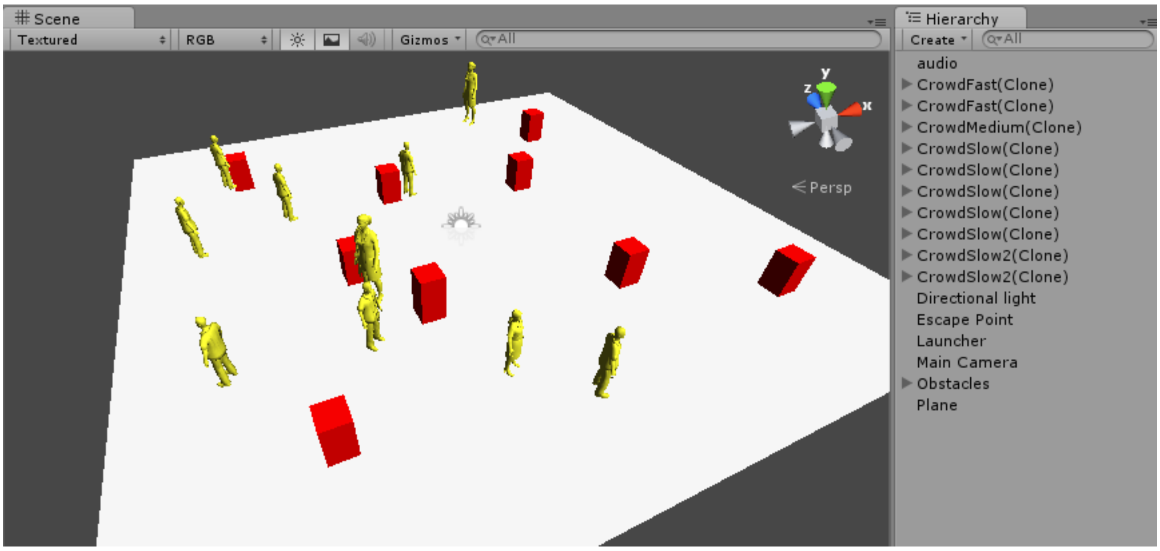


Figure 5.4 Crowd avoid collision with each other

The crowd are successly fully wander around on a plance and without collide with each other in which can refer Figure 4.5 .



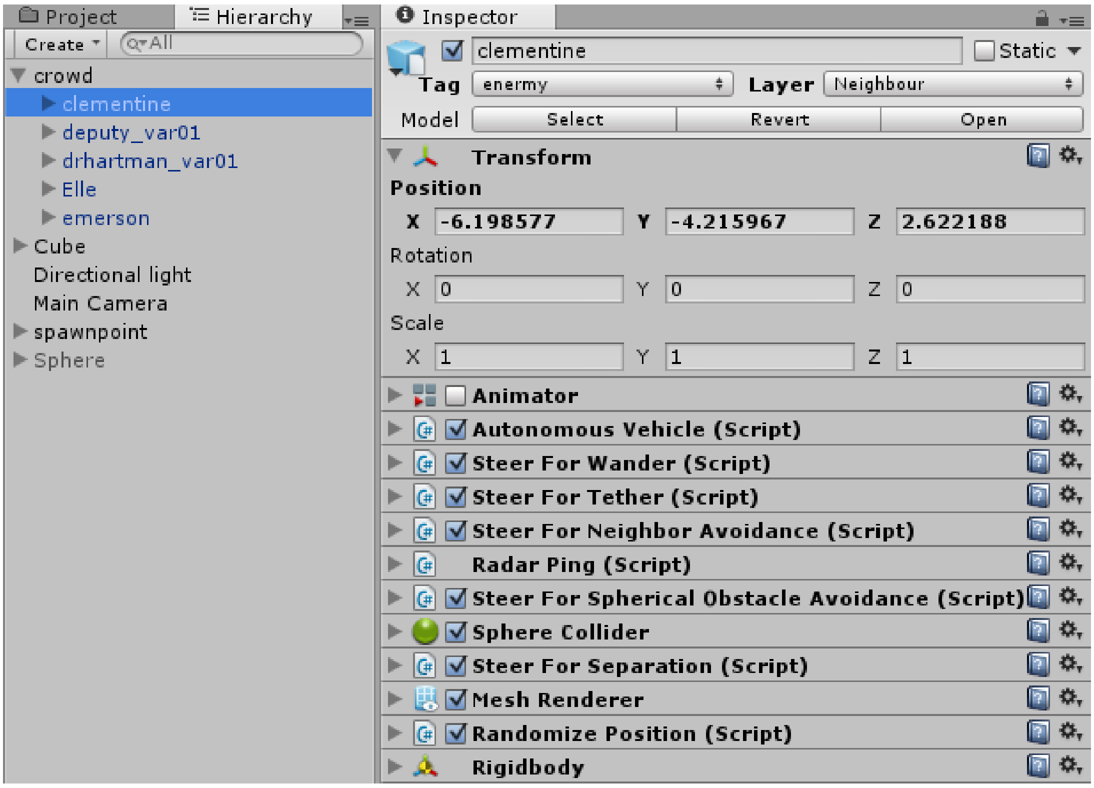
audio
CrowdFast(Clone)
CrowdFast(Clone)
CrowdMedium(Clone)
CrowdSlow(Clone)
CrowdSlow(Clone)
CrowdSlow(Clone)
CrowdSlow(Clone)
CrowdSlow(Clone)
CrowdSlow2(Clone)
CrowdSlow2(Clone)
Directional light
Escape Point
Launcher
Main Camera
Obstacles
Plane

Figure 5.5 Final product

5.2 CHALLENGES AND DIFFICULTIES

There are various challenges faced during the development of this project. During the initial stage of the development, I am tried to apply Unity Steer into the project. However, Unity Steer's scripts are not suitable to be use develop this project.

- First of all, there are a lot of scripts need to be added into the character to avoid collision happen between crowd and obstacles, wander around, collision detection among crowd and obstacles. Refer Figure 5.6



crowd
- clementine
- deputy_var01
- drhartman_var01
- Elle
- emerson

Cube
Directional light
Main Camera
spawnpoint
Sphere

☑ clementine □ Static
Tag enermy Layer Neighbour
Model

Transform
Position X -6.198577 Y -4.215967 Z 2.622188
Rotation X 0 Y 0 Z 0
Scale X 1 Y 1 Z 1

□ Animator
☑ Autonomous Vehicle (Script)
☑ Steer For Wander (Script)
☑ Steer For Tether (Script)
☑ Steer For Neighbor Avoidance (Script)
Radar Ping (Script)
☑ Steer For Spherical Obstacle Avoidance (Script)
☑ Sphere Collider
☑ Steer For Separation (Script)
☑ Mesh Renderer
☑ Randomize Position (Script)
Rigidbody

Figure 5.6 List of script of Unity Steer

- Each of the script contains long coding, which is at least 100 lines of code for each script and there is a lot of variable need to be set before run the project. Most of the variables are not state clearly used for what purpose, therefore is hard for make adjustable on the value of the variable.
- A lot of function will be call in a script to perform the task.
- The detection script for Unity Steer sometimes is not work in my project, it will unable to detect any crowd or obstacles when they are nearby. The detection sometime is slow which mean the detection happens when they are very close to the obstacle and crowd.

- Collision will happens even they are able to detect there is crowd and obstacle nearby them. They will pass through the crowd and obstacle.

Due to it is challenge when using the Unity Steer, therefore I had decided to create own simple code to run the project. This time is focus created a collider on a character to detect the nearby obstacle and crowd. At the initial model, I have use capsule shape object represent the crowd. Each of the character have the own collider; however an extended sphere shape collider is added at the front of the capsule which is to prevent too close detection. Close detection cause the action on changing direction of the object is not process smoothly.

Create walking animation to each of the character is take time. Before create the animation, have to insert skeleton on all of the character and adjust the animation frame by frame. At the same time have to make sure the animation have been created is nature. Due to the time constraint, I develop the project based on the objective of project only.

5.3 LIMITATION

There are some limitations in this project:

- The crowd only move around in certain range without any animation but just floating on the plane.
- After those crowds had spawned into the screen, they do not have a fix destroy point for them to escape from the screen after a while they had appeared.
- The actual human crowd in hospital will produce some noise even when they are walking in hospital. Therefore, if audio source have added into this project will produce more high quality product.
- The crowd in this system does not have nice textures which mean they do not have a normal human skin with clothing.

CHAPTER 6

CONCLUSION

Through this study, we come out with Game is not only create for entertainment but also can be used in other field such as medical field. Serious game for internal medical practice is an effective and interesting learning method compare to the old learning method. The Serious game of internal medical practice will be developing based on the actual environment of a hospital. Crowd Simulation s part of the important segment for develop this serious game. In crowd simulation, collision avoidance and steering had become an important element in order to determine the realistic and believability of virtual crowd. With the collision avoidance method is can solve the intersection problem between crowd and obstacles. There is three common parameter have been used in crowd simulation which is distance, velocity and direction. Crowd simulation is just a small part in an application but it will bring realistic to user.

The information and data observe by me is fit into my research and objective. From the observation, they crowd are able to avoid collision happen by themselves. Crowd are able to avoid collide with each other and obstacles.

My project is developing based on the ADDIE methodology. Based on the steps in ADDIE, my project had smooth going carry on. After I done each phase, I evaluate it before enter to next phase to ensure if there is error happens, I can solve it immediately. The implementation is done after the research, with this I had got the correct information and develop on a correct situation.

There are some recommendation and suggestion for this research. For the perfect result, various animations can be added into crowd such as walking and talking. This can improve the realistic of the game environment. Background sound is recommended to add on the game. Besides that, the texture of crowd also can be improve to make them looks real like human.

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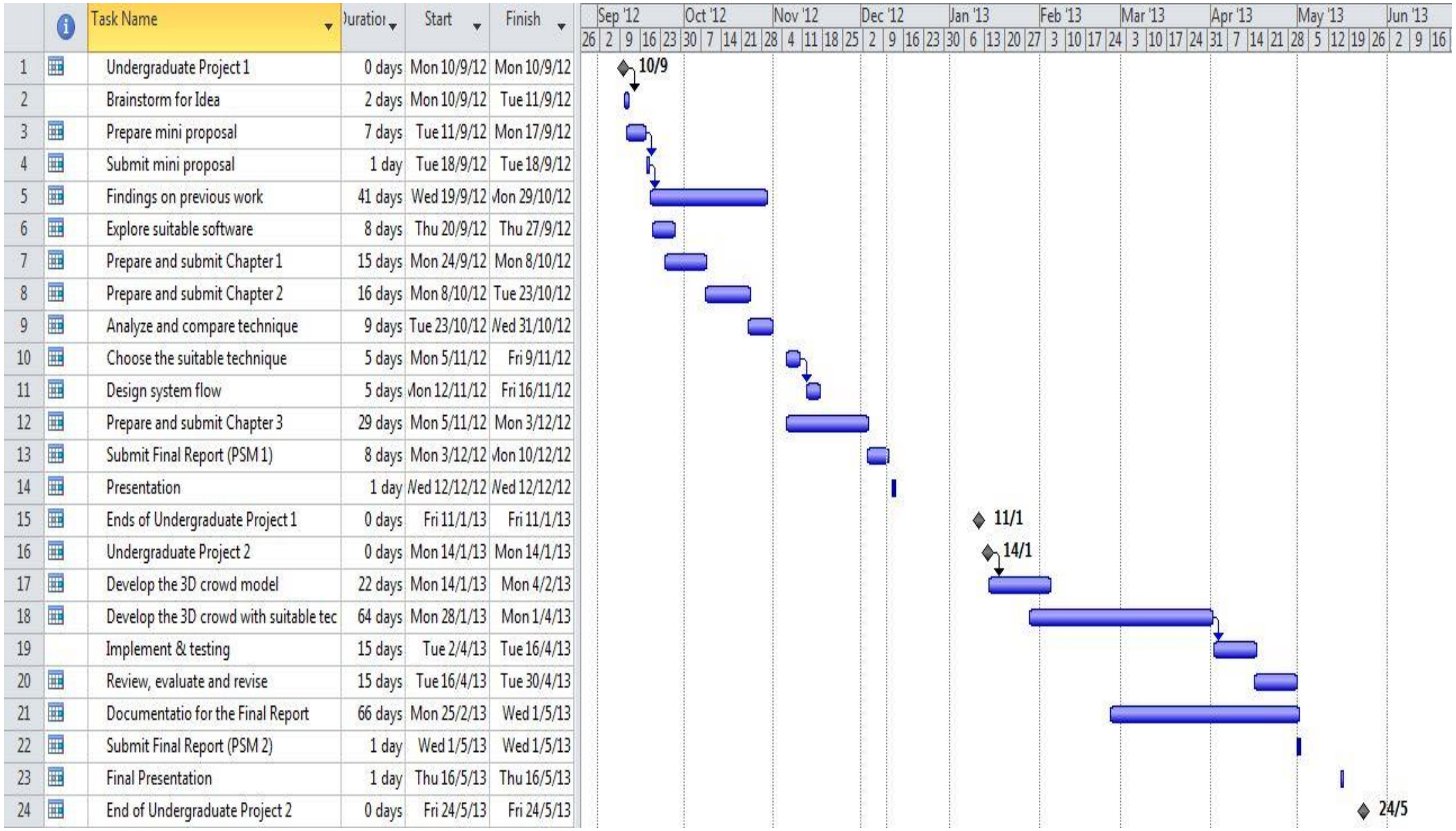
APPENDIXES

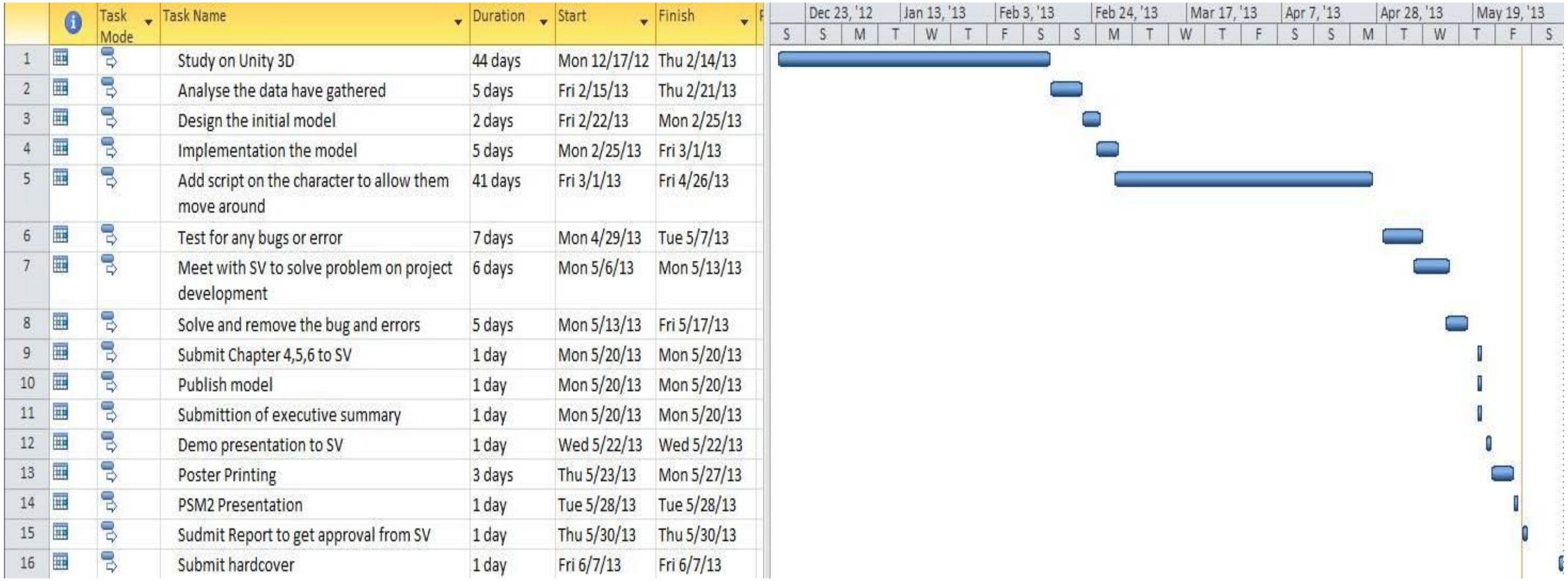
APPENDIX A

(PSM 1)



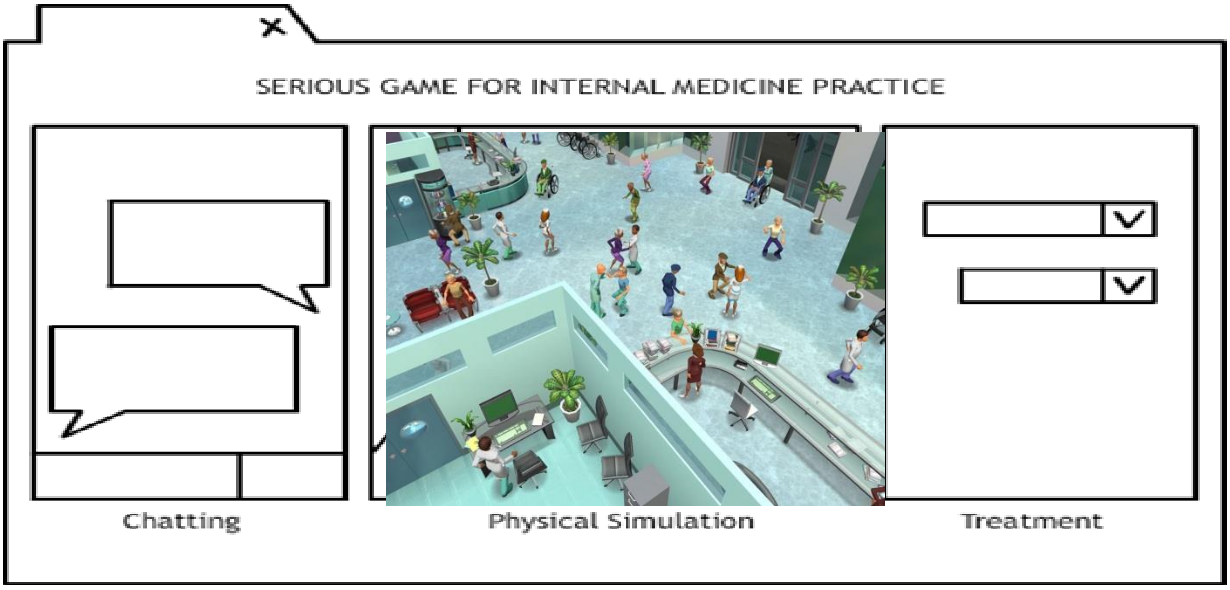
		Task Name	Duratior	Start	Finish
1	▦	Undergraduate Project 1	0 days	Mon 10/9/12	Mon 10/9/12
2		Brainstorm for Idea	2 days	Mon 10/9/12	Tue 11/9/12
3	▦	Prepare mini proposal	7 days	Tue 11/9/12	Mon 17/9/12
4	▦	Submit mini proposal	1 day	Tue 18/9/12	Tue 18/9/12
5	▦	Findings on previous work	41 days	Wed 19/9/12	Mon 29/10/12
6	▦	Explore suitable software	8 days	Thu 20/9/12	Thu 27/9/12
7	▦	Prepare and submit Chapter 1	15 days	Mon 24/9/12	Mon 8/10/12
8	▦	Prepare and submit Chapter 2	16 days	Mon 8/10/12	Tue 23/10/12
9	▦	Analyze and compare technique	9 days	Tue 23/10/12	Wed 31/10/12
10	▦	Choose the suitable technique	5 days	Mon 5/11/12	Fri 9/11/12
11	▦	Design system flow	5 days	Mon 12/11/12	Fri 16/11/12
12	▦	Prepare and submit Chapter 3	29 days	Mon 5/11/12	Mon 3/12/12
13	▦	Submit Final Report (PSM 1)	8 days	Mon 3/12/12	Mon 10/12/12
14	▦	Presentation	1 day	Wed 12/12/12	Wed 12/12/12
15	▦	Ends of Undergraduate Project 1	0 days	Fri 11/1/13	Fri 11/1/13
16	▦	Undergraduate Project 2	0 days	Mon 14/1/13	Mon 14/1/13
17	▦	Develop the 3D crowd model	22 days	Mon 14/1/13	Mon 4/2/13
18	▦	Develop the 3D crowd with suitable tec	64 days	Mon 28/1/13	Mon 1/4/13
19		Implement & testing	15 days	Tue 2/4/13	Tue 16/4/13
20	▦	Review, evaluate and revise	15 days	Tue 16/4/13	Tue 30/4/13
21	▦	Documentatio for the Final Report	66 days	Mon 25/2/13	Wed 1/5/13
22	▦	Submit Final Report (PSM 2)	1 day	Wed 1/5/13	Wed 1/5/13
23	▦	Final Presentation	1 day	Thu 16/5/13	Thu 16/5/13
24	▦	End of Undergraduate Project 2	0 days	Fri 24/5/13	Fri 24/5/13

(PSM 2)



		Task Mode	Task Name	Duration	Start	Finish
1			Study on Unity 3D	44 days	Mon 12/17/12	Thu 2/14/13
2			Analyse the data have gathered	5 days	Fri 2/15/13	Thu 2/21/13
3			Design the initial model	2 days	Fri 2/22/13	Mon 2/25/13
4			Implementation the model	5 days	Mon 2/25/13	Fri 3/1/13
5			Add script on the character to allow them move around	41 days	Fri 3/1/13	Fri 4/26/13
6			Test for any bugs or error	7 days	Mon 4/29/13	Tue 5/7/13
7			Meet with SV to solve problem on project development	6 days	Mon 5/6/13	Mon 5/13/13
8			Solve and remove the bug and errors	5 days	Mon 5/13/13	Fri 5/17/13
9			Submit Chapter 4,5,6 to SV	1 day	Mon 5/20/13	Mon 5/20/13
10			Publish model	1 day	Mon 5/20/13	Mon 5/20/13
11			Submittion of executive summary	1 day	Mon 5/20/13	Mon 5/20/13
12			Demo presentation to SV	1 day	Wed 5/22/13	Wed 5/22/13
13			Poster Printing	3 days	Thu 5/23/13	Mon 5/27/13
14			PSM2 Presentation	1 day	Tue 5/28/13	Tue 5/28/13
15			Sudmit Report to get approval from SV	1 day	Thu 5/30/13	Thu 5/30/13
16			Submit hardcover	1 day	Fri 6/7/13	Fri 6/7/13

APPENDIX B


SERIOUS GAME FOR INTERNAL MEDICINE PRACTICE
Chatting
Physical Simulation
Treatment