THE APPLICATION OF A* ALGORITHM FOR FIRST PERSON SHOOTER GAME

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I declare that we have read the thesis and according to our view, the thesis is sufficient enough for the quality and scope purpose of getting the Bachelor Degree of Science in E-Commerce and Multimedia Technology.

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DECLARATION

We hereby declare the materials and works in this thesis are original except for quotations, excerpts and references, which have been duly acknowledged.

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ABSTRACT

THE APPLICATION OF A ALGORITHM IN FIRST PERSON SHOOTER GAME*

Computer technology has increased significant improvement over the last ten years in which processor of the computer has made a significant advancement from early generations of Intel Pentium core processors until the current Intel I7 core processor, which shown the trends of computer that changed from computer that only worked on typing words to current and future computers that can do multitasking such as watching movies, playing games and others. Hence, with the Artificial Intelligence (AI) in the computer games was not the things that need to be surprised. A algorithm is one of the challenge to approach the realistic AI in computer games. Many previous video games had used the A* algorithm for path finding search. In this report will highlight the A* algorithm as a main strategy for bot to approach the player in a short path. Besides, this report has covered finite state machine and obstacle avoidance to represent as the AI elements in the First Person Shooter game.*

*Keywords: A*algorithm, Finite State Machine, Obstacle Avoidance, Artificial Intelligence, First Person Shooter.*

ABSTRAK

Teknologi komputer telah meningkat peningkatan yang ketara berbanding sepuluh tahun yang lalu di mana pemproses komputer telah membuat kemajuan yang ketara dari generasi awal pemproses teras Intel Pentium sehingga teras pemproses Intel I7 semasa, yang menunjukkan trend komputer yang berubah dari komputer yang hanya bekerja menaip perkataan untuk komputer semasa dan masa depan yang boleh buat multitasking seperti menonton filem, bermain permainan dan lain-lain. Oleh itu, dengan "Artificial Intelligence" (AI) dalam permainan komputer tidak adalah perkara-perkara yang perlu terkejut . "A* algorithm" adalah salah satu cabaran untuk mendekati realistik AI dalam permainan komputer . Banyak permainan video sebelum ini telah mengunakan "A * algorithm" untuk mencari laluan carian. Dalam laporan ini akan memperkenalkan "A * algorithm" sebagai strategi utama untuk bot untuk mendekati pemain dalam jalan yang singkat. Selain itu, laporan ini mengandungi "Finite State Machine" dan "Obstacle avoidance" untuk mewakili sebagai elemen AI dalam permainan "First Person Shooter".

Kata Kunci: A*algorithm, Finite State Machine, Obstacle Avoidance, Artificial Intelligence, First Person Shooter.

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CHAPTER 1

INTRODUCTION

Recently computer games undergo change of fame due to increase of prices and performance between consoles and personal computers. Early computer games begin with text adventure which consist of simple text input. The graphics became part of computers, games later on.

The proliferation of computer games starts early 1990 dues to the bottom fell oof console video game market. The oversupply for consoles, and the decreasing prices of computers make computer gaming a preferable option for a lot of people. (McGuigan, 2014)

History of FPS began in 1992 where the first FPS game, Wolfenstein 3D was released in 1992 by Id Software Company. Wolfenstein 3D stunted the world with its textured 3D graphics, high quality sound considered in 1992 and unique playing styles where players can use weapons such as knife, machine guns and rifle. Then in 1993, Id Software Company released another famous FPS game, Doom. Doom was way more sophisticated than Wolfenstein 3D where Doom provides the players choice to select more weapons. One of Doom's main feature is multiplayer games were allowed to be phased under a phone line or local area network. Doom was a big triumph and further secure Id Software as the leader of FPS game developers.

FPS games begin to mix with other elements. Bethesda Softwork released their famous RPG/FPS named Daggerfall in 1996 which consist of open-ended gaming and a very complex environment where gamers could fight, travel, stole, and shopping.

1.1 What is FPS?

FPS is a type of action game that played from the perspective of the protagonist. FPS games usually map the motion of gamers and supply a view of what would a real person's action in the game. A FPS usually show the arms of the protagonist on the lower part of the screen, carrying any weapon that is being provided. The player is expected to move his avatar through the game by moving to front, to behind, to the side and others using game control devices. Moving to the front of the game control devices causes the avatar moving towards the scene, usually with a slight-left vibrate motion to exactly mimic the human gait. In order to increase the game realistic, a lot of games include human activities such as footsteps to the sound effects.

There are two general modes in FPS games, mission or quest mode and multiplayer mode. The mission mode usually the fixed mode for single player which usually need players to fight through multiple levels of difficulty towards some final objective while the multiplayer mode need the participation of at least two players via a network and playing in a shared game environment. There are a lot of FPS playing modes for multiplayer mode, which consist of death matches, capture the flag, team death match search and destroy, assault of headquarters and last man standing. (Janssen, n.d.)

1.2 Problem Statement

A*algorithm is used so that zombies are able to find the shortest path to search for their targets, which is the computer game player. However, A* algorithm unable to perform effectively when there are lots of zombies perform movement at the same time. Others algorithms such as Finite State Machine can only perform two behaviors of zombies, which are walking and chasing only whereas

Obstacle Avoidance only allow players to be surrounded by five zombies. If there are more than five zombies, those zombies will clash with each other and graphic of the computer games does not become realistic. Problems of current FPS games are how interesting FPS games should become where some computer games players think that the current FPS games are not interesting enough. Besides that, there are issues whether FPS games will cause violence actions of FPS games players.

1.3 Project Goal

The main goal of this FPS game is to incorporate the A*algorithm and examine the effectiveness of A* algorithm.

1.4 Project Objective

The main objectives of this FPS game are:

1. To incorporate A*algorithm in FPS game.
2. To examine the effectiveness of A*algorithm

1.5 Project Scope

The project scope is about the limits of the project. Thus, the limitation of this game are

- Can only be played desktop computers
- This game needs the latest graphic card and processor. For instance, the processor must have minimum Core 2 Duo E8600 and graphic card minimum is Nvidia GT 240.
- Does not support non-computer playing devices such as joystick or mobile device.

1.6 Project Target

According the statistic found in chapter 3, the optimal target for this game is around 18 years old to 22 years old especially those who enjoy playing FPS games.

1.7 Project Description

"The Exception" is a survival video game in the type of First Person Shooter Game (FPS) is a type of game that provides players to control its character movement and switch their desire weapons during combat operation. In "The Exception" story, people from the James' hometown are gone, except James, the main character of the game. In order for James to survive he needs to escape/ get out of the building/hospital, however, he needs to overcome the obstacles in every level and must reach to the top of the building and takes the helicopter to escape.

In this game, the enemies are zombies. Based on statistics in chapter 3, players will normally enjoy shooting enemies using guns. In this game development, we will inject AI elements, therefore, this AI elements would be able to activate. The enemies to perform their behaviors/states such as idle, chase, patrol, attack. Finite State Machine (FSM) is suitable for enemies to perform their behaviors. A FSM is a type of abstract machine which provide a number of possibilities happen, but possibility offer the FSM are not unlimited. (Rouse, 2005) In other words, the FSM for enemies that can change from one state to another by triggering the condition. In order for the enemies to chase the players in a short path, the A* algorithm enables the enemies to do so. When the enemies were being blocked by an object, the obstacle avoidance algorithm can help them to solve the problems.

This project is to develop a 3-Dimensional (3D) in more interactive and more realistic based on storyline to bring players closer to the simple virtual reality. Besides, this game contains levels of difficulties, players still can easily enjoy the flow of the game. Perhaps this game can inspire the future programmers and developers about the importance of the game industries.

1.8 Project Methodology

The methodology for this project actually needs to follow the System Development Life Cycle (SDLC). System Development Life Cycle is a guideline for developing this game. There are five main phases in the SDLC. These included planning phase, analysis phase, design phase, implementation phase and maintenance phase. Each phase is essential for completing this game. The main SDLC guideline is listed below:

Phase 1 (Planning):

- Brain storming the appropriate ideas for this project.
- Identify hardware and software.
- Identify the skill for this project.
- Set the target user and project scope.

Phase 2 (Analysis)

- Determine the feasibility of the game
- Set up the questionnaire to conduct a survey

Phase 3 (Design)

- Design character, environment and guns
- Identify the interface and functionality of the buttons

- Design the main page and pause page

Phase 4 (Implementation)

- Test and debug
- Test the capability of this game on PC.

Phase 5 (Maintenance)

- Update and customize the game to make sure the game performance is good.

1.9 Project Timeline

The target to accomplish this game is expected within the timeline. The detail of the timeline is illustrated in the Gantt chart in the section of Appendix A.

1.10 Summary

The name of our game is called *The Exception*, we will implement A*algorithm, FSM amd obstacle avoidance. The objective of creating this game is to incorporate the A*algorithm and examine the effectiveness of A* algorithm. We use SDLC methodology which are planning, analysis, design, implementation and maintenance.

CHAPTER 2

LITERATURE REVIEW

The first series of first person shooter game called Wolfenstein 3D was ever created and released back in1992 which was released by the company name id Software. (Klevjer, 2006) Although, this game is in 2d platform, but it brings to the player more joyful and entertainment. In the 21 Century, the zombie has rapidly growth in films, video games and the novels. People start to love the way of the zombie . This is due to zombie genre has inspired in pop culture media today. (Twohy, 2008)

In this topic, the following sections are listed as below:

- Artificial Intelligence (AI)
- Previous Work
- The Effect of Input Device
- Fitts' Law
- Phycology View
- Application View

2.1 Artificial Intelligent (AI)

The AI is similar with human intelligence and it's developed in computer or other devices to perform a task in a short time. (Rouse, 2010) One of the AI elements in computer games is path finding. Generally, path finding in computer games refers to finding a best shortest route between two end points. As an important growth of industry, path finding has become popular with frustrating problem in the industry. A common problem faced by the industry is how to avoid the obstacle and seek an efficient path in different terrain. More efficient solution came out from the researcher to solve path finding problem in

complex environments. Hence, various search algorithms were generated and attracted an attention from the researchers that had changed the needs of the gamer.

2.1.1 A* Algorithm

A* in the game industry has been a better search algorithm ever made that used to find solutions to tackle the path finding problems. This algorithm repeatedly discovers most promising location. After finding the destination, the algorithm has finished to explore. If the algorithm can't find the destination, it will make a note of neighbor location for further exploration.

```
1. Add the starting node to the open list.
2. Repeat the following steps:
   a. Look for the node which has the lowest
      f on the open list. Refer to this node
      as the current node.
   b. Switch it to the closed list.
   c. For each reachable node from the current
      node
       i. If it is on the closed list, ignore
          it.
      ii. If it isn't on the open list, add it
          to the open list. Make the current
          node the parent of this node. Record
          the f, g, and h value of this node.
     iii. If it is on the open list already,
          check to see if this is a better
          path. If so, change its parent to the
          current node, and recalculate the f
          and g value.
   d. Stop when
       i. Add the target node to the closed
          list.
      ii. Fail to find the target node, and the
          open list is empty.
3. Tracing backwards from the target node to the
   starting node. That is your path.
```

Figure 2.1.1.1: Pseudo code of A* algorithm

Source: (Xiao & Hao, 2011)

The figure 2.1.1.1 has shown that the pseudo code of A* algorithm. When talking about A*, it used f (n) = g (n) + h (n) equation to perform the search path operation. (Xiao & Hao, 2011)The g (n) represents an exact cost from starting point to any point of n, h (n) is an estimated cost form start point to the goal.

A* algorithm has several advantages. First, A* algorithm performs path finding search from first location until the destination if there exists a path. (Xiao & Hao, 2011) The algorithm is optimal if h (n) is less than or equal to the actual path from start to the goal.

In the game industry, some game had implemented the A* algorithm in order to control the bots in certain location. However, if the map in game is larger, it is difficult for computer bots to move smoothly. For example, if the grid space is 100 X 100, it takes time and work for computer to calculate the total cost of path. Hence, several optimizations for A* are discussed in the following sections.

2.1.2 Optimizing the A* Algorithm

2.1.2.1 Hierarchical Path finding A* (HPA*)

The hierarchical path finding is a powerful tool to speed the process of path finding. The issues of A* algorithm can be reduced by breaking the map hierarchically. (Xiao & Hao, 2011) For instance, consider you are travelling from Kuala Lumpur to Petaling Jaya, the roadmap of Malaysia is showing that all roads are annotated with driving distances, A* will optimize the route. However, it is expensive to compute all the roads in the roadmap due to the huge size of the roadmap. Hence, using the HPA* is optimum to compute the all roads and it does not work at a low level of detail as original A*algorithm.

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