Exploring Cognitive Aspects of AI in Game Development

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Abstract— This paper illustrates the Design elements of Game Designing including various levels of adaptive game levels. These video game principles are used in virtual reality and training scenarios for military applications. This paper also deals with the analysis of various kinds of Path-finding algorithms needed for the movement of the in-game character. The role of Artificial Intelligence (AI) is vital as it affects the success or failure of the game, and the advantages it brings along. In this paper, we explore the computational and design requirements for Dynamic Difficulty Adjustment system.

Keywords--Artificial intelligence, game development, pathfinding, DDA(Dynamic Difficulty Adjustment), player modelling, video games.

I. INTRODUCTION

Video games are designed to generate engaging experiences: suspenseful horrors, whimsical amusements, fantastic adventures. They have been around for several decades. They gained greater popularity in the 80s and 90s. It is an electronic game that involves interaction with a user interface to generate visual feedback on a two- or three- dimensional video display devices such as a TV screen, virtual reality headset or computer monitor. In video games, artificial intelligence (AI) is used to produce responsive, adaptive or intelligent behaviors in bot characters similar to human-like intelligence. AI in games is a system that makes the game characters to act like human beings that can make smart decisions to achieve the target in a video game[2], [3].

Video games can be boring for the users when they are too easy and frustrating when they are too hard, but this can be avoided by using DDA. The goal of DDA is to keep the user interested from the beginning to the end, providing a good level of challenge [4]. There are twelve different types of video games which are popular all over the world like Massively Multiplayer Online (MMO), Real Time Strategy (RTS), First-Person Shooter (FPS), Role-Playing Game (RPG), etc. FPS is a type of three-dimensional shooter game, featuring a first-person point of view with which the player sees the action through the eyes of the player character [1], [6].

II. LITERATURE SURVEY

This paper [1] discusses briefly first-person shooter player modelling and various aspects of skills such as capturing, measuring as well as predicting the rapid expertise. The skills in this research is generally a property of a player, in terms of their average performance. When their skill is matched equally, then the players find the game more interesting, whereas the players find it difficult when they are matched with players with excellent abilities or high experience. In the gaming world, if a player's skill were known before they played, their opponents could be selected in a way that they optimize their gaming experience. It also highlights different aspects of computer game design, which consists of adaptive elements of game levels, characteristics of bot behavior and player matchmaking in multiplayer games. They have also successfully predicted the player's skill using less than a minute of their keyboard press.

The application of this research can be directly applied to matchmaking and DDA systems, potentially improving player satisfaction in the short term.

This paper [2] discusses briefly on the pathfinding algorithm. Pathfinding in games generally addresses the problem of finding a shortest path from the source point to the destination point by avoiding obstacles. Besides the above algorithm, it also illustrates various other algorithms mainly heuristic, a-star and their implementations in Unity3D. Unity3D is a game development tool which features an integrated editor, terrain editing, shaders, scripts, networking, physics, etc.

Heuristic algorithm finds the approximate solution in finite time but not the optimal solution. It is often used to solve a class of decision problems and NP-complete problems. Its objective is to obtain a solution in a reasonable time period which suits for solving the given problem.

A-star algorithm is a computer algorithm used in pathfinding and graph traversal. It is defined as a process of obtaining a path between multiple nodes. In this paper, it is applied in search of the fastest and the shortest path.

This paper [3] presents the research done by the authors to test the areas in games where the AI can be applied as it has various advantages. The success or failure of the particular game can be decided by the integrity of the AI developed. It briefly discusses the provenance which is nothing but the origin of AI, Open Provenance Model (OPM), Search Engine (SE), the role of AI development in games and various pathfinding algorithms in detail. It gives overview of the different types of pathfinding algorithms which are widely used, mainly Breadth-First Search with its types, Dijkstra's Algorithm, Depth-First Search with its types and many others which contribute for the game development. It also elaborates the Pathfinding AI in 3D games. Its problem is defined as four components: initial state, descriptions of the possible actions available, the goal test and the path cost. It states that game AI targets to improve and enhance game experience. AI helps to make a game more meaningful and it also controls the character in game.

This paper involves the study of existing application of AI in games and the concepts behind them.

This paper [4] discusses the computational and design requirements for a DDA. It clearly presents a probabilistic model for finding the uncertainty in games. It gives the detailed description of the implementation of these techniques and how they can be used to create a flexible interactive experience that takes the decision in an instant.

As we know that the games can get less interesting after a period of time, when the player has completed the necessary missions of the game or the game is too hard or too simple for the user. The user always wants the game to provide some difficult missions which can get the users to play the game even more. This refers to the flexibility which maintains the bond between the game and the player. This is achieved using DDA, which refers to the system that automatically adjusts itself according to the input of the players skill.

Nowadays, the concept of inventory is widely used in games to keep the player interested in game. Inventory is a collection of the digital items which the player desires to have in the inventory. The developers also focus on providing more fancy items that increases the demand of the game. For an instance if we take the CSGO which is an online multiplayer game, then the developers have steam market which is the place for the players to buy skins for the weapons used in the game, the souvenir skins by the professional players and the gloves and many other collectible items. This is how the developers of the gaming community keep the players engaged in their games.

In this paper [5], we explore the background of FPS games, canonical map types of standard game, notable examples of non-canonical map types, investigation of different bot behaviors and coordinated team actions for CS (Counter Strike) Game bots. This paper also presents one such extension, which makes the planning of the game tactics easier. The testing of algorithm of done two experiments: bot-to-bot computer and human players. The outcome of these experiments performed are described in this paper. However, flexibility of the game was demonstrated in detail.

CS is most popular and widely played online game. It is a FPS game in which the player can only see the hands of the bot which holds the weapons and the UI of the game shows the health of the character, the items it is carrying which includes different nades, a small radar which shows the mini map and the developer console which helps to give necessary commands to the game to adjust the necessary settings. Bots play an important role in this game when the player has less number of players on the server than required. The bots can act as a human and take necessary actions through the user input. The bot actions solely depend on the programming done by the programmer. The programmer should consider the players desires and the feedbacks from them. The feedback is important as some changes can be encountered by the player while playing game.

In this paper [6], the analysis of the game traffic is done, and the outcome of the game can be determined as who will win or lose. This paper discusses briefly the game traffic of the multiplayer game, its problems, objectives and experiments done with different networks. The data packets are used in online multiplayer games. The data packets are transferred from the client computer to the server and they should be fast in response. The packets are mainly the data carriers and the data are taken as input to the client computer. The traffic on the network greatly affects the game performance, higher the traffic lower is the performance and lower the traffic higher is the performance. The servers of the game are also affecting the input lag. When the servers are overseas, then the packet transfer is slow which results in higher input lag, whereas when the server is local then the transfer is comparatively faster and thus the input lag is not seen. Not only packet delay but packet loss is also harmful to game performance. If the computer hardware is powerful with high speed internet, then the gamer can enjoy the game at its fullest.

The packet loss and delay should be kept minimum and the choke should be zero in online games as these factors greatly impact the game performance.

Authors in this paper [7] proposed a character generation approach for the M.U.G.E.N. game that creates attractive AI characters using cheap computation process without the intervening of the expert designer. There is a major advantage described here as that there is no need of prior knowledge of how to code the strategies of the AI character. Besides this, the implementation can create a wide diversity of players with different strategic skills. This paper also focuses on the AI, character, fighting games and genetic programming (GP). It has been reported in this paper that the AI character that acts like a human is contributing to the commercial success. However, there is an acknowledgement by the authors that the multiplayer games often do not require high AI performance in order to make commercial success as long as there are human players who play matchmaking in these games, so the need of bots in such servers is eliminated.

Initially the bot character requires more time to adapt according to the input received as the data received is less to know the player's skill and to match the skill from the obtained data is tough for the AI character. After various tests, it was observed that the character built by evolutionary things were significantly much better than the coded ones. But the minimal human intervention is required in the process and the machine learns on its own.

The characters were given more preference over the coded ones as the players found them to be unpredictable, attractive and difficult. The coded ones were given less affection than the GP character.

This paper [8], clearly shows how the neural network ensembles for video game artificial intelligence with the help of evolutionary multi-objective optimization. This paper focuses on automated method of producing artificial neural network (ANN) controller which can display friendly playing behavior for commercial video game. The authors did study of Ms. Pac-Man using multi-object evolutionary algorithm (MOEA) for training or evolving the architectures and connection weights in ANN. We have selected the commonly-used Pareto Archived Evolution Strategy (PAES) algorithm for purpose.

In this paper, the ANN is evolved with the PAES for the computer player to automatically learn and play the game. The controller is trained and tested in the single-net and multi-net models. Where the multi-net approach is compared with single-net models in terms of performance then the controller is working very effectively. Various models along with their experiments which shows that the controller is easy to make choices depending to different complex environments for controlling the game agent.

III. FUTURE SCOPE AND RESEARCH AREA

As we studied that various algorithms like DFS, BFS, Dijkstra's have more time complexity as compared to a-star algorithm, thus a-star is mostly preferred for pathfinding in game. Using the a-star algorithm in game ultimately improves the DDA system problem.

The existing game map contains 4 sites, in that two are bomb plant sites and the remaining two are the terrorists and counter-terrorists spawns respectively. But in this project only 2 sites are present, one is for terrorist and another is for counter-terrorists. In Existing game, the aim of the counter-terrorist is to guard the bomb sites from the terrorist by eliminating them, whereas the terrorist must retake the sites from the counter-terrorists and plant the bomb and guard the bomb till it detonates. When the bomb is planted by the enemy team then the counter-terrorists must secure the site by killing the terrorist and defuse the bomb before it explodes.

Here, we won't be using the bomb concept, instead the VIP will be captured by the terrorist and the rescue mission will be carried out by the military team. When the terrorist spots the military person then the terrorist will try to press the buzzer which will alert the executioner to kill the VIP and the military team will lose the allotted mission.

For the above game development, we will be using a-star algorithm for pathfinding along with heap-sort, line and distance algorithm to effectively reduce the time complexity.

IV. CONCLUSION

After analysis of a-star algorithm in comparison with different algorithms, best outcomes have been obtained. The DDA problem has been detected and the efforts will be made to minimize the DDA system. As this algorithm required Unity3D engine, we got the overview of the features present inside the engine.

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