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The application of artificial intelligence in FPS Games

Xu Liu

Faculty of Electronic and Information Engineering, Guangdong Baiyun University,Guangzhou, Guandong, 510450, China

1065199174@qq.com

Abstract. It has been a long time since games and artificial intelligence(AI) influenced each other. However, when it comes to the area of the application of AI in games most people talk about chess games. AI also plays an important role in First-person shooter games. First-person shooter games, also known as FPS games, provide abundant testing environments for developing and testing artificial intelligence algorithms too, and the advances in artificial intelligence have allowed the game industry to produce better FPS games. This essay is a iterature review that summarizes why and how people apply AI in FPS games, in both players' aspect and the game industry aspect. This essay briefly introduce the current research status, analyzes current challenges, and predicts future research directions by studying the application of artificial intelligence in FPS games as well as introduce the application of artificial intelligence in FPS games, explore the application of artificial intelligence in the gaming industry and its impact on FPS game development, and provide reference information for relevant research work.

Keywords: Artificial Intelligence, First-Person Shooting Game, Deep Learning, Video Game.

1. Introduction

Games have been supporting the development and research of AI (artificial intelligence, hereinafter referred to as AI) for a long time. With the development of the game industry, games also benefit from AI in the application of AI in games [1]. The application of AI in first-person shooter (FPS) games is mainly reflected in two aspects: One is using AI to play games, such as learning the game habits of human players, behavior control of non-player characters (NPC), simulating players, path planning, etc. The other is using AI in game development and design, such as game content generation and testing, game iteration, man-machine combat AI, and NPC character design. AI is widely used in FPS games, but few papers discuss the application of AI in FPS games. This essay is a literature review about the applicaiton of AI in FPS games. The first part is the introduction and the second part list the research methodology. And the third part briefly introduces the history of FPS games and illustrates some AI algorithmsr, as well as how FPS games and AI influence each other. Part 4 introduces the application of AI in FPS games industry, analyzes the practical value of AI in FPS games and its impact on FPS game development, Part 5 lists some game platforms and competitions that can help AI research, and Part 6 predicts the future development and upcoming challenges of AI in FPS games providing reference information for relevant research work.

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2. Research methodology

This paper is a review that sums up the application of AI in FPS games adopting literature study as the research methodology and using Keyword Searching, and References/Works Cited Lists in Google Scholar to get valuable references.

3. An overview of AI in first-person shooter games

The world's first FPS game, Maze War, was created in 1974 and built a basic game mechanism for subsequent games of this type. The first-person shooter game is based on the player's first-person perspective and is characterized by its immersive experience. FPS games can provide dramatic plots, exquisite pictures, vivid sound effects, and more flexible actions to enhance the game experience of players. At present, FPS games in the game market mostly use 3D or Pseudo 3D technology to ensure their attractiveness to players. Players' perspectives can be rotated up and down, left and right at will. They can directly observe the surrounding environment from the perspective of the game characters, and carry out activities such as shooting, sprinting, squatting, shoveling, and dialogue. FPS game mode can be divided into PVP and PVE modes. PVP refers to the battle between players, such as in the Comepetitive games of Overwatch (Blizzard, 2014), and Rainbow Six: Siege(Ubisoft, 2015), while PVE refers to the battle between players and computers, such as Borderland 2 (Gearbox software, 2012). FPS can also be divided into online and stand-alone types. Stand-alone refers to the server and game ontology can run with only one device. Online refers to that multiple devices transmit information to the server through the network to enable multiple players to participate in the game. According to the number of players, it can be divided into multi-player mode, such as Destiny 2 (Bungie, 2019), and single-player mode, such as Fallout 4 (Bethesda software, 2015) (or 1.5-player mode of an NPC teammate, which is not different from single player mode).

Many FPS games are very suitable for carrying out AI research because of their wide variety, flexible game modes, controllable environment, and the ability to collect a large number of experimental data. AI also benefits the development of FPS games and the game industry [2].

3.1. Playing FPS games with AI

AI can be used in both FPS games and the FPS game industry. AI can not only play FPS like human players (most of which appear in AI-related academic research and experiments) but also can play the NPC role accompanying the player (which often appears in game production and testing). In the game industry, AI is mainly used for procedural content generation (PCG), automatic pathfinding, personification of NPC teammates, man vs. AI combat, providing a more realistic gaming experience, a more balanced match-making mechanism, and identifying plug-ins.

3.2. Why let AI play FPS games

Because FPS games have the characteristics of fast pace, short reaction time, teamwork, and a stable and controllable game environment. These characteristics make a very suitable platform for testing AI algorithms. Some FPS game platforms, such as Vizdoom and Botprize, can be used to hold AI competitions for testing purposes. In the game manufacturing industry, AI can help manufacturers test the playability of games by simulating human players. When AI plays games as an NPC role, the NPC using AI technology can have more interaction with players and provide more experience and empathy [3]. However, AI should not imitate human behavior completely. For example, in the FPS game, NPC should not spawn-kill players like other players do, because spawn-kill will give players a bad game experience and can destroy the playability of the game. In a word, it is necessary to make the game challenging, but not to make human players feel frustrated that they cannot defeat NPC opponents [4].

3.3. How AI plays FPS games

The planning-based refers to the use of algorithms to plan actions and decisions for autonomous agents.

(1) Tree search algorithm

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There are many tree search algorithms, such as blind search (depth-first, breadth-first) and greedy algorithm (A*). For example, the path-finding technology in the FPS game Battlefield series is based on the A* path-finding algorithm [5].

(2) STRIPS-like representation

F.E.A.R. (Sierra Entertainment, 2005), the first-person shooting horror game, is famous for its use of AI in NPC behavior planning and has been widely praised for its NPC behavior. In F.E.A.R, STRIPS-like expressions are used to plan which NPCs perform which actions (such as raid, evasion, suppression, shooting, etc.) to defeat the player character.

(3) Supervised learning

Supervised learning [6] refers to knowing the input and output to find out the functional relationship between them and then induce the other examples according to the relationship. The application of Supervised learning in the game is to record the game behavior of human players and train the AI to imitate the behavior of human players.

(4) Reinforcement learning

Reinforcement learning refers to continuous interaction with the environment and continuously adjusting the behavior according to feedback to maximize the overall benefit of action [7]. The characteristic of reinforcement learning is that during reinforcement learning training, corresponding feedback is required, and the labels of training data are not a requirement.

(5) Evolutionary algorithm

The evolutionary algorithm is to simulate the evolution of organisms in nature, to simulate the natural selection of organisms in the computer [8]. For example, in the FPS game Destroyer II (GTInteractive, 1994), a loop controller has been evolved, which can learn to attack some randomly moving enemies in the room through visual input.

(6) Hybrid algorithm

For example, the Monte Carlo tree search algorithm [9]. The dynamic script adjusts the script according to the current game state and provides real-time rewards through reinforcement learning.

In conclusion, the combination of different AI methods is used to create more realistic and intelligent NPC enemies in FPS games to challenge players uniquely and fascinatingly.

4. Application of AI in the game industry

There are two major ways for AI to assist the game industry, one is to help generate game content, and the other is to build player models [10]. Applying AI to game production can not only make game content richer and higher quality but also help creators save time and money to design a better game [11].

4.1. Game content generation

For game production, AI can shorten the production cycle and save labor costs to focus on providing higher-quality game content and more realistic and diversified game experiences to its customers. One way to use AI to make games is procedural content generation (PCG): PCG is a way to dynamically generate game content through AI. Such as maps, weapons or enemies, and so on, all of which can be generated in this way. For cost reduction, PCG can save unnecessary labor costs, and producers can use their budgets on more valuable areas. For example, in L4D2 (Valve Corporation, 2009), based on the player's feedback, the "AI director" will generate enemies, environments, and background music. Another example is to generate enemies with different levels of difficulty according to players'skill-level [12]. In the article [13], the author describes a new PCG method that can generate levels that can match the skill level of players in real-time.

AI can also be used to generate weapons in FPS games. For example, in [14], developers have produced a large number of weapons by combining PCG and evolutionary algorithms. Those weapons not only have diverse functions but also maintain the balance of the game, which greatly enriches the play styles of the game.

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4.2. Player modeling

Player modeling has an impact on AI-assisted game design and PCG. Players prefer to fight with opponents that behave like human players, and player modeling can help generate such NPC opponents. In [15], the author briefly introduces Expert UnrealBot which was created by AI through using professional players' understanding and behaviors [15]. Another article [16], mentions that the Turing test was used in Botprize 2014 to test the similarity between AI bots and human players to find out which is the best bot that acts like to human. At present, the NPC in L4D2 and F.E.A.R. have applied player modeling technology in the game.

The combination of player modeling and PCG can generate suitable game content according to the tastes and needs of players: modeling players through neural networks and then generating the game content adaptively. Most of the game masterpieces are combined with a certain amount of AI technology to some extent. Making NPC more humanized can increase the empathy of players for NPC and enrich the gaming experience of players.

5. FPS platform for AI research

With the development of information technology and the game industry, there have been powerful game production engines and game-based experimental platforms for AI research [17].

5.1. FPS game and AI research

From around 2000, AI researchers began to pay attention to complex strategic simulation games. Compared with chess games, real-time strategy games are more complex [2]. For example, StarCraft (Blizzard Entertainment,1998), a classic multi-role and real-time strategy game released by Blizzard Entertainment.

5.2. FPS research or application platform of AI

(1) Unity

Unity is a fully integrated development engine with various functions. It is the most frequently used engine and platform for game design in the world [18]. Unity provides a large number of AI tools and plug-ins, which can create advanced AI models in FPS games. With the help of the Unity engine, Interstellar Marines(Zero Point Software,2013) shows players a realistic universe through pictures, sound effects, and game-playing methods.

(2) Unreal Engine:

Unreal Engine is another popular game engine for developing FPS games. Its built-in AI tools allow developers to create humanized NPCs more easily. Unreal Tournament III (UT3 in brief) is developed using a Client/Server structure, which allows game simulation to run on the server without rendering the actual game.

Unreal Tournament III (UT3): Unreal Tournament III is a First-person-shooter game developed by Epic Games4 based on Unreal engine. UT3 is a multiplayer FPS game with complex artificial intelligence allowing players to play games with computer-controlled characters (robots).

(3) Deepai Gym:

Deepai Gym is a toolkit for developing reinforcement learning algorithms. It can compare the performance of different reinforcement learning algorithms in FPS games.

(4) VizDoom

VizDoomis a software based on the classic FPS game Doom. It is also an open-source research platform for reinforcement learning [19]. With the characteristics being lightweight, fast, and flexible, it is suitable for developing and testing different deep-learning algorithms in FPS games. According to the test result from the article [20], it shows that as an AI research platform, VizDoom confirms that visual enhancement learning is viable in the first-person perspective environment under a 3D environment.

(5) Deepmind Lab:

Deepmind Lab, an engine based on Quake III Arena (ID software, 1999), is a 3D navigation and puzzle-solving task platform [21].

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(6) Botprize:

Botprize is a game competition platform for comparing different AI performances. Participants of the competition use self-designed AI NPC to compete with the NPC provided by Botprize in the simulated FPS game environment.

6. Challenges and opportunities

The development of artificial intelligence not only contributes to the FPS game industry but also brings new challenges, such as cheating through AI [1]. For example, use the target detection algorithm to detect and identify the enemy and calculate the direction and distance that the mouse needs to move, and then send these data to the mouse in order to control aiming and shooting. Compared with the traditional cheating methods, cheating with AI is difficult to detected by the anti-cheating system, and this unique cheating method can be applied to a wider range of FPS games. After training, AI can behave identically to human players which can be hard to expose. However, AI can also assist in the anti-cheating system. For example, abnormal operations can be identified and marked by collecting a large number of human players' data. Using AI for cheating is not a cost-effective way in the current situation, so it is not a critical problem for the game industry. But with the development of AI and the game industry there still will be many challenges upcoming.

7. Conclusion

In this paper, we have presented how FPS games and artificial intelligence influences each other. We introduce the characteristics of FPS games and the application of AI in FPS games. Then we summarize the application of AI in FPS games from two perspectives and the advantages of using AI in FPS games. One is to use AI for FPS games. In this part, we demostrate some examples of using AI personification NPC, and the other is the application of AI in the game industry, such as player modeling and game content generation. AI can help NPC act like human beings and provide a better gaming experience to human players; The application of AI in the game industry can shorten the game production process, and reduce the costs to make game developers create better games. The article also analyzes the mutual impacts between AI and FPS games and briefly introduces some AI algorithms and application fields in FPS games as well as the FPS research or application platform of some AI.

In conclusion the application of AI in FPS games has practical value in both AI research and the game industry though the current problem is the huge investment requirement. As the development of AI and game market, there will be more FPS games get boosted by the AI techniques, and there will be more future research focus about the application of artificial intelligence in FPS games.

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