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Review of artificial neural networks in first-person shooter games

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Abstract. More and more games have entered the market as computer processing power has improved, drawing in a sizable fan base. As a result, the video game industry has seen a rise in both revenue and the breadth of its product offering. Whether or not a game can generate enough revenue is dependent on a number of factors, including the game's ability to attract players, the quality of its gameplay, and the experience it provides to those that play it. This paper through methods of literature review and analysis will review the target detection, image recognition, and other artificial intelligence-related technology used in games, as well as provide suggestions for future development and a summary of the current state of the field.

Keywords: artificial neural network, first person shooter game, computer game.

1. Introduction

By 2022, the Chinese market is projected to account for approximately one-third of worldwide esports sales, according to Newzoo, a pioneer in global market research and predictive analytics for the gaming business. In terms of earnings, the Asian-Pacific region will represent about half of the world's gaming market [1]. During the anti-occupation years, the online gaming industry expanded into a whole supply chain to meet the demand from gamers of all ages. The exponential expansion of the gaming population can be directly attributed to the proliferation of online games during the past few years. The number of Chinese mobile online game users is expected to reach 600 million by 2020, and is expected to continue growing rapidly. FPS games account for as much as 47.13 percent of the whole gaming market, which has reached a record amount of 250 billion yuan [2]. Providing a satisfying gaming experience for customers is now a primary goal in order to maintain a growing player base.

Many first-person shooters have AI enemies for new players to face, as the 100 people who appear in Jedi Survival based on the player's level. However, these NPCs are not separated into tiers and cannot be on par with the player's level. As a result, the player does not have a sufficient feeling of accomplishment, and the implementation of AI is imperfect.

When it comes to player-versus-player combat or story, today's popular games are near-perfect. However, they don't provide players with artificial intelligences that can keep up with them as they level up. After logging in, most players will have a bad time due to hostile server environments and high-level gamers killing them. Applying AI to games has the potential to dramatically increase players'

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interest, provide a sense of achievement in the battle with AI, and make players' operations more skilled, all of which contribute to player retention as AI technology advances.

In this paper, we will use the research methods of a literature review and literature analysis to summarize the target detection, image recognition, and other AI-related technologies used in the game, offer some recommendations, and discuss some possible directions for future study and development. There are a lot of games out there right now, but none of them use artificial intelligence-related techniques. As a result, the future of AI in games seems bright. This paper provides a wealth of algorithms and games paired with the idea, which can encompass the game involved in most of the principles of AI, target detection techniques, deep reinforcement learning, artificial neural networks, and so on. Therefore, this paper is useful as a point of reference for game developers and those working to advance artificial intelligence in the gaming industry.

2. Application of basic theory and related technology

2.1. Game development engine

A game development engine is a crucial part of any system for creating and editing computer games or any interactive real-image application. These frameworks equip game developers with the resources they require to create games rapidly and easily. Most gaming engines are cross-platform and can be used on a number of different computer systems. A few examples of game engines are the rendering engine, the physics engine, the collision detection system, the sound engine, the scripting engine, the computer animation engine, the artificial intelligence engine, the network management engine, and the scene management engine [3-4]. For the development of the engine competency determines whether the game is stable or not, the selection of a suitable development engine is one of the main aspects. The engine comprises a number of operations, such as creating new game projects, altering game animation game scenes, logic, etc. Games have entered the high-definition age with the arrival of Sony's PS3 and Microsoft's XBOX360, and the eight-core processor game consoles have vastly improved the quality and effects of games compared to older PC games. As a result, the "next generation" of gaming was initiated [5]. The Unreal Engine has become the most popular engine for making cutting-edge video games thanks to its innovative blueprint development method, comprehensive skeletal animation system, high-quality and precise lighting normal mapping, potent material mapping, rich and complete API calls, and support for multi-platform release [6].

2.2. Artificial neural network

It was around the year 1980 that the artificial neural network [4] was developed as a special mode of information communication that mimics the process of information transfer by modeling it after the neural networks in the human brain. The concept of an artificial neural network (ANN) has been gaining traction recently. An ANN is a mathematical model that mimics the way human neurons connect to one another in order to store and retrieve information (the "memory"). Fully connected networks, feed-forward networks, and convolutional networks are the three main types of artificial neural networks. Neural networks have great potential in many data-related applications. The usage of artificial neural networks allows for the efficient processing of a game's vast amounts of data, as well as the screening and training of non-playable characters to provide the player with the most relevant information possible.

2.3. Target detection algorithm and deep learning

Image categorization is taken to the next level with target detection algorithms, which not only identify target types but also locate and contextualize them inside images. Algorithms for detecting targets are one type of use of artificial neural networks. In this paper, we focus primarily on the One-stage algorithm (end-to-end) for target detection and recognition because, in comparison to reading the player's data directly from the game, the use of a target detection algorithm is more closely related to the player's operation, allowing the simulation of the player's aiming and shooting process via the target detection algorithm's configuration.

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Because machine learning is essential to the development of artificial intelligence, its subfield, deep learning (also known as DL), is a promising new area of study. The study of artificial neural networks gave rise to the idea of deep learning; one type of deep learning structure is the multilayer perceptron, which consists of several hidden layers. When it comes to discovering high-level representations of attribute classes or features, deep learning excels because it combines low-level characteristics to generate more abstract high-level representations. The goal of deep learning research is to create neural networks that can learn analytically like the human brain [5]. These networks would then be able to understand data like sights, sounds, and texts in a manner similar to the human mind.

3. Realization and analysis of AI

3.1. Players' needs analysis and AI decision-making system

It is now necessary to consider the player's level of expertise in the game before attempting any one shot. Players that begin the game without the necessary operating skills or acquaintance with the map are frequently eliminated by other players. Therefore, players should be able to practice shooting against AIs of a similar level, and AI characteristics should be altered accordingly to accommodate players of varying skill levels. At the same time, players should be able to tailor the game's interface settings to their individual preferences. This is why it's important to implement player versus computer and character customization options in addition to the traditional player vs player action.

NPCs will be made at the point of resurrection and, once created, will make decisions based on data gathered from their immediate environment and from other NPCs, all in an effort to simulate the player's decision-making process. When a trigger is pulled in a first-person shooting game, the NPC will get a message and use the game's decision-making mechanism to determine how to respond. The game's decision-making algorithm decides how smart the AI is, and whether or not the character controlled by the AI can make the right call in the given situation and take the necessary action. The decision-making process is responsible for all of these results.

3.2. AI perception system

The perception system provides information for the AI decision-making system and is built with less complexity than other components. There are now three methods available to deliver information about the game world for AI characters that work together to form the game's perception system. The three techniques are called polling, event-driven, and trigger [6].

First, polling is the quickest and easiest approach to give the NPC player access to information about its environment. Polling is synonymous with querying. The system repeatedly checks the status of the sensor to see if a predetermined event has occurred, however this approach is flawed. It is tough to make modifications to the code when there are more players and NPCs since too much information is acquired in one polling and most of it is not obviously helpful for NPCs' activities. However, its useful features allow it to be used in less complex contexts.

In contrast to polling, an event-driven technique involves waiting for a certain time to pass before retrieving data and passing it on to other NPCs. To handle the player's reaction to the NPC's activity, event-driven time keeps track of potential future occurrences and reacts to the associated state whenever they occur. This method keeps an eye on the game's environment and reacts accordingly; this monitoring can be done at regular intervals to look for changes or in conjunction with triggers. After a certain amount of time has passed, a notification is sent to the AI character that was following the event [7].

Thirdly, we have "triggers," which function similarly to NPC-triggering devices in that they cause the relevant NPC (a non-player controlled intelligent character) to do an action when a certain event occurs. Set the login trigger when the player signs in, the scene trigger when they enter a new area, and the collision trigger when they collide with an object. The three methods are used together to enhance one another and create a more humane decision-making mechanism for the intelligent character in the game who is not controlled by the user.

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3.3. Extensible state machine

Every choice the player makes in the game will alter the present situation and affect how the game evolves. The idea of state machines must be introduced if NPCs are to adapt to the player's actions. Due to their inability to scale, finite state machines are rarely a good choice for handling the game's many different scenarios. Instead, scalable state machines should be used [8]. By using scalable state machines, AI may improve its decision-making system to a larger extent, and avoid the challenges of scaling poorly. Each element t of T can be represented as a quintuple, source (t), target (t), event (t), condition (t), action (t)>, where S is the set of states, S0 is the accidental state, I is the set of input messages, V is the set of variables, O is the set of output messages, and T is an ensemble of state migrations. where source (t) is the migration's meta-state, target (t) is the destination state, event (t) is the incentive event on migration (t) consisting of a number of input variables or null, condition (t) is the precondition for t to be able to execute (or null), and action (t) is the action caused by migration (t) consisting of a series of variable assignment statements or output statements (or null). The result of migration t is represented by action(t), which may be a series of statements assigning values to variables, statements producing output, or nothing at all. To perform a migration, the EFSM must be in the target state target (t) and have received the incentive event event(t), all while the precondition condition(t) of the migration is True.

Starting from the game's initial state, the game's AI constructs a route for the NPC to follow throughout the game. In order to respond appropriately to the player's action, the non-player controlled intelligent character will transition to the desired state. This template represents the player's internal thought process in-game, as they assess the scenario and behave accordingly.

3.4. Target detection algorithms and deep reinforcement learning applications

When the intelligent, non-player character finally locates the player, it should begin firing at the player. A non-player controlled intelligent character should follow a similar procedure as the player during the operation, which entails finding the adversary, aiming at the enemy, and firing. For use in games, algorithms must be quick to react and light on processing resources. Therefore, a single-stage algorithm is more practical; his algorithm follows the principle of using a dedicated CNN model to accomplish end-to-end target detection; the computer image is sent to the CNN network in real-time for prediction; and finally, the detected target is processed based on the network's predictions. This mimics the action of a non-player character aiming at the player and firing once they have been identified as the target. The player's reaction time can be tested multiple times to get an average value, and then that value can be fed into a target detection algorithm to get the player image position after the target aiming time of the player, yielding a non-player controlled intelligent role with a level similar to that of the player.

Gaming can also benefit from the optimization of the decision-making system of AI characters controlled by the game's AI with the help of deep reinforcement learning. It will initially function in accordance with the pre-generated action line, keeping track of the current line's parameters and adding the reward process in accordance with the current performance. After being exposed to a large amount of data, the AI will be able to make decisions based on what it considers to be the best course of action in any given situation, much like a human player would. This includes summarizing relevant data, determining where threats are most likely to materialize, and making educated guesses about how to best respond.

4. Conclusion

The present study primarily functions as a comprehensive literature analysis on the utilization of ANNs within the gaming sector. This article undertakes an analysis of the requirements of gamers, taking into consideration their gaming experience and the prevailing market conditions, with the objective of integrating AI into games. Subsequently, the research proceeds to devise the decision-making system and perception system for the AI. The decision-making engine of the AI incorporates a scalable state machine to customize its actions according to the player's individual playstyle. In order to enhance the performance of AI, optimize the player's gaming experience, and improve the AI's capacity to fulfill

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user requirements, the perception system grants the AI access to auditory and visual capabilities equivalent to those of the player.

This document has room for improvement as it mostly presents a conceptual framework for the game's design, without the practical implementation of the algorithms presented. Likewise, the availability of empirical evidence supporting the algorithm's feasibility is limited. Furthermore, the examination of the game's operation, as well as its continuous maintenance and optimization, lacks specific recommendations. However, further investigation and refinement in these domains are anticipated in the upcoming period, which will serve as substantiation for the program's feasibility.

Given the anticipated ongoing advancements and broadening applications of artificial neural networks, it is highly probable that their integration into video games will emerge as a prominent industry trend in the foreseeable future. The gaming experience for players will be further enhanced as improved algorithms are implemented alongside the upgrading or replacement of electronic components.

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