

Artificial Intelligence (AI) Use in Video Games: A Literature Review

Maria Contractor

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1 Background

Artificial intelligence (AI) is a form of computer technology that can range from inferring a Google Search to projecting the trajectory of a Comet decades from now [3]. Additionally, the video game market has significantly increased and was valued at approximately 134.9 billion dollars in 2018 [20]. In the context of video game use, artificial intelligence tries to mimic human actions and learns from previous data to correct its mistakes [19]. Video games use AI to improve player satisfaction, create a more realistic experience, and make game development autonomous [15]. A large part of using AI in video games is the concept of replay-ability, which is the idea of a player to replay a game after they have completed. Furthermore, if a game is exceedingly predictable, a player may lose interest and will not want to continue playing the game due to the lack of challenges [2]. One of the first uses of AI in a video game was Pac-Man, whose objective is to avoid four ghosts while collecting as many pills as possible. Each of the ghosts in Pac-Man follow a script that tries to get to Pac-Man, which is known as Scripted Artificial Intelligence [3]. This literature review seeks to explore the uses and types of artificial intelligence in video games, the use of artificial intelligence within game training, and medical uses of artificial intelligence in game training.

2 AI Types and Algorithms

Artificial intelligence in video games have significantly advanced throughout the years, with many different applications. AI includes a subsection of machine learning [4]. Machine learning is defined as adapting to different environments and teaching itself through previously known data [2]. Machine learning includes subsections of reinforcement learning and deep learning. Reinforcement learning is defined as a technique where trial and error is used to gain ‘rewards’ [4], whereas deep learning uses training on datasets to perform a task [5]. Each of these concepts can individually create AI algorithms that can be used to enhance

video games. Primarily, the Monte Carlo Tree Search (MCTS) method, a non-deterministic and heuristic search algorithm, was used in the game Settlers of Catan [11]. Settlers of Catan is a multiplayer game that allows players to grow their ‘settlements’ and receive the most points. The MCTS method is considered as a strong opponent against human players [14]. Another important AI algorithm is an artificial neural network (ANN), which consists of layers, nodes, and connections much like the human brain. The input passes through the network and makes adjustments as necessary [17]. A game that uses ANN is Simulated Motor Cross, which is a simulated motor-bike game that includes terrains and body simulations. In Simulated Motor Cross, an ANN is used to trace through different paths and can adapt, such as accelerate or turn [14]. Furthermore, conceptual AI is used to translate the ideas that people have into the games and vice versa [16]. Video games are different, but each of them have similar challenges that include the same concepts. With the use of conceptual AI, few algorithms can be used to handle complex concepts. AI algorithms such as MCTS and ANN allow for a better player experience and can be used to train games.

3 AI in Video Game Training

Video games testing consists of technical assessments and gameplay assessments. Technical assessments measure bugs or frame rates, while gameplay assessments measure difficulty or consumption rates [18]. Specific companies have developed automated video game testing algorithms such as Google AI and RiverGame. Google AI’s game testing system was patented to teach characters how to make decisions and perform actions based on previously learned data. Google’s AI can advance the use of AI in video games significantly by decreasing the amount of time it takes to release new video games [6]. Additionally, RiverGame is another automated game training system that focuses on different aspects of gameplay such as sounds, animation, output, and overall performance [10]. With RiverGame’s technology, many of the tedious game testing tasks become simpler and more efficient through AI. Though there are many benefits to incorporating AI in video game training, there are also limitations. As games are trained, they are constantly being changed. It is common for source code to change, making it difficult for AI to adjust to. Furthermore, there are greater costs to creating an automated game testing design due to reproducibility issues [13]. Both benefits and drawbacks allow for developers to understand the processes of automated game testing.

4 AI in Prosthetic Use

Although AI has been used for video games, it can also be used for medical purposes. The use of virtual reality (VR) to help train amputees to receive their prosthetics. VR in prosthetic training can help decrease the rejection rates of

fitting the prosthetic device onto patients [12]. Limbitless Solutions works to use AI in gamified training to ease the process of fixing bugs and making game-play easier. Specifically, the game Limbitless Runner uses an electromyographic wearable controller which performs gesture recognition and analysis while engaging the children’s audience [9]. With AI in video game testing, researchers can focus on the user’s interest rather than fixing tedious tasks within the game. Further research shows that AI can be used to control prosthetic arms through electromyographic patterns [7]. Specifically, ANN involves pattern recognition from EMG signals with an overall success rate of 88.4 percent. With ANN, pattern recognition can classify motions effectively with a faster computation time [1]. The use of AI in prosthetic training is important for future developments and can begin a new generation of prosthetic acceptance [8].

5 Conclusion

Overall, the use of AI in video games can be used to aid with ease of playability, fixing bugs, improving satisfaction, etc. AI can be used to train games through algorithms and techniques such as Monte Carlo Search Trees and Artificial Neural Networks. Furthermore, different applications like Google AI and RiverGame have been at the forefront of video game training through such techniques. AI can also be used for game training in prosthetic use to help with prosthetic acceptance rates, which Limbitless Solutions is currently testing.

References

- [1] Md. Rezwanul Ahsan, Muhammad Ibn Ibrahimy, and Othman O. Khalifa. Electromyography (EMG) signal based hand gesture recognition using artificial neural network (ANN). In *2011 4th International Conference on Mechatronics (ICOM)*, pages 1–6, May 2011.
- [2] Johann Alvarez. Machine Learning in Video Games: The Importance of AI Logic in Gaming. 2013.
- [3] Dylan Cattelan. Evolution of AI in Video-Games from 1980 to Today, December 2019.
- [4] Romain Gaunthier. Can AI revolutionize automated game testing?, April 2021.
- [5] Chengshuo Jiang. Analysis of Artificial Intelligence Applied in Video Games. In *2020 International Conference on Artificial Intelligence and Computer Engineering (ICAICE)*, pages 142–145, October 2020.
- [6] Huzaifa Khan. Google Patents System To Automate Game Testing Using AI, March 2023.

- [7] Morten B. Kristoffersen, Andreas W. Franzke, Raoul M. Bongers, Michael Wand, Alessio Murgia, and Corry K. van der Sluis. User training for machine learning controlled upper limb prostheses: a serious game approach. *Journal of NeuroEngineering and Rehabilitation*, 18(1):32, February 2021.
- [8] Diu Khue Luu, Anh Tuan Nguyen, Ming Jiang, Markus W. Drealan, Jian Xu, Tong Wu, Wing-kin Tam, Wenfeng Zhao, Brian Z. H. Lim, Cynthia K. Overstreet, Qi Zhao, Jonathan Cheng, Edward W. Keefer, and Zhi Yang. Artificial Intelligence Enables Real-Time and Intuitive Control of Prostheses via Nerve Interface. *IEEE Transactions on Biomedical Engineering*, 69(10):3051–3063, October 2022. Conference Name: IEEE Transactions on Biomedical Engineering.
- [9] Albert Manero, John Sparkman, Matt Dombrowski, Ryan Buysens, and Peter A. Smith. Developing and Training Multi-gestural Prosthetic Arms. In Jessie Y.C. Chen and Gino Fragoneni, editors, *Virtual, Augmented and Mixed Reality: Interaction, Navigation, Visualization, Embodiment, and Simulation*, Lecture Notes in Computer Science, pages 427–437, Cham, 2018. Springer International Publishing.
- [10] Ciprian Paduraru, Miruna Paduraru, and Alin Stefanescu. RiverGame - a game testing tool using artificial intelligence. In *2022 IEEE Conference on Software Testing, Verification and Validation (ICST)*, pages 422–432, April 2022. ISSN: 2159-4848.
- [11] Diego Perez-Liebana, Spyridon Samothrakis, Julian Togelius, Tom Schaul, and Simon Lucas. General Video Game AI: Competition, Challenges and Opportunities. *Proceedings of the AAAI Conference on Artificial Intelligence*, 30(1), March 2016. Number: 1.
- [12] Ivan Phelan, Madelynne Arden, Maria Matsangidou, Alicia Carrion-Plaza, and Shirley Lindley. Designing a Virtual Reality Myoelectric Prosthesis Training System for Amputees. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, number 49, pages 1–7. Association for Computing Machinery, New York, NY, USA, May 2021.
- [13] Cristiano Politowski, Fabio Petrillo, and Yann-Gaël Guéhéneuc. A Survey of Video Game Testing. In *2021 IEEE/ACM International Conference on Automation of Software Test (AST)*, pages 90–99, May 2021.
- [14] M. Ranjitha, Kazaka Nathan, and Lincy Joseph. Artificial Intelligence Algorithms and Techniques in the computation of Player-Adaptive Games. *Journal of Physics: Conference Series*, 1427(1):012006, January 2020. Publisher: IOP Publishing.
- [15] Tanvi Rath and N Preethi. Application of AI in Video Games to Improve Game Building. In *2021 10th IEEE International Conference on Communication Systems and Network Technologies (CSNT)*, pages 821–824, June 2021. ISSN: 2329-7182.

- [16] Firas Safadi, Raphael Fonteneau, and Damien Ernst. Artificial intelligence in video games: towards a unified framework. *International Journal of Computer Games Technology*, 2015:5:5, January 2015.
- [17] Geoff Skinner and Toby Walmsley. Artificial Intelligence and Deep Learning in Video Games A Brief Review. In *2019 IEEE 4th International Conference on Computer and Communication Systems (ICCCS)*, pages 404–408, February 2019.
- [18] Pierre Le Pelletier de Woillemont, Rémi Labory, and Vincent Corruble. Automated Play-Testing through RL Based Human-Like Play-Styles Generation. *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment*, 18(1):146–154, October 2022. Number: 1.
- [19] Sayid Adli Yakan. Analysis of Development of Artificial Intelligence in the Game Industry. *International Journal of Cyber and IT Service Management*, 2(2):111–116, May 2022.
- [20] Imants Zarembo. ANALYSIS OF ARTIFICIAL INTELLIGENCE APPLICATIONS FOR AUTOMATED TESTING OF VIDEO GAMES. *ENVIRONMENT. TECHNOLOGIES. RESOURCES. Proceedings of the International Scientific and Practical Conference*, 2(0):170–174, June 2019. Number: 0.