ARTIFICIAL NEURAL CONTROLLER SYNTHESIS FOR TORCS

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ABSTRACT

With the development of science and technology, computer games, video games and mobile games as an entertainment are becoming more popular in our society. Although all of the digital games offer excellent graphics, the quality of gameplays is still a weak point of many games, particularly off-line games. There are few crucial issues that could improve off-line gameplay. Storyline, level of difficulty, rewards, reinforcement used, gaming strategy, and the inclusion of None-Player Character (NPC). NPC is an important factor in a game. Player can easily complete the game if the NPC used is too easy to be defeated. In other way, player may uninstall the game if they found the game is not beatable after spending few days on the game. As such, there are many Artificial Intelligence (AI) techniques have been introduced and included in different games genres in order to generate better and attractive NPC. Those NPCs may consist of human player characteristics and behaviors in handling the game. Generating car racing game NPC is crucial as there are complex problems found in car racing game. Many factors can influence the controller's behavior such as varying road conditions, damage control and unexpected behaviors of opponents. The inclusion of AI technique could generate better car racing game NPC and it is also beneficial to autonomous mobile car manufacturing as the generated controllers could be transferred to real car for auto piloting. In this research, a free open source 3D-based simulator named The Open Racing Car Simulator (TORCS) is chosen as the research platform. The main motivation of this research is to investigate whether hybrid Differential Evolution (DE) and Feed-forward Neural Network (FFNN) as well as hybrid Pareto-based Differential Evolution (PDE) and FFNN could generate better controllers that could replace normal NPC used in the car racing games. The focuses of the experiments involved four main research objectives: (1) to test the feasibility of the hybrid DE and FFNN in TORCS; (2) to obtain a suitable fitness function for evolving autonomous car controllers; (3) to reduce the time taken in the optimization processes and improve the efficiency of controllers' driving behaviors by minimizing the number of sensors used; and (4) to determine which combination of multi-objective functions is most suitable for evolving the required autonomous car controllers. The results showed: (1) DE hybrid FFNN could generate optimal controllers, (2) the proposed fitness function had successfully generated the required car's racing controllers, (3) the proposed minimization algorithm had been successfully minimize the number of RF sensors used, (4) the PDE algorithm could be implemented to generate optimal solutions for car racing controllers, and (5) the combination of components for average car speed and distance between the car and track axis is very important compared to other components. As a conclusion, this research has shown that the DE hybrid FFNN algorithm and PDE hybrid FFNN algorithm are useful and promising in evolving autonomous car racing controller.